ISOLATION AND BIOCHEMICAL CHARACTERIZATION OF AN AMYLASE PRODUCING THERMOPHILIC BACTERIUM FROM GARDEN SOIL

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Abstract: A thermophilic bacterium (strain Th-3), which was able to degrade starch maximally, was isolated from the soil of Delhi University Botanical Garden. The temperature and pH optima and incubation time for the maximum growth of isolated bacterium were found to be 45°C, pH 6.0 and 24 h, respectively. In addition to amylase production, the bacterium had also shown positive results for production of protease, lipase and catalase as well as for nitrate reduction. Th-3 exhibited maximum amylolytic activity, when assayed at 45°C at pH 6.5 in the culture harvested at 24 hours of growth. The bacterium was non-pathogenic, as tested on Himedia sheep blood agar plates. The strain was sensitive to most of the antibiotics tested, except ampicillin and kanamycin to which it had shown resistance. The biochemical, microscopic and morphological features of the isolated strain indicated that it was Gram-positive, rod-shaped and closely resembled *Bacillus* species.

Keywords: Amylase, Amylolytic activity, Starch degrading enzyme, Thermophilic amylase, Thermophilic bacterium

INTRODUCTION

The starch degrading enzyme (amylase) is among the most important enzymes widely used in industries and commercial sectors. Microbial amylases are more stable, economical and easily available. Amylases are the enzymes that catalyse the breakdown of starch into sugars by breaking polysaccharides bonds (Gupta *et al*., 2003). Isolation of amylases can be done from a number of sources, such as plants, animals and microbes, though microbial amylases are most preferred and used in industry (Dey and Banerjee, 2012). The major advantages of using microorganisms for the production of amylases are their ability to produce them in bulk and ease at which they can be manipulated for desired products (Roses and Guerra, 2009). Amylases can be divided in to three groups, i.e., α-amylases, β-amylases and glucoamylases. α-Amylases [endo-1,4-α-D-glucan glucohydrolase, EC 3.2.1.1] are extracellular amylases. These are endoacting enzymes that cleave 1, 4-α-D-glucosidic linkages between adjacent glucose units in the linear amylase chain. β-amylases [α-1, 4-glucan maltohydrolase, EC 3.2.1.2] are exoacting enzymes that cleave non-reducing chain ends of amylose, amylopectin and glycogen molecules. Glucoamylases [exo-1, 4-α-D-glucan glucohydrolase, EC 3.2.1.3] are able to hydrolyze 1, 6- α-linkages at the branching points of amylopectin (Pandey *et al.*, 2000). The history of industrially produced amylase from fungal source began in 1894, which was used for the treatment of digestive disorder (Swargiari and Baruah, 2013). Today, amylase has great significance in present day biotechnology with its applications, ranging from textile, paper, food, fermentation and pharmaceutical industry (Vijayaraghavan *et al*., 2011). The role of amylases has also been acknowledged in clinical, medical and analytical chemistry. The aim of the present study was to isolate and characterize a starch degrading bacterium from soil sample collected from Botanical Garden, University of Delhi, India. Present study is focussed on the standardization of production and assay optima of amylase with respect to temperature, pH and incubation period of growth.

MATERIAL AND METHOD

Collection of Sample and Isolation of Bacterial Strain

One gram of garden soil sample collected from Botanical Garden, Department of Botany, University of Delhi, Delhi, India was dried and suspended in Erlenmeyer flasks containing 50 ml of enrichment medium for selective growth of the starch degrading (amylase producing) bacteria.

Preparation of Enrichment Media

In brief, 100 ml enrichment media was prepared by 2 g of starch (sole source of carbon), 0.5 g of ammonium sulphate, 0.5 g of di-potassium-hydrogen phosphate, 0.1 g magnesium sulphate, and 0.5 g calcium chloride in 100 ml of distilled water. The media was sterilized in an autoclave and then 1 g of dried soil sample was suspended in it for selective growth of starch utilizing bacteria. The flask was kept at 45°C at 250 rpm for 24 h in rotary shaker.

Isolation of Strains and Maintenance of Pure Culture

The enriched culture was serially diluted from 10^{-1} to 10^{-6} and was spread plated on Nutrient Agar media that contained (g/L): 1 g beef extract, 5 g peptone, 5 g sodium chloride, 2 g yeast extract, 15 g agar. Five strains that grew optimally at 45°C were selected (Th-1, Th-2, Th-3, Th-4 and Th-5) and their pure cultures were prepared and maintained.

Tests for Amylolytic Activity
Plates with bacterial colonies were flooded with Lugol's Iodine solution (2 g potassium iodine and 1 g iodine crystal dissolved in 300 ml distilled water, filtered and stored in brown bottle) and observed for clear and transparent zone of degradation of starch under and around colonies. Of the various colonies, the one that exhibited highest degradation was selected for biochemical and other physico-chemical characterization.

Identification of the Selected Microbial Strain
Isolated strain was identified by morphological, biochemical and physiological analysis. Colonial characteristics and microscopic observations were also done.

Pathogenicity Test
Pathogenicity test was performed, using Himedia sheep blood agar plates. Sterile sheep blood agar plate was streaked with 24 hours old bacterial culture. It was incubated at 45°C for 24 hours in an incubator for the detection of fastidious organism. The blood culture pattern of the selected bacterial strain was checked for gamma-hemolysis.

Biochemical Characterization
The biochemical tests were performed for carbohydrate utilization (using Hi-Carbohydrate Utilization Test Kit), motility, Gram staining, urea hydrolysis, nitrate reduction and hydrogen sulphide production.

Production of Hydrolytic Enzymes
Screening of the selected bacterial strain was done to check the production of other hydrolytic enzymes such as protease, lipase, xylanase, catalase and oxidase.

Antibiotic Susceptible Test
Antibiotic susceptibility test was done to determine the sensitivity or resistance of the bacterial strain as per procedure adopted for aerobic and facultative anaerobic bacteria to various antimicrobial compounds (Bauer *et al.*, 1966), using Himedia antibiotic discs. Bacterial culture was grown overnight in nutrient broth at 45ºC and 250 rpm in a rotary shaker. The freshly grown culture was spread on nutrient agar plates and the antibiotic discs were mounted on the surface of the plates carefully. Plates were then incubated overnight at 45ºC and the inhibition zones were measured using Hi antibiotic zone scale^{TM}-c (Table 3). On the basis of inhibition zone, bacteria have been characterized as antibiotic resistant (less than 15 mm of zone), antibiotic intermediate (16-20 mm) and susceptible (21 mm or greater) (Ammor *et al.*, 2007).

Optimization of Growth Conditions With Respect to Temperature, pH and Incubation Period
Optimizations of various parameters, such as temperature, pH and incubation period, are necessary for the maximum production of amylase. The growth of the organism was observed at different ranges of temperature (30°C- 55°C), pH (5-9) and incubation period (8-72 h).

Amylase Production
The nutrient medium containing starch was inoculated with bacterial colony and was cultured for 24 h at 45ºC at 250 rpm in rotary shaker. From this, inoculum (1% v/v) was transferred to amylase production medium (sucrose- 15g/l, peptone- 15g/l, NH_4Cl- 25g/l, $MgSO_4$- 0.7g/l, K_2HPO_4- 2g/l, starch- 2g/l) and was incubated again for 24 h at 45ºC at 250 rpm.

Isolation of Enzyme
In order to obtain crude enzyme, 24 h old culture grown in amylase production medium was transferred to centrifuge tubes and centrifuged at 12,000 rpm for 15 min. The resultant supernatant was used as the crude enzyme extract.

Amylase Assay
The enzyme activity was assayed following the method of Bernfeld (1955) using 3, 5 – dinitrosalicylic acid (DNS). In this reaction 2 ml of 1% (w/v) soluble starch was prepared in 50 mM phosphate buffer and was incubated at 45°C for 15 min with 0.2 ml of diluted enzyme solution. To this, 4 ml of DNS solution was added to stop the reaction, which was further followed by heating in water bath for 5 min. After the contents were cooled at room temperature, absorbance was measured at 540 nm, using UV-visible spectrophotometer. Standard curve of maltose was constructed that helped in estimating concentration of reducing sugars present in our sample. The enzyme activity was expressed as Units/ml.

Effect of Different Incubation Periods
The experiment was carried out individually at varying incubation periods (i.e., 8, 12, 24, 48 and 72 h) at 45°C at 250 rpm in a rotary shaker and was then analysed for amylase activity. The absorbance was measured at 540 nm with UV-visible spectrophotometer.

Effect of Temperature on Production of Amylase
To study the effect of temperature on amylase activity, the assay was carried out at different temperatures in the range of 30, 35, 40, 45, 50, 55 ºC for 24 h at 250 rpm in a rotary shaker. Amylase activity was then calculated using standard procedure.

Effect of pH on Production of Amylase
The effect of pH for amylase production was studied by culturing the bacterium at different pH of the production medium (in the range of pH 5, 5.5, 6, 6.5, 7, 7.5 and pH 8) for 24 h. The spectrophotometric analysis was done at 540 nm and amylase activity was calculated using standard procedure.

Statistical Analysis
Each experiment was conducted in triplicate. Standard Deviation (± SD) was calculated and represented in the form of line bars in the figures.

RESULT

Test for Amylolytic Activity
Initially, the soil sample, when plated on nutrient agar media, revealed the presence of 5 bacterial strains that grew at 45ºC. When tested with lugol's iodine solution, although all the strains exhibited clear zones, strain Th-3 had shown maximum clear zone under and around the colony, exhibiting its amylolytic nature (Fig: 1). Therefore, strain Th-3 was selected for further studies and its pure culture was maintained.

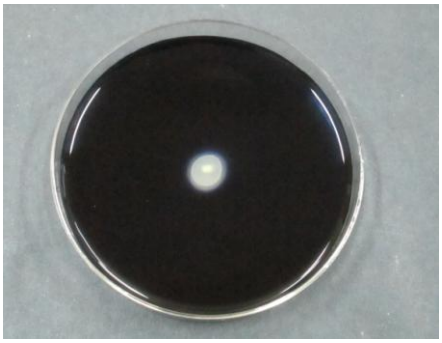


Fig 1. Qualitative screening of culture of Th-3 for the production of extracellular amylase. The zone clearence under and around the colony at the centre of the Petriplate represents amylolytic activity

Morphological and Microscopic Features
Morphologically, Th-3 colonies were translucent and creamy white in color. All the colonies were with entire regular margin. Gram staining and microscopic observation revealed that the bacterium was Gram +ve and rod-shaped.

Pathogenicity Test
While performing pathogenicity test on Himedia sheep blood agar plates, it was observed that the strain Th-3 was non-pathogenic, as agar under and around the colony was unchanged (this is also called non-hemolysis) (Fig: 2).

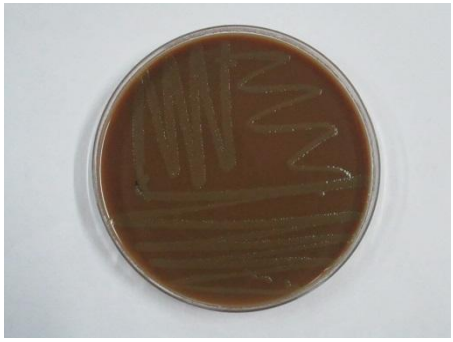


Fig 2. Pathogenicity test of the culture of Th-3 exhibiting non-hemolysis, representing its non-pathogenic nature

Carbohydrate Utilization Test
The carbohydrate utilization test was performed by incubating bacterial isolate Th-3 with different carboohydrates (Table 1). The observations indicated that there was differential utilization of carbohydrate sources by this bacterium.

Table 1: Utilization of carbohydrates by the bacterial strain Th-3

S.No	Carbon Source	Bacterial Strain Th-3
1	Lactose	Positive
2	Xylose	Positive
3	Maltose	Positive
4	Fructose	Positive

5	Dextrose	Positive
6	Galactose	Negative
7	Raffinose	Positive
8	Trehalose	Positive
9	Melibiose	Positive
10	Sucrose	Positive
11	L-Arabinose	Positive
12	Mannose	Negative
13	Inulin	Negative
14	Sodium Gluconate	Negative
15	Glycerol	Negative
16	Salicin	Negative
17	Dulcitol	Positive
18	Incsitol	Negative
19	Sorvitol	Negative
20	Mannitol	Negative
21	Adonitol	Positive
22	Arabitol	Positive
23	Erythritol	Negative
24	α-Methyl-D-glucoside	Positive
25	Rhamnose	Negative
26	Sellobiose	Negative
27	Melezitose	Negative
28	α-Methyl-D-mannoside	Positive
29	Xylitol	Negative
30	ONPG	Negative
31	Esculin Hydrolysis	Positive
32	D-Arabinose	Negative
33	Citrate utilazation	Negative
34	Malonate utilazation	Positive
35	Sorbose	Negative

Biochemical Characterization and Production of Hydrolytic Enzymes

Strain Th-3 was characterized with respect to the biochemical parameters given in Table 2. Among the hydrolytic enzymes, this strain was screened positive for protease, lipase and catalase. The bacterium was motile and was found to be positive for nitrate reduction.

Table 2: Different biochemical tests performed on bacterial isolate Th-3

S.No	**Biochemical Test**	**Result**
1	Protease activity test	Positive
2	Lipase activity test	Positive
3	Xylanase activity test	Negative
4	Catalase activity test	Positive
5	Oxidase activity test	Negative
6	Motility test	Motile
7	Gram staining	Gram +ve
8	Urea hydrolysis	Negative
9	Nitrate reduction test	Positive
10	Hydrogen sulphide production test	Negative

Antibiotic Susceptibility Test

The susceptibility of bacterial strain Th-3 was studied against different antibiotics listed in Table 3. The strain was sensitive to most of the antibiotics tested, except ampicillin and kanamycin to which it had shown resistance.

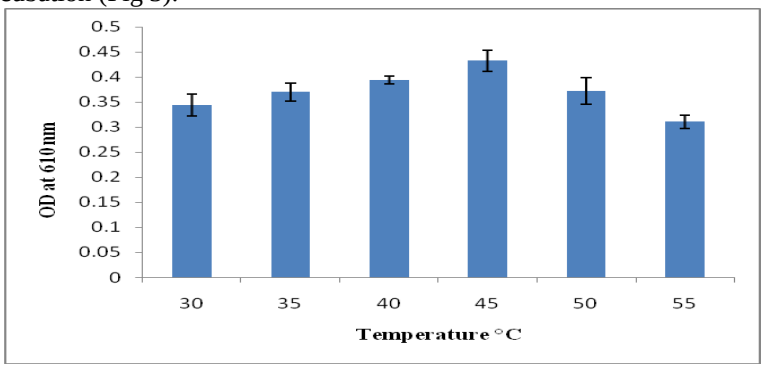
Table 3: Sensitivity/resistance of the bacterial strain Th- 3 to different antibiotics

Antibiotic Discs	**Symbols**	**Concenteration**	**Diameter of zone of inhibiton (mm)**
Amikacin	AK	30mcg/disc	17 (sensitive)
Ampicillin	AMP	10mcg/disc	Resistant

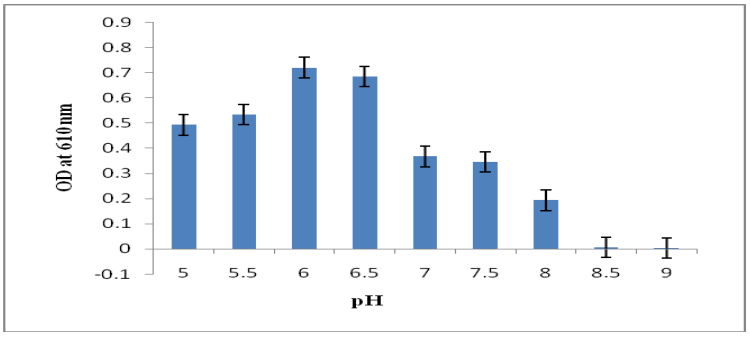
Carbenicillin	CB	100mcg/disc	18 (sensitive)
Cefaclor	CF	30mcg/disc	15 (sensitive)
Cefazolin	CZ	30mcg/disc	23 (sensitive)
Cefotaxime	CTX	30mcg/disc	19 (sensitive)
Ceftazidime	CAZ	30mcg/disc	18 (sensitive)
Ceftriaxone	CTR	30mcg/disc	21 (sensitive)
Chloramphenicol	C	30mcg/disc	16 (sensitive)
Ciprofloxacin	CIP	5mcg/disc	18 (sensitive)
Erythromycin	E	10mcg/disc	15 (sensitive)
Gentamicin	GEN	10mcg/disc	22 (sensitive)
Kanamycin	K	5mcg/disc	Resistant
Norfloxacin	NX	10mcg/disc	25 (sensitive)
Ofloxacin	OF	5mcg/disc	16 (sensitive)
Penicillin-G	P	2 units/disc	19 (sensitive)
Rifampicin	RIF	30mcg/disc	21 (sensitive)
Streptomycin	S	10mcg/disc	17 (sensitive)
Tetracycline	TE	10mcg/disc	18 (sensitive)

Optimization of Growth Conditions

On standardization of growth conditions, it was observed that the best growth of Th-3 occured at 45°C, at pH 6 and at 24 hours of incubation (Fig 3).



A



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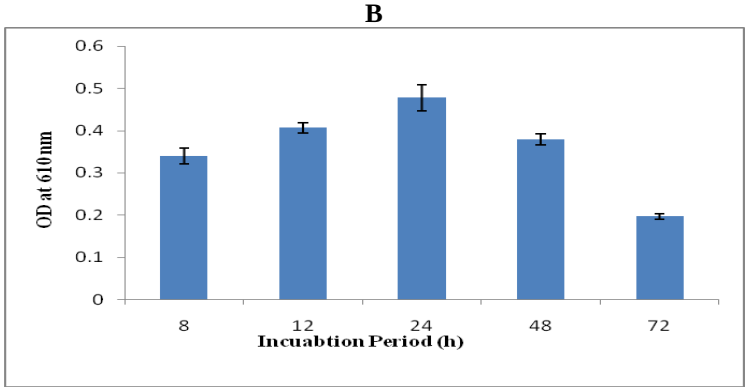
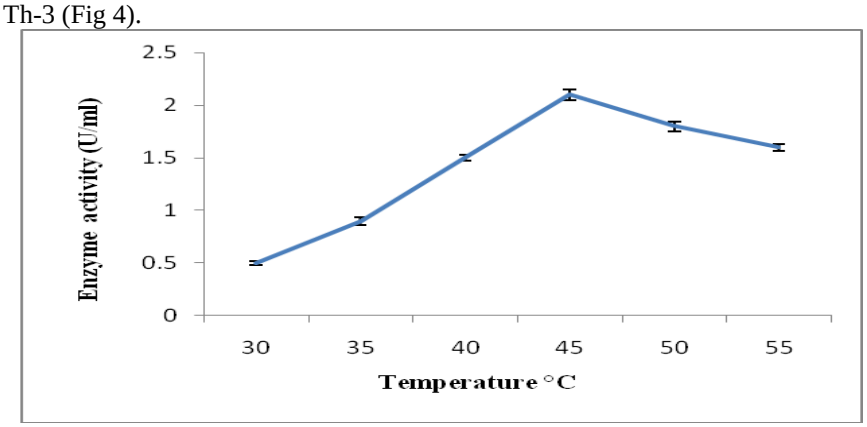


C

Fig 3. Optimization of growth conditions of the isolated bacterial strain Th-3 at different temperatures (A), pH (B) and incubation period of growth (C)

Effect of Temperature, pH and Incubation Period on Amylase Activity

When assays for amylase activities were performed at different temperatures, pH and incubation period, it was found that the activity of this enzyme was maximum at 45°C, at pH 6.5 and at 24 hours of growth of the bacterial strain Th-3 (Fig 4).



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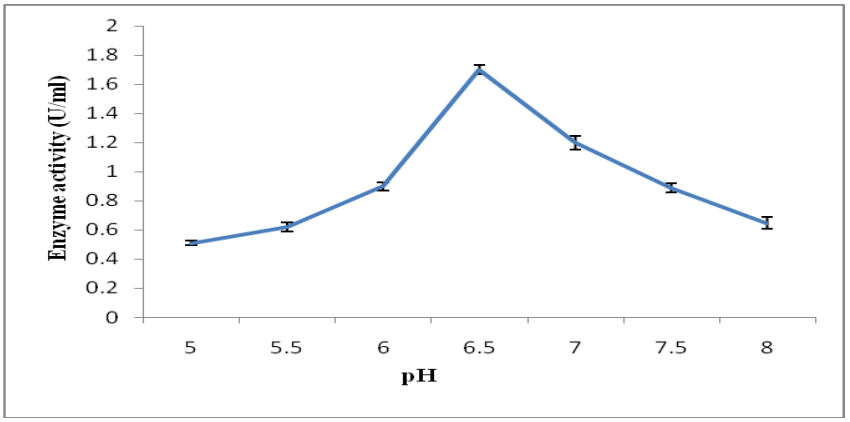

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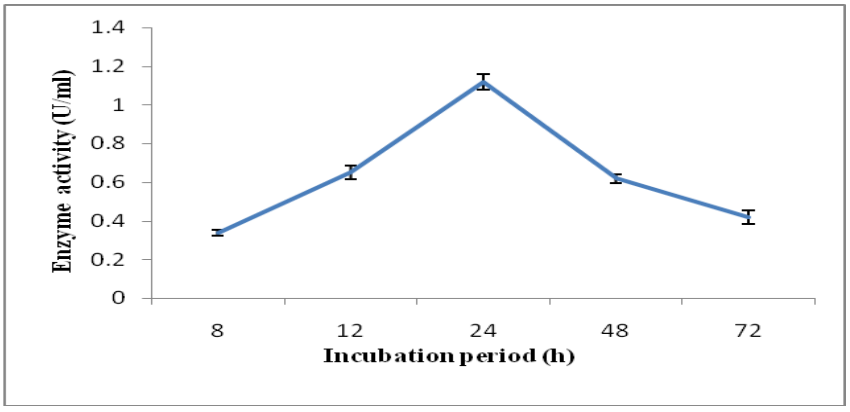

C

Fig 4. Amylase activity, assyed at different temperatures (A), pH (B) and incubation period of growth (C) of the isolated bacterial strain Th-3

DISCUSSION

The genus *Bacillus* produces a large variety of extracellular enzymes, of which amylases are of considerable industrial importance (Swain *et al.*, 2006). In addition to amylase production, the isolated bacterial strain Th-3 had also shown positive results for production of protease, lipase and catalase as well as nitrate reduction, which were in accordance with the observations made by other authors (Deb *et al.*, 2013). Optimization of growth conditions are the prime step in using microorganisms for the production of enzymes (Kathiresan and Manivannan, 2006). In this context, temperature is a vital factor that controls the synthesis of bacterial extracellular enzymes. Bacterial amylases are produced at a much wider range of temperature. *Bacillus subtilis*, *B. licheniformis* and *B. stearothermophilus* are among the most commonly used *Bacillus* spp. reported to produce α-amylase within the temperature range of

37–60°C (Mendu *et al.*, 2005). In the present study, we observed that the optimum temperature for maximum growth of the bacterium and amylase production was 45°C, suggesting its thermophilic nature. The higher temperature (50°C and above) inhibited its growth and amylase activity. Aiba et al. (1983) also reported that the high temperature may inactivate expression of gene(s) responsible for amylase synthesis. pH of the growth medium is also among the important physical parameter that has to be optimized for the enzyme secretion. The pH range observed during the growth of microbes also affects enzyme production in the medium (Banargee and Bhattacharya, 1992). Most of the amylase secreting bacterial strains revealed pH range between 6 and 7 for the best growth of the organism and enzyme specific activity (Bose and Das, 1996; Mishra and Behera, 2008). Similarly, under this catagory the optimum pH for maximal growth of Th-3 was 6, and optimum pH for its maximum amylase activity was 6.5. In another study, the activity of enzyme was also observed at slighly alkaline pH (at around pH 9) (Deb *et al*., 2013).

It has already been reported that the enzyme activity is directly dependent on the period of incubation of bacterial strain in the culture medium (Smitt *et al*., 1996; Mishra and Behera, 2008). Some reports signify that with the increase in incubation time, enzyme activity decreased (Aiyer, 2004). In the present investigation, both growth as well as amylase activity increased with increasing period of incubation up to 24 h, followed by their decrease at further increase in the period of incubation. This suggested that the enzyme production in the isolated bacterial strain Th-3 is a growth associated phenomenon. In some studies, maximum activity of amylase was reported at 12 h in *Bacillus* species (Bozic *et al.*, 2011); nevertheless, more often amylase cannot be detected in the culture broth of *Bacillus* sp. before 12 h of incubation (Asgher *et al.*, 2007). In *B. stearothermophilus* AN 002 maximum activity occurred at 6 h of cultivation. Among all the antibiotics screened for, strain Th-3 was resistant to ampicillin and kanamycin. The results were similar to those reported by Samanta et al. (2012) for bacterial strain *Bacillus* sp. isolated from municipal waste. The isolated bacterium was non-pathogenic in nature, as tested on Himedia sheep blood agar plates. The biochemical, microscopic and morphological features of the isolated strain indicated that it was Gram-positive, rod-shaped and closely resembled *Bacillus* species. Thus, the non-pathogenicity of the starch degrading Th-3 and its sensitivity to most of the antibiotics suggested the possibility of exploiting this thermophilic bacterium for commercial production of amylase for diverse industrial applications.

CONCLUSION

Amylases are important enzymes used for industrial purposes and biotechnological research. Though amylases can be produced from various sources and are prevalent in industries from many decades, the microbial sources have shown significant role in their commercial production. It is also important to note that the commercial production of amylase from microbes is limited to few selected strains of fungi and bacteria. Therefore, it was necessary to isolate efficient microbial strains that can produce high titres of enzyme that can actively work on starch. For industrial applications, high temperature catalysis of enzyme is an extremely important feature; therefore, an attempt was made to look for production of amylase from a thermophilic bacterium. Protein engineering or chemical modification of the existing enzyme is also necessary to make this enzyme efficient in various other industrial sectors apart from food, textile, paper and pharmaceutical industry. The present investigation highlights the importance of a bacterial soil isolate which was non-pathogenic Gram-positive rod and which could grow at high temperature and produce thermophilic extracellular amylase, suggesting its applicability for high temperature catalysis of diverse industrial processes.

ACKNOWLEDGEMENT

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STANDING TREE BIOMASS AND CARBON CONTENT IN NATURAL FORESTS OF KUMAUN IN CENTRAL HIMALAYA

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Abstract: Forest is one of the major carbon sinks which mitigates climate change problems, if deforested, they become a major source for atmospheric carbon and influence the climate from local to global level. Therefore forest must be conserved and managed in a scientific way as well as in collaboration with community residing close to the forests, because forests are depleting very fast from such sites. It is therefore prerequisite and very urgent for scientific community to save the existing forests wherever they occur. Keeping in view, we investigated the certain aspects i.e. biomass and carbon of forests located in Lohaghat, a remote border area of Kumaun in Uttarakhand. In studied forest sites, tree species richness, density and basal area ranged from 02-05, 920-1345 individual ha^{-1} and 58.7-93.0m^2ha^{-1} respectively. Tree biomass of forests ranged from 495 to 718 t ha^{-1}. Of this, *Quercus leucotrichophora* and *Pinus roxburghii* accounted for 56-79 and 1-76 percent, respectively, however, rest of species accounted for 1-25 percent. Tree carbon content in forests ranged from 229 to 341tha^{-1}. Of this, *Quercus leucotrichophora* and *Pinus roxburghii* shared 193-244 and 04-168 t ha^{-1}. Our estimates of biomass and carbon are on higher side than earlier estimates reported by several workers for natural forests and fast growing plantations in plain area of the region. Thus it is concluded that high potential of biomass and carbon contents of studied forests must be conserved, otherwise any deforestation and degradation activities would release the already stored carbon into the atmosphere, therefore it requires a more appropriate way so that they could not further degraded from such existing forests and also promotes for new regeneration to maintain the future sustainability. Such scientific inputs not only save the high carbon potential of forests but also continuously will sequester the atmospheric carbon through enhancing tree productivity. Further it is to say that climate change is also a cause of land use changes and practices, thus we have to be very careful about forest conservation and carbon management that would sorted out the present growing climate change problems apart from various other tangible and non-tangible benefits.

Keywords: Tree species, basal area, biomass, carbon content, natural forest site, central Himalaya

INTRODUCTION

Forest are very complex ecosystem which guided and influenced by variety of factors such as available conditions, their use, demand and supply as well as socio-economic and ecological considerations. Though the forests are an important component of biosphere and play significant role in the development of State and Country. The conservation, management and use of forest resources have a long history and their rational use implies that these are managed in such a manner so as to yield greatest sustainable benefits to the present generation through maintaining its potential to meet the needs of future generations. The benefits from forests and biodiversity could be sustained only if the essential ecological processes which govern its functioning are maintained that depends on the understanding of the rules related to the fundamental ecological variables (Lodhiyal, 2011). Recent climate change scenario alarmed the human society particularly the scientific community for combating the challenges. Forests recognized as one of the major sink in mitigating the climate change problems and or may be the source of atmospheric carbon if they degraded and deforested. Therefore must be conserved and managed in an integrated way which needs the scientific cum participatory approach of management whereas the growing anthropogenic pressure is existed. It is therefore prerequisite and very urgent to save the remaining forests of the region, state and country. Keeping in view, we studied the forests which were located in a remote border area of Lohaghat in Kumaun of Uttarakhand in the context of biomass and carbon perspectives. Biomass is the total mass of living matter with a given unit of environmental area and the carbon potential is the efficiency of particular species that contain and sequester carbon depending on how much biomass is stored in different parts of forest trees. Carbon percent in dry weight vary from 45 to 50 percent depending on the plant species and its locality where they are growing. Magnussen and Reed (2004) developed a factor for the estimation of carbon from biomass (dry weight). Carbon in the form of carbon dioxide is accumulating in the atmosphere at a rate of about 3.5 billion metric tons per annum as a result of fossil fuel combustion, tropical deforestation and forest fuel combustion (Jina et al., 2008). Carbon sequestration can be defined as the removal of CO2 from atmosphere (source) into green plants (sink) where it can be stored indefinitely (Watson et al., 2000). However, a few studies on biomass estimation were carried out in central Himalayan forests (Chaturvedi and Singh, 1987; Rawat and Singh, 1988; Rana et al., 1989; Lodhiyal et al., 2002; Lodhiyal and Lodhiyal, 2003; Lodhiyal and Lodhiyal, 2012) and poplar plantations (Lodhiyal et al., 1995; Lodhiyal and Lodhiyal, 1997; Singh and Lodhiyal, 2009). However, carbon potentials in oak and pine forests of Kumaun region were also studied by Lodhiyal and Lodhiyal (2012). The objective of present study forests was: To

estimate biomass and carbon content in each studied forest.

MATERIAL AND METHOD

The forest sites lie between 29°24'N lat. and 79º28'E long situated at 1700-2000m elevation in Lohaghat of Champawat district. The tree analysis was done by using 10 x10m size quadrat placed randomly in each Banj Oak and Pine dominated forests (Misra, 1968; Saxena and Singh, 1982; Singh and Singh, 1992). The circumference of each tree species was measured at breast height i.e. at 1.37 m from the ground level. For the estimation of tree biomass, we used the allometric equations developed by Chaturvedi and Singh (1987) for pine forests and Rawat and Singh (1988) for oak forests. The total biomass was determined by summing up the respective component values of each tree species occurred in each forest.

The regression equation was used in the form of: ln y = a + b ln x,

Where y= dry weight of component (kg), x= GBH (cm), a= intercept, b= slope or regression coefficient and ln= log natural

The carbon stock was determined using the biomass value of species multiplied by factor as given by Magnussen and Reed (2004) which is as follows: C = 0.475 x B

Where C = is the carbon content and B is the Oven dry biomass.

RESULT

Tree density and basal area

A total seven tree species i.e. *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.- Ham. ex D. Don, *Cedrus deodara* (Roxb) G. Don, *Pinus roxburghii* Sarg., *Prunus cerasoides* D. Don, *Acacia mearnsii* De Wild. and *Rhododendron arboreum* Smith were reported in all the studied forest sites. The tree density values are given in the Table1 these density values were also published in earlier issue of journal of plant development science (Lodhiyal et al., 2013). Total basal area of Banj oak forest ranged 58.66- 70.14m^2ha^{-1} and chir- pine forest was100 m^2ha^{-1}. Density and basal area of *Quercus leucotrichophora* ranged 720-925 trees $ha^{-1}$and 31.39- 39.87 m^2ha^{-1} in Banj oak forest. Density and basal area of *P. roxburghii* was 720 trees $ha^{-1}$and 64.41 m^2ha^{-1} in chir- pine forest. The density was ranged from 125-200 of *C. deodara* and 25-720 of *P. roxburghii* individual ha^{-1} in site 4. On the basis of density and basal area *Q. leucotrichophora* was dominant species in site 1, 2 and 3 and *P. roxburghii* was dominant species in site 4. *Q. leucotrichophora* has shared 44-65% basal cover at site-1 to 3 and *P. roxburghii* shared 72% basal cover at site-4 (Table1).

Table 1. Comparative study of density, basal area and IVI of forests in each site (values in parentheses are the percent contribution).

Tree species	Density (individual ha^{-1})				Basal area(m^2/ha)			
	Site 1	Site-2	Site-3	Site-4	Site-1	Site-2	Site-3	Site-4
Q. leucotrichophora	910	925	720	-	38.49(65.6)	39.87(63.4)	31.39(44.8)	-
M. esculenta	155	185	225	-	3.19 (5.4)	3.63 (5.8)	11.25(16.0)	-
C. deodara	125	185	-	200	12.20(20.8)	14.48(23.0)	-	28.6 (30.8)
P. roxburghii	50	25	260	720	4.09(7.0)	1.54 (2.5)	26.0 (37.1)	64.4(69.2)
R. arboreum	25	-	-	-	0.75(1.2)	-	-	-
P. cerasoides	-	-	30	-	-	-	1.5(2.1)	-
A. mearnsii	-	25	-	-	-	3.33(5.3)	-	-
Total	1265	1345	1235	920	58.66 (100)	62.85 (100)	70.14 (100)	93.00(100)

Biomass estimates

Present estimate of forest tree biomass was 650.9tha^{-1} in the studied site-1. Of this, aboveground and belowground biomass accounted for 72 and 28 percent respectively (Table 2). Of the total biomass, *Q. leucotrichophora* contributed 513.61 tha^{-1} followed by *M. esculenta* 64.4 tha^{-1} while minimum 3.95 tha^{-1} shared by *R. arboreum*. As per component wise biomass is concerned, bole component contributed 38.1% in the aboveground biomass while stump root contributed 20.2% biomass in belowground part (Table 2).

Table 2. Component wise biomass (tha^{-1}) in each tree species in forest site-1(values in parentheses are the percent contribution).

Species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total (tha^{-1})
Q. leucotrichophora	189.37 (36.9)	117.88 (22.9)	45.05 (8.8)	20.21 (3.9)	372.5 (72.5)	117.18 (22.8)	21.82 (4.3)	2.10 (0.4)	141.1 (27.5)	513.61 (100)
M. esculenta	17.61 (27.4)	11.48 (17.8)	5.30 (8.2)	2.73 (4.2)	37.12 (57.6)	5.82 (9.0)	0.75 (1.2)	20.71 (32.2)	27.71 (42.4)	64.4 (100)
C. deodara	26.59 (55.6)	6.36 (13.4)	2.41 (5.0)	1.68 (3.6)	37.04 (77.6)	4.86 (10.3)	2.06 (4.4)	3.75 (7.7)	10.67 (22.4)	47.71 (100)
P. roxburghii	13.28 (62.6)	3.35 (15.8)	0.06 (0.3)	0.63 (2.9)	17.32 (81.6)	2.98 (14.0)	0.84 (4.0)	0.08 (0.4)	3.9 (18.4)	21.22 (100)
R. arboreum	1.39 (35.2)	0.93 (23.5)	0.37 (9.4)	0.17 (4.3)	2.86 (72.4)	0.79 (20.0)	0.25 (6.3)	0.05 (1.3)	1.09 (27.6)	3.95 (100)
Total	248.24 (38.1)	140 (21.5)	53.19 (8.2)	25.42 (3.9)	466.85 (71.7)	131.63 (20.2)	25.72 (3.9)	26.69 (4.2)	184.47 (28.3)	650.89 (100)

Note: TAG= Total above ground, TBG= Total below ground

Total biomass was 677.94 tha^{-1} in the studied forest site-2. Of this, aboveground and belowground biomass accounted for 73 and 27 percent respectively (Table 3). Of the total biomass, *Q. leucotrichophora* contributed 512.06 tha^{-1} followed by *M. esculenta* 75.17 tha^{-1}. In this site, *P. roxburghii* contributed minimum biomass 7.34 tha^{-1}. However, the component wise biomass, the bole component shared 38.6% in aboveground biomass while stump root shared 20.2% biomass in belowground biomass (Table 3).

Table 3. Component wise biomass (tha^{-1}) in each tree species in forest site-2(values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total
Q. leucotrichophora	195.20 (38.1)	121.39 (23.8)	46.20 (9.0)	21.03 (4.1)	383.82 (75)	120.19 (23.5)	5.91 (1.1)	2.14 (0.4)	128.24 (25)	512.06 (100)
M. esculenta	20.17 (26.8)	13.19 (17.5)	6.14 (8.2)	3.16 (4.2)	42.66 (56.7)	6.76 (8.9)	0.86 (1.2)	24.89 (33.2)	32.51 (43.3)	75.17 (100)
C. deodara	31.27 (57.0)	8.27 (15.1)	3.36 (6.2)	2.35 (4.4)	45.25 (82.7)	6.31 (11.5)	2.84 (5.1)	0.36 (0.7)	9.51 (17.3)	54.76 (100)
P. roxburghii	4.59 (62.6)	1.12 (15.2)	0.02 (0.3)	0.24 (3.3)	5.97 (81.4)	1.05 (14.3)	0.29 (3.9)	0.03 (0.4)	1.37 (18.6)	7.34 (100)
A. mearnsii	10.73 (37.5)	6.39 (22.3)	2.23 (7.8)	1.13 (3.9)	20.48 (71.5)	2.28 (8.0)	0.30 (1.1)	5.55 (19.4)	8.13 (28.5)	28.61 (100)
Total	261.96 (38.6)	150.36 (22.2)	57.95 (8.5)	27.91 (4.1)	498.18 (73.4)	136.59 (20.2)	10.2 (1.5)	32.97 (4.9)	179.76 (26.6)	677.94 (100)

Note: TAG= Total above ground, TBG= Total below ground

Total biomass of tree species in forest site-3 was 718.5tha-1. Of this, aboveground and belowground biomass was 64 and 36 percent respectively. Of the total biomass, Q. leucotrichophora contributed 406.03tha-1 followed by M. esculenta 150.32tha-1 while P. cerasoides contributed minimum biomass 19.38 tha-1. However, in component wise biomass, the bole and stump root component shared maximum 40.9 and 17.7% in aboveground and belowground biomass respectively (Table 4).

Table 4. Component wise biomass (tha^{-1}) in each tree species in forest site-3 (values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig /cone	Foliage	TAG	Stump root	Latera l Root	Fine root	TBG	Total
Q. leucotrichophora	150.12 (36.9)	92.89 (22.9)	35.56 (8.8)	16.14 (3.9)	294.71 (72.5)	92.89 (22.9)	16.79 (4.2)	1.64 (0.4%	111.32 (27.5)	406.03 (100)
M. esculenta	48.34 (32.2)	30.21 (20.0)	12.16 (8.0)	6.22 (4.2)	96.93 (64.4)	12.91 (8.6)	1.69 (1.2)	38.79 (25.8)	53.39 (35.6)	150.32 (100)
P. roxburghii	89.38 (62.6)	23.28 (16.3)	0.33 (0.2)	3.94 (2.8)	116.93 (81.9)	19.74 (13.8)	5.60 (3.9)	0.50 (0.4)	25.84 (18.1)	142.77 (100)
P. cerasoides	6.19 (31.9)	3.87 (19.9)	1.57 (8.2)	0.80 (4.1)	12.43 (64.1)	1.67 (8.6)	0.21 (1.1)	5.07 (26.2)	6.95 (35.9)	19.38 (100)
Total	294.03 (40.9)	150.25 (20.9)	49.62 (6.9)	27.1 (3.8)	521 (72.5)	127.21 (17.7)	24.29 (3.4)	46.00 (6.4)	197.5 (27.5)	718.5 (100)

Note: TAG= Total above ground, TBG= Total below ground

The total biomass of tree species was 495.03 tha^{-1} in studied forest site-4. Of this, aboveground and belowground biomass share was 80 and 20 percent respectively. Of the total biomass *P. roxburghii* contributed 71.5% while *C. deodara* 28.5% (Table 5). However, the component wise biomass bole contributed maximum 57.4% in aboveground and Stump root contributed 14.9 % in belowground biomass (Table 5).the component wise biomass was in aboveground order: Bole 47.3-61.4> branch 15.5-25.7>twig 0.2-4.9>foliage 2.8-3.3 percent while in belowground component it was stump root 13.1-15.6>lateral root 3.9-4.4> fine root 0.4-1.3 percent (Table 5).

Table 5. Component wise biomass (tha^{-1}) in each tree species in forest site-4 (values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total
C. deodara	66.72 (47.3)	36.25 (25.7)	6.89 (4.9)	4.67 (3.3)	114.53 (81.2)	18.55 (13.1)	6.24 (4.4)	1.73 (1.3)	26.52 (18.8)	141.05 (100)
P. roxburghii	217.34 (61.4)	55.76 (15.7)	0.86 (0.2)	9.98 (2.8)	283.94 (80.1)	55.17 (15.6)	13.61 (3.9)	1.26 (0.4)	70.04 (19.9)	353.98 (100)
Total	284.06 (57.4)	92.01 (18.6)	7.75 (1.6)	14.65 (2.9)	398.47 (80.5)	73.72 (14.9)	19.85 (4.0)	2.99 (0.6)	96.56 (19.5)	495.03 (100)

Note: TAG= Total above ground, TBG= Total below ground

Carbon content estimates

Carbon content was 309.4 tha^{-1} in forest site-1. Of this aboveground and belowground accounted for 72 and 28 per cent respectively (Table 6). *Q. leucotrichophora* contributed highest carbon 243.94 tha^{-1} followed by *M. esculenta* 30.56 tha^{-1}. Among the components, bole and stump root contributed maximum 38.1 and 20.2% carbon in aboveground and belowground part respectively (Table 6). The carbon content in different tree species ranged from 57.6-77.6 and 22.4-42.4 % in above and belowground part, respectively. But among the studied tree species the *C. deodara* and *M. esculenta* contributed maximum (77.6%) and minimum (57.6%) carbon in above ground part while carbon contribution in belowground part showed its reverse trend respectively (Table 6).

Table 6. Component wise carbon content (tha^{-1}) in each tree species in forest site-1 (values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total (tha^{-1})
Q. leucotrichophora	89.95 (36.9)	55.99 (22.9)	21.39 (8.8)	9.60 (3.9)	176.93 (72.5)	55.66 (22.8)	10.36 (4.3)	0.99 (0.4)	67.01 (27.5)	243.94 (100)
M. esculenta	8.36 (27.4)	5.45 (17.8)	2.52 (8.2)	1.29 (4.2)	17.62 (57.6)	2.76 (9.0)	0.35 (1.2)	9.83 (32.2)	12.94 (42.4)	30.56 (100)
C. deodara	12.6 (55.6)	3.0 (13.4)	1.14 (5.0)	0.8 (3.6)	17.54 (77.6)	2.3 (10.3)	1.0 (4.4)	1.8 (7.7)	5.1 (22.4)	22.64 (100)
P. roxburghii	6.31 (62.6)	1.58 (15.8)	0.03 (0.3)	0.29 (2.9)	8.21 (81.6)	1.41 (14.0)	0.39 (4.0)	0.39 (0.4)	2.19 (18.4)	10.4 (100)
R. arboreum	0.66 (35.2)	0.44 (23.5)	0.17 (9.4)	0.08 (4.3)	1.35 (72.4)	0.37 (20.0)	0.12 (6.3)	0.02 (1.3)	0.51 (27.6)	1.86 (100)
Total	117.88 (38.1)	66.46 (21.5)	25.25 (8.2)	12.06 (3.9)	221.65 (71.7)	62.5 (20.2)	12.22 (3.9)	13.03 (4.2)	87.75 (28.3)	309.4 (100)

Note: TAG= Total above ground, TBG= Total below ground

Total carbon in the studied forest site-2 was 326.79 tha^{-1}. Of this aboveground and belowground accounted for 74 and 26 percent respectively (Table 7). *Q. leucotrichophora* contributed highest carbon 248.2 tha^{-1} followed by *M. esculenta* 35.56 tha^{-1}. Among the components, bole and stump root contributed maximum 39.6 and 19.8% carbon in aboveground and belowground part respectively (Table 7). The carbon content in different tree species ranged from 82.7-56.7 and 43.3-17.3 % in above and belowground part, respectively. But among the studied tree species the *C. deodara* and *M. esculenta* contributed maximum (82.7%) and minimum (56.7%) carbon in above ground part while carbon contribution in belowground part showed its reverse trend respectively (Table 7).

Table 7. Component wise carbon content (tha^{-1}) in each tree species in forest site-2(values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total
Q. leucotrichophora	97.72 (38.1)	57.66 (23.8)	21.94 (9.0)	9.98 (4.1)	187.3 (75)	57.08 (23.5)	2.80 (1.1)	1.02 (0.4)	60.9 (25)	248.2 (100)
M. esculenta	9.58 (26.8)	6.26 (17.5)	2.91 (8.2)	1.50 (4.2)	20.25 (56.7)	3.21 (8.9)	0.28 (1.2)	11.82 (33.2)	15.31 (43.3)	35.56 (100)
C. *deodara*	14.85 (57.0)	3.93 (15.1)	1.60 (6.2)	1.12 (4.4)	21.5 (82.7)	3.00 (11.5)	1.35 (5.1)	0.17 (0.7)	4.52 (17.3)	26.02 (100)
P. roxburghii	2.18 (62.6)	0.52 (15.2)	0.01 (0.3)	0.11 (3.3)	2.82 (81.4)	0.49 (14.3)	0.13 (3.9)	0.01 (0.4)	0.63 (18.6)	3.45 (100)
A. *mearnsii*	5.09 (37.5)	3.03 (22.3)	1.06 (7.8)	0.53 (3.9)	9.71 (71.5)	1.08 (8.0)	0.14 (1.1)	2.63 (19.4)	3.85 (28.5)	13.56 (100)
Total	129.42 (39.6)	71.4 (21.9)	27.52 (8.4)	13.24 (4.1)	241.58 (73.9)	64.86 (19.8)	4.7 (1.4)	15.65 (4.8)	85.21 (26.1)	326.79 (100)

Note: TAG= Total above ground, TBG= Total below ground

Total carbon in the studied forest site-3 was 341.3tha^{-1}. Of this, aboveground and belowground accounted for 73 and 27 percent respectively (Table 8). *Q. leucotrichophora* contributed highest carbon 192.87 tha^{-1} followed by *M. esculenta* 71.39 tha^{-1}. Among the components, bole and stump root contributed maximum 40.9 and 17.7% carbon in aboveground and belowground part respectively (Table 8). The carbon content in different tree species ranged from 81.9-64.1 and 18.1-35.9 % in above and belowground part, respectively. But among the studied tree species the *P. roxburghii* and *P. cerasoides* contributed maximum (81.9%) and minimum (64.1%) carbon in aboveground part while in belowground part carbon contributed minimum (18.1%) and maximum (35.9%) for *P. roxburghii* and *P. cerasoides* respectively (Table 8).

Table 8. Component wise carbon content (tha^{-}1) in each tree species in forest site-3 (values in parentheses are the percent contribution).

Component /Species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total
Q. leucotrichophora	71.31 (36.9)	44.12 (22.9)	16.89 (8.8)	7.67 (3.9)	139.99 (72.5)	44.12 (22.9)	7.98 (4.2)	0.78 (0.4)	52.88 (27.5)	192.87 (100)
M. esculenta	22.96 (32.2)	14.35 (20.0)	5.78 (8.0)	2.95 (4.2)	46.04 (64.4)	6.13 (8.6)	0.80 (1.2)	18.42 (25.8)	25.35 (35.6)	71.39 (100)
P. roxburghii	42.46 (62.6)	11.06 (16.3)	0.16 (0.2)	1.87 (2.8)	55.55 (81.9)	9.38 (13.8)	2.66 (3.9)	0.24 (0.4)	12.28 (18.1)	67.83 (100)
P. cerasoides	2.94 (31.9)	1.84 (19.9)	0.75 (8.2)	0.38 (4.1)	5.91 (64.1)	0.79 (8.6)	0.10 (1.1)	2.41 (26.2)	3.3 (35.9)	9.21 (100)
Total	139.67 (40.9)	71.37 (20.9)	23.58 (6.9)	12.87 (3.8)	247.49 (72.5)	60.42 (17.7)	11.54 (3.4)	21.85 (6.4)	93.81 (27.5)	341.3 (100)

Note: TAG= Total above ground, TBG= Total below ground

The total carbon of tree species was 228.65 tha^{-1} in studied forest site-4. Of this, aboveground and belowground carbon share was 80 and 20 percent respectively. Of the total carbon *P. roxburghii* contributed 71% while *C. deodara* 29% (Table 9). However, the component wise carbon bole contributed maximum 59.1% in aboveground and Stump root contributed 15.3% in belowground carbon (Table 9).

Table 9. Component wise carbon content (tha^{-1}) in each tree species in forest site-4 (values in parentheses are the percent contribution).

Tree species	Bole	Branch	Twig/ cone	Foliage	TAG	Stump root	Lateral Root	Fine root	TBG	Total
C. deodara	31.7 (47.3)	17.2 (25.7)	3.3 (4.9)	2.2 (3.3)	54.4 (81.2)	8.8 (13.1)	3.0 (4.4)	0.8 (1.3)	12.6 (18.8)	67.0 (100)
P. roxburghii	103.23 (61.4)	20.02 (15.7)	0.41 (0.2)	4.74 (2.8)	128.4 (80.1)	26.20 (15.6)	6.46 (3.9)	0.59 (0.4)	161.65 (19.9)	161.65 (100)
Total	134.93 (59.1)	37.22 (16.3)	3.71 (1.6)	6.94 (3.0)	182.8 (80.0)	35 (15.3)	9.46 (4.1)	1.39 (0.6)	45.85 (20.0)	228.65 (100)

Note: TAG= Total above ground, TBG= Total below ground

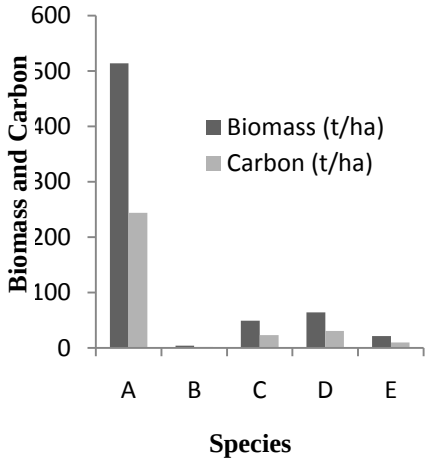
DISCUSSION AND CONCLUSION

The present estimates of density, basal area, biomass and carbon content shows that each of the findings varied in different studied forest sites. Tree density in studied forest sites ranged from 920-1345 individual ha^{-1}, values are within the range 420- 1640 tree ha^{-1} reported for temperate forests of Western Himalaya (Saxena and Singh, 1982), 540-1630 ha^{-1} for pine forests (Chaturvedi and Singh, 1987) and higher side than 570-760 ha^{-1} reported for Oak forests (Rawat and Singh, 1988). Basal area of Banj oak and Chir Pine forest ranged from 58.7- 93 m^2ha^{-1} was on higher side than 33.9- 36.8 m^2ha^{-1} reported for Oak forest (Rawat and Singh, 1988), however estimates values are on higher side than 36.3- 84.3 m^2ha^{-1} reported for the temperate broad leaved forest Garhwal Himalaya (Sharma et al., 2009) and 25- 47 m^2ha^{-1} for Chir- Pine forest in Central Himalaya (Chaturvedi and Singh, 1987).

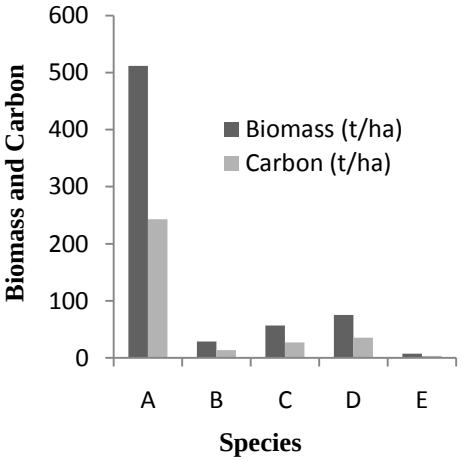
Present estimates of biomass 651-718 tha^{-1} reported for Banj oak dominated forests was on higher side than 285-458 t ha^{-1} reported for Oak forests (Rawat and Singh, 1988), 426 t ha^{-1} for Oak-Pine mixed forest (Rana et al., 1989) and 236-400 t ha^{-1} for oak mixed forests of higher elevation(Adhikari el al.,1998) while lower side than 556-782 tha^{-1} reported for Rianj and Tilonj dominated mixed oak forests of central Himalaya(Rana et al.,1989). In the studied forest sites, *Q. leucotrichophora* contributed maximum 56.5-78.9% of total biomass forests. Biomass of Chir-pine dominated forest was 495 tha^{-1}, of which *P. roxburghii* which was higher side than 112-283 tha^{-1} reported for Pine forest in central Himalaya (Chaturvedi and Singh, 1987) and 199 tha^{-1} for Chir Pine forest for Central Himalaya (Rana et al., 1989). Among the studied forests, *Q. leuchorichophora* contributed highest biomass and carbon content in forest site- 1, 2 and 3 while *P. roxburghii* shared maximum biomass in forest site-4.

Carbon content in Banj oak forests ranged from 309 to 341tha^{-1} which falls within the range 271-380 tha^{-1} for Oak dominated forests of Central Himalaya (Rana et al., 1989), Carbon content in Chir pine forest was 228.65 tha^{-1} which was much higher than 97 t ha^{-1} for Chir-pine forest (Rana et al., 1989) and 207 tha^{-1} for mixed Banj-oak Chir-pine forest (Rana et al., 1989). Present estimates of carbon content was much higher side than 248-296 t C ha^{-1} for reported for Oak Van Panchayat forests and 86-122 tha^{-1} for pine van Panchayat forest (Jina et al., 2008), 148 tha^{-1} in oak forest (Melhi et al., 1998) and 250-300 tha^{-1} for central Himalayan forests (Singh and Singh,1992). The biomass and carbon stocks of tree species occurred in different studied forest sites is depicted in Figure1.

In the studied forest sites, species richness ranged from 2-5, which was close to the natural forests studied by various workers in the region (Saxena and Singh, 1982; Singh and Singh, 1992; Bisht and Lodhiyal, 2005). The basal area was in order: site-4>site-3>site-2>site-1, which indicates the variation from site to site. While biomass and carbon stock was also varied which was in order: site-3>site-2>site-1 >site-4. It showed clearly that storage of biomass and carbon was decreased with increase in number of species richness.



Site-1



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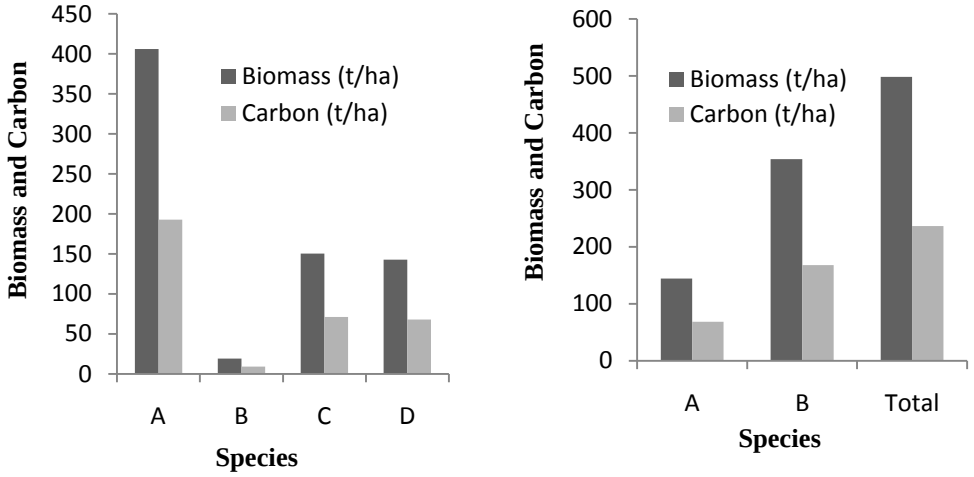

Site- 3: **Site- 4**

Figure 1. Bar diagram showing biomass and carbon content in each tree species occurred in each forest site **(Site-1:** represented for A= Q. *leucotrichophora*, B= *R. arboreum* C= *C. deodara* D= *M. esculenta* and E= *P. roxburghii*; **In site-2** A= Q. *leucotrichophora*, B= *A. mearnsii*, C=*C. deodara*, D= *M. esculenta* E= *P. roxburghii* and D= *P. roxburghii*; **In site-3:** A= *Q. leucotrichophora*, B=*P. cerasoides*, *C= M. esculenta* and D= *P. roxburghi*; **In site-4:** A= *C. deodara* and B= *P. roxburghii*) .

So in this case we can say that to get maximum stock whether it would be for biomass or carbon the highest and lowest species richness (number of tree species) does not means to affect the growing stock. However a minimum number of species richness must be there that would determine the status of growing stocks i.e. biomass and carbon but it depend how much that particular tree species having canopy density, basal area, tree height and various other related characteristics of the site. In present study, there was a variation in density in each tree category; which indicates that some species in the site has lesser number of densities than other species in the studied sites, however the biomass and carbon stocks was on the higher side than the natural forests and fast growing plantation species of central Himalaya (Singh and Singh, 1992; Singh and Lodhiyal, 2009). This is also concluded that high potential of forest biomass and carbon stocks of studied forest sites must be conserved because any faulty activities such as deforestation and degradation would release the already stored carbon into the atmosphere if not conserved. Therefore a more appropriate way is required so that the stock of dry matter and carbon from the forest sites could be conserved as well as such sites must be supported for tree species regeneration as sites are needed cautions to maintain their sustainability. Thus if we used the better scientific inputs to such sites it would not only save the high carbon potential of forest but continuously sequesters the atmospheric carbon through increasing of its productivity. Recent days land use practices and faulty human activities are the causes of climate change, therefore, forest conservation combined with sufficient regeneration process is only one the most powerful tools in combating the climate change problem apart from fulfilling various tangible and non-tangible benefits to the society and environment at regional and global level.

Table 10: Biomass of different sites in tha^{-1} and % in studied forest sites

Component /Species	Site 1	Site 2	Site 3	Site 4
Q. leucotrichophora	513.61(78.9)	512.06(75.5)	406.03(56.5)	-
M. esculenta	64.4(9.9)	75.17(11.1)	150.32(20.9)	-
C. deodara	47.71(7.3)	54.76(8.1)	-	141.05(28.5)
P. roxburghii	21.22(3.3)	7.34(1.1)	142.77(19.9)	353.98(71.5)
R. arboreum	3.95(0.6)	-	-	-
A. mearnsii	-	28.61 (4.2)	-	-
P. cerasoides	-	-	19.38(2.7)	-
Total	650.89(100)	677.94(100)	718.5(100)	495.05(100)

Table 11: Carbon of different sites in tha^{-1} and % of studied forest sites

Component /Species	Site 1	Site 2	Site 3	Site 4
Q. leucotrichophora	243.94(78.8)	248.2(75.9)	192.87(56.5)	-
M. esculenta	30.56(9.9)	35.56(10.9)	71.39(20.9)	-
C. deodara	22.64(7.3)	26.02(8.0)	-	67.00(29.3)
P. roxburghii	10.4(3.4)	3.45(1.1)	67.83(19.9)	161.65(70.7)
R. arboreum	1.86(0.6)	-	-	-
A. mearnsii	-	13.56(4.1)	-	-
P. cerasoides	-	-	9.21(2.7)	-
Total	309.4(100)	326.79(100)	341.3(100)	228.65(100)

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RESPONSE OF BIOCHEMICAL ACTIVITY OF *HELIANTHUS ANNUUS* L. CV.PAC – 36 TO SULPHUR DIOXIDE

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Abstract: Sulphur dioxide(SO_2) has been studied more extensively than any other pollutant as it is one of the most dominant primary air pollutants in the atmosphere. Some of the environmental effects of SO_2 include acidification of soils, lakes and rivers on one hand and injuries and devastating damage to vegetation under natural and controlled conditions on the other. Its acute and chronic exposure results in the general disruption of metabolic and fundamental cellular processes. The sensitivity of an oil-yielding cultivar of sunflower (*Helianthus annuus* L.cv.PAC-36) to SO_2 pollution had been observed using 2612, 3265, 3918 and 4571µg m^{-3} of SO_2 on 30,50,70 and 90d old plants. Analysis of plant samples collected showed that photosynthetic pigments (chlorophyll a, b and carotenoids) were degraded and leaf extract pH and ascorbic acid content declined in SO_2 treated plants. However, the higher concentration of SO_2 proved more toxic as against the lower concentrations.

Keywords: Ascorbic acid, chlorophyll, *Helianthus*, pollutant, sulphur dioxide

INTRODUCTION

Among the various air pollutants, the oxides of sulphur (SO_x) are probably the most widespread and intensively studied. Of these sulphur dioxide (SO_2) is one of the principal contaminants of air. It causes severe damage to vegetation under natural and control conditions (Verma and Agarwal,1996). Acute and chronic exposure to SO_2 can result in the general disruption of metabolic and fundamental cellular processes (Ewald and Schlee,1983). In order to perform the essential phenomenon of photosynthesis, plants require chlorophyll pigments which provide light energy to photosynthesis I and II. SO_2 pollution affect these pigments (chlorophyll a, b and carotenoids) and this directly influences the photosynthetic ability of the plants. A decrease in chlorophyll content is an indicator of air pollution injury-mainly SO_2 pollution(Gilbert, 1968). The present paper deals with the study of the effects of different concentrations of SO_2 on photosynthetic pigments, ascorbic acid content and leaf extract pH of *Helianthus annuus* L.cv.PAC-36 (family – Asteraceae), an oil-yielding cultivar of sunflower.

MATERIAL AND METHOD

Seeds of *Helianthus annuus* L.cv.PAC-36 were procured from I.A.R.I., New Delhi. The seeds were sown in polythene bags filled with sandy loam soil. The plants were treated with 2612, 3265, 3918 and 4571 µg m^{-3} SO_2 for 2h daily from 11^{th} day to maturity of the crop using $1m^3$ polythene chambers. The SO_2 gas was prepared chemically by reacting sodium sulphite with concentrated sulphuric acid. A set of plants were left untreated to serve as control. Leaves isolated from 30, 50,70 and 90 d old plants were analyzed for various biochemical parameters (chlorophyll a and b, carotenoid content ,ascorbic acid content and leaf extract pH(Table-1). The amount of chlorophyll a and b were measured according to Arnon (1949). The amount of carotenoids was determined by using formula of Maclachlan and Zalik (1963). The ascorbic acid content in the sample was calculated according to Keller and Schwager (1977). The leaf extract pH was measured with the help of digital electronics pH meter by homogenizing 5 g fresh leaves with 25ml double distilled water. The data obtained for various attributes in treated set and control both were subjected to statistical analysis.

RESULTS

The accumulation of biochemical components in the leaves of studied cultivar of *Helianthus annuus* L.cv.PAC-36 were affected to a great extent on exposure with different concentrations of sulphur dioxide. The higher concentration of SO_2 proved more toxic as against the lower concentrations. Degradation of chlorophyll a was more than that of chlorophyll b. The concentration 4571 µg m^{-3} of SO_2 had reduced chlorophyll a and b upto 28.65 and 21.74 percent (Fig - 1). Carotenoids are the accessory pigments provided for photoprotection. Its amount was reduced upto 22.77 percent on exposure with 4571µg m^{-3} SO_2. Amount of ascorbic acid was also affected adversely. However, upto the plant age of 50d, exposure of 2612µg m^{-3} of SO_2 did not induce any considerable reduction but its content was observed to be substantially lowered at higher concentrations and resulted in highly significant reduction(significant at 1% level) (Fig - 2). After prolonged exposure, as the cumulative doses of the pollutant were increased, more difference in the pH of non-fumigated and fumigated plants were recorded. Maximum effect was recorded at the crop maturity where 4571µg m^{-3} SO_2 reduced the pH by 21.25 percent.

DISCUSSION

Damage in plants is correlated with chlorophyll reduction . The decreased content of chlorophyll a, b and carotenoids of leaves on treatment with SO_2 could be due to disturbances in chloroplast ultrastructure and chlorophyll a was found to be more susceptible than chlorophyll b(Gupta, 1992). High sensitivity of chlorophyll a hampers the plant growth as it plays significant role in the process of photosynthesis. Reduced photosynthetic ability of chlorophyll molecule is associated with the formation of sulphurous (H_2SO_3) and sulphuric acid (H_2SO_4) formed by the reaction of water and absorbed SO_2 by plant tissues .These then dissociate to form toxic ions(H^+,$H_2SO_3^-$,SO_3^-,and SO_4^{-2})which cause degradation of chlorophyll molecule to phaeophytin and Mg^{+2} ions(Rao and Le Blanc ,1966). Higher concentrations of SO_2 may cause total senescence by inhibiting chlorophyllase activity, RUBISCO and PEP carboxylase (Ziegler,1972).

Carotenoid pigments serve a dual function of collecting energy for photosynthesis and protecting chlorophyll against photodestruction in times of excess light. Its significantly reduced content indicate inhibited photosynthetic capacity of the plant (Verma and Aggarwal,2001).

Sulphur dioxide is responsible for the production of free radicals in plant (Health,1994) which increase the cell permeability (Pell and Dann,1991). Plants develop "antioxidants" in order to prevent free radicals formation. Ascorbic acid is one of these antioxidants. A definite correlation exists between ascorbic acid content and resistance of plants (Varshney and Varshney,1984).Resistant plants contain high amount of ascorbic acid while sensitive plants posses low levels of ascorbic acid (Chaudhary and Rao,1977). Decline in leaf extract pH in SO_2 treated plants revealed that plants with acidic pH were more susceptible to SO_2 than those with pH value 7 or more (Yunus et al.,1985).Several pH dependent enzymatic activities get altered by decline in leaf extract pH and this in turn adversely affect the plant metabolism.

Table 1 : Biochemical response of *Helianthus annuus* L.cv.PAC-36 on exposure to different concentrations of SO_2.

Plant age,d	SO_2 ($\mu g\ m^{-3}$)	Attribute				
		Chlorophyll a	Chlorophyll b	Carotenoids	Ascorbic acid	Leaf extract pH
30	0	0.692	0.515	0.480	1.273	6.669
	2612	0.631	0.498	0.465	1.195*	6.569
	3265	0.603*	0.467*	0.447*	1.133**	6.421*
	3918	0.579**	0.436**	0.424**	1.084**	6.252**
	4571	0.532**	0.403**	0.391**	0.990**	6.012**
	CD5%	0.067	0.036	0.030	0.073	0.181
	CD1%	0.095	0.051	0.043	0.103	0.254
50	0	1.083	0.828	0.797	1.895	6.721
	2612	0.941*	0.791	0.765	1.786*	6.521
	3265	0.914*	0.738*	0.719*	1,702**	6.206*
	3918	0.884**	0.702**	0.688**	1.623**	6.119**
	4571	0.846**	0.651**	0.628**	1.541**	5.876**
	CD5%	0.126	0.067	0.077	0.101	0.372
	CD1%	0.177	0.095	0.107	0.142	0.522
70	0	1.441	1.153	1.131	2.440	6.790
	2612	1.214*	1.119	1.107	2.388*	6.440
	3265	1.190**	1.098**	1.063*	2.325**	6.026**
	3918	1.161**	1.041**	1.001**	2.261**	5.926**
	4571	1.119**	1.003**	0.987**	2.173**	5.624**
	CD5%	0.169	0.036	0.049	0.052	0.385
	CD1%	0.237	0.051	0.069	0.073	0.539
90	0	1.619	1.311	1.291	2.801	6.836
	2612	1.291*	1.199	1.169*	2.545*	6.324
	3265	1.237**	1.146**	1.124**	2.427**	5.818**
	3918	1.201**	1.101**	1.079**	2.348**	5.731**
	4571	1.155**	1.028**	0.997**	2.231**	5.383**
	CD5%	0.271	0.117	0.110	0.243	0.631
	CD1%	0.380	0.164	0.155	0.341	0.885

CD – Critical difference *Significant at 5% level.

**Significant at 1% level.

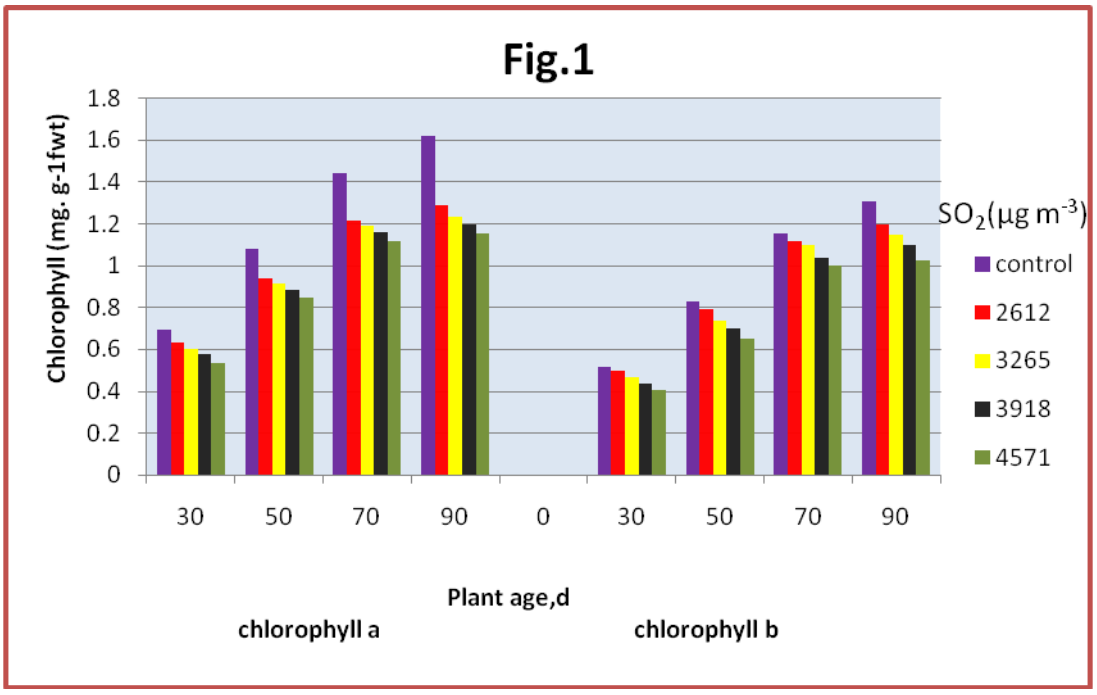

Fig.1 : Response of Chlorophyll **a** & **b** (mg g^{-1} fwt) in *Helianthus annuuss* L.cv. PAC - 36 at different plant age(30d,50d,70d,90d) on fumigation with various concentrations of SO_2.

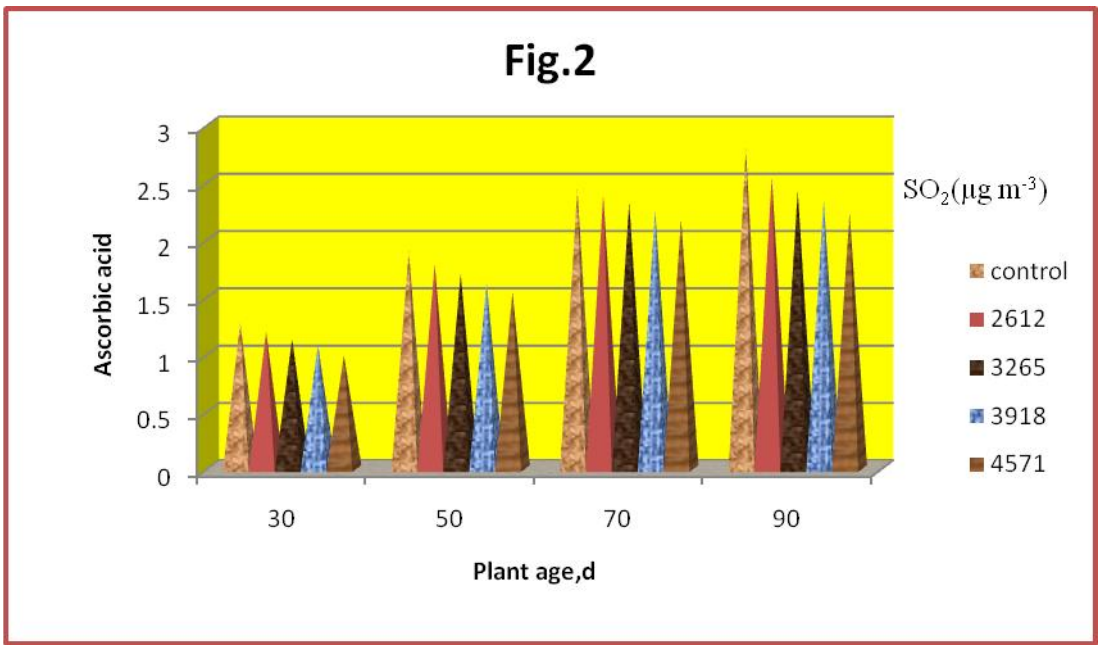

Fig.2 : Response of Ascorbic acid in *Helianthus annuuss* L.cv.PAC - 36 at different plant age (30d,50d,70d,90d) on fumigation with various concentrations of SO_2.

CONCLUSION

It is delineated from the above analyses that all the four concentrations of SO_2 used in the experiment affected the studied cultivar adversely causing appreciable reductions in biochemical components.

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CHARACTERIZATION OF THERMOPHILIC AMYLASE FROM AN OBLIGATE THERMOPHILE, *THERMOACTINOMYCES VULGARIS*

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Abstract: Amylase finds a wide range of applications in starch industries, i.e., baking, brewing, distillery. The wild-type (1227) and mutant strains (1261 and 1286) of *Thermoactinomyces vulgaris* were screened for the production of amylase using 1% soluble starch. The maximum production of amylase was observed after 12 h of incubation at 50ºC in wild-type strain 1227 of *T. vulgaris*. The amylase was found to be thermophilic, exhibiting its optimal activity at 75ºC and at pH 6.0 in this obligate thermophile; and it preferred soluble starch as its substrate. Among the metal ions tested, Mn^{2+} was most stimulatory, while Hg^{2+} was most inhibitory to the activity of amylase. Thus, *T. vulgaris* amylase is a thermophilic metalloenzyme, requiring Mn^{2+} for its high-temperature catalysis, which can be exploited for amylase-based industries of diverse interests.

Keywords: Amylase, Metalloenzyme, *Thermoactinomyces vulgaris*, Thermophilic amylase

INTRODUCTION

Amylases are enzymes which hydrolyze starch molecules to give diverse products, including dextrins and progressively smaller polymers composed of glucose units (Windish and Mhatre, 1965). Amylases constitute a class of industrial enzymes, which alone form approximately 25% of the enzyme market (Burhan et al., 2003; Rao et al., 1998; Sidhu et al., 1997). This plays a vital role in many industrial processes such as sugar, textile, paper, brewing, baking and distilling industries. It is also used in food and pharmaceutical industries as a digestive aid (Sivaramakrishnan et al., 2006).

The enzymes from thermophilic microbes have been proved to be more useful in biotechnological applications. Thermophiles represent an obvious source of thermostable enzymes, being reasonable to assume that such character will confer their proteins a high degree of thermal stability. The *Thermoactinomyces* growing at high temperature is thus a good source of industrially important enzymes.

MATERIAL AND METHODS

Strains Used and Culture Conditions

A wild-type strain (Stock no. 1227) and two mutant strains (Stock nos. 1261, and 1286) of *T. vulgaris*, which were kindly supplied by Professor D.A. Hopwood, John Innes Centre, Norwich, U.K., were used for screening the production of extracellular amylase. The auxotrophic strains 1261 (nicotinamide$^-$thiamine$^-$) was streptomycin resistant. The other auxotrophic strains 1286 (thiamine$^-$) was streptomycin sensitive. The media and culture conditions, as described by Hopwood and Wright (1972) were used with certain modifications (Singh, 1980; Sinha and Singh 1980).

Screening of *T. vulgaris* Strains for the Production of Extracellular Hydrolytic Enzymes

Amylase activity was determined, using soluble starch (1%) as a substrate in Hopwood's medium (Hopwood and Wright, 1972). Sterile modified Hopwood's agar medium was poured on a sterile Petri-plate and allowed to solidify at room temperature. It was then inoculated with the wild-type (1227) and auxotrophic mutant strains of *T. vulgaris*, using 0.2 mm cork-borer and incubated for 24-48 h at 50^{o}C. The plates were then stained with Lugol's Iodine (2 g KI and 1 g I_2 crystal dissolved in 300 ml distilled water, filtered and stored in brown bottle). The formation of a halo zone surrounding the colony under blue black background was considered positive for amylase activity.

Culture Condition for Amylase Production

The Hopwood medium, supplemented with 3% starch as sole carbon source was used as a production medium. The 30 ml of sterilized liquid medium was inoculated with 1ml of spore suspension containing 10^7 spores/ml (having O.D. of 0.65 at 600 nm). The contents were mixed thoroughly and incubated at 50°C. Mycelium was filtered out with Whatmann no. 1 filter paper, and the filtrate was used for assaying the amylolytic activity of *T. vulgaris*. In order to investigate the optimum conditions for maximum production of amylase, samples were taken at regular time intervals (i.e., after 4, 8, 12, 16, 20 and 24 h) and assayed at its growth temperature (50°C) for amylase production.

Assay for Amylase Activity

The amylase activity was assayed by the method of Bernfeld (1955) by estimating the reducing sugar (maltose) produced during starch hydrolysis using 3,5 dinitrosalicylic acid (DNS) as a coupling reagent. The reaction mixture consisted of 0.5 ml of 1% (w/v) soluble starch in 20 mM sodium acetate buffer (pH

5.0-6.0) and 0.5 ml of appropriately diluted enzyme solution was incubated at 50ºC for 15 min. The reaction was stopped by adding 1 ml of 3,5 dinitrosalicylic acid (DNS) solution, followed by heating in a boiling water bath for 5 min. The contents were then cooled to room temperature, and after the addition of 10 ml distilled water, the absorbance was measured at 540 nm with UV-Visible Spectrophotometer (UV-1700 Pharma Spec, Shimadzu). The activity of 1 unit (U) of amylase was defined as that amount of enzyme liberating 1 mM of reducing sugar (with maltose as standard) per minute under standard assay conditions. Specific activtiy was expressed as enzyme units per mg of protein (U/mg protein). Protein concentration in enzyme solution was determined by the method of Bradford (1976).

Effect of Temperature on Amylase Activity

The optimum temperature, needed for maximal amylase activity, was determined by incubating the reaction mixture for 15 min at varying temperatures, starting from 50ºC to 95ºC.

Effect of pH on Amylase Activity

The effect of pH on the activity of the amylase was studied by performing the enzyme assay over a range of pH from 4.0 to 11.0, using 20 mM sodium acetate buffer (pH 4.0-6.0), 20 mM potassium phosphate buffer (6.5-8.0) and 20 mM glycine-NaOH buffer (8.5-11.0).

Substrate Specificity

The substrate specificity of the enzyme was checked by using different substrates such as soluble starch, corn starch and potato starch (at a 1% concentration each) separately in the reaction mixture and the residual activity was detected for each substrate under standard assay conditions.

Effect of Metal Ions on Amylase Activity

The effect of different metal ions on amylase activity was determined by the addition of metal ions in the form of their respective chlorides at a final concentration of 1 and 5 mM to the reaction mixture, and the assay was performed under standard conditions of temperature and pH. The tested ions included chloride salts of the following – Li^{+}, Na^{+}, K^{+}, Mg^{2+}, Ca^{2+}, Ba^{2+}, Cr^{3+}, Mn^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+} and Hg^{2+}. The activity assayed in the absence of metal ions was taken as control.

Effect of Metal Chelating Compound (EDTA) on Amylase Activity

The effect of different concentrations of a metal chelating agent, ethylene-diaminetetraacetic acid (EDTA) on the specific activity of *T. vulgaris* amylase was studied. The enzyme assays were done under standard conditions without and with 5 mM of the stimulatory divalent cation (Mn^{2+}).

RESULT

Amylase Activity Test

Screening for amylase producing ability of *T. vulgaris* strains was done by growing them in the medium, containing soluble starch (1%) as a substrate, based on the zone of hydrolysis. The presence of a clear halo zone around the colony of *T. vulgaris* after staining the starch with I-KI indicated the presence of amylase activity in the wild-type (1227) and mutant strains (1261 and 1286) after 48 h of incubation at 50ºC (Fig 1).

Cultivation Conditions for Amylase Production in *T. vulgaris*

In order to investigate the optimal conditions for maximum production of amylase, samples from the growing cultures were taken at regular time intervals (i.e., after 4, 8, 12, 16, 20 and 24 h) and assayed for amylase production at their growth temperature (50ºC). The maximum activity of amylase was observed after 12 h of growth in the wild-type strain 1227.

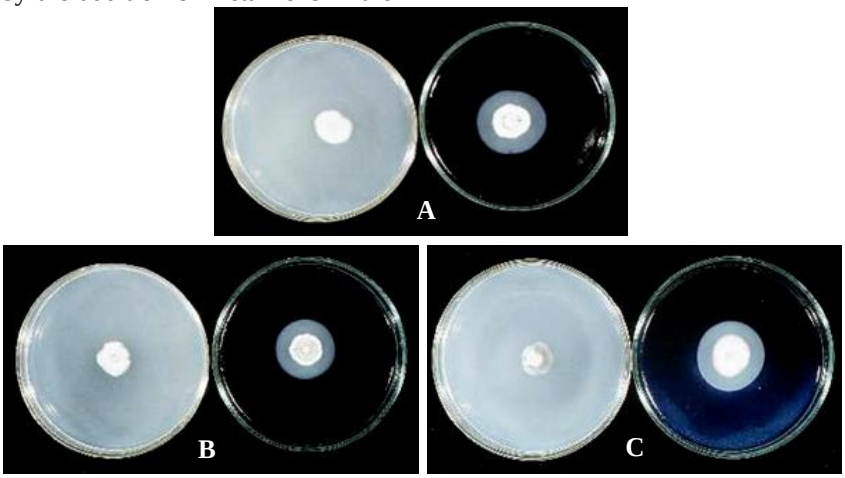

Fig 1. Screening of *Thermoactinomyces vulgaris* wild-type strain 1227 (**A**) and its auxotrophic mutant strains 1261 (**B**) and 1286 (**C**) for the production amylase after 48 h of incubation at 50°C.

The amylase activity increased with the increase in the time interval till 12 h, exhibiting 10.678 U/mg protein in wild-type strain 1227 (Fig. 2). Thus, the maximum production of amylase was observed after 12 h of incubation at 50º C. Hence, production medium after 12 h was used as enzymatic source for further characterization of amylase from wild-type strain 1227 of *T. vulgaris*.

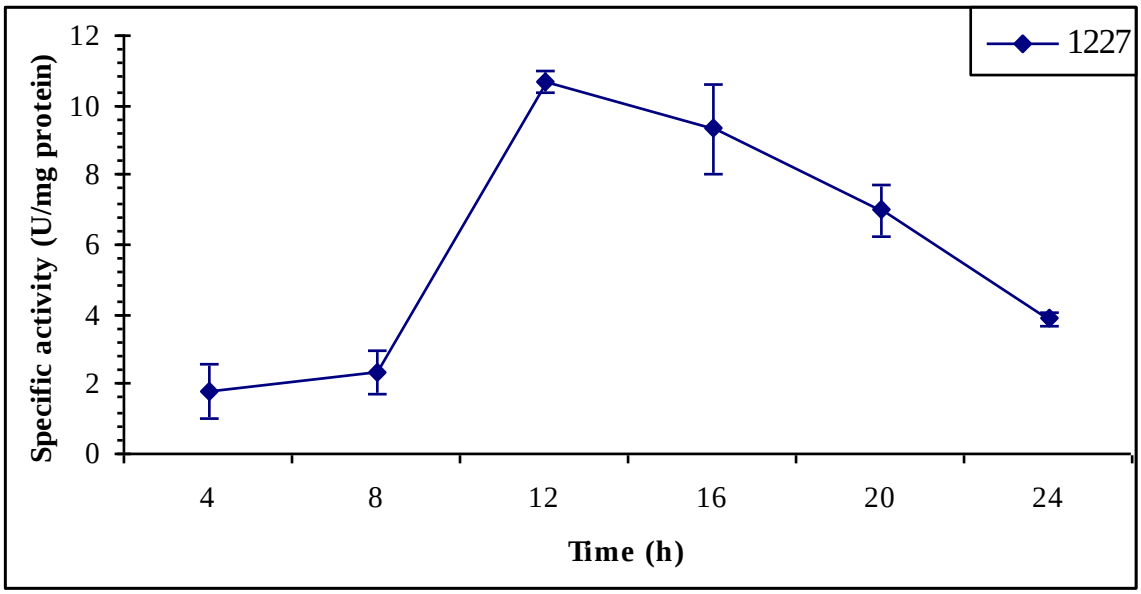

Fig 2. Cultivation condition for amylase production in wild-type (1227) and mutant strains (1261 and 1286) of *T. vulgaris*.

Effect of Temperature on Amylase Activity

The optimum temperature for amylase activity was determined by performing the assays at varying temperatures, starting from 50°C to 95°C. The optimum temperature of amylase of wild-type strain (1227) was found to be 75ºC with a specific activity of 17.626 U/mg protein (Fig. 3).

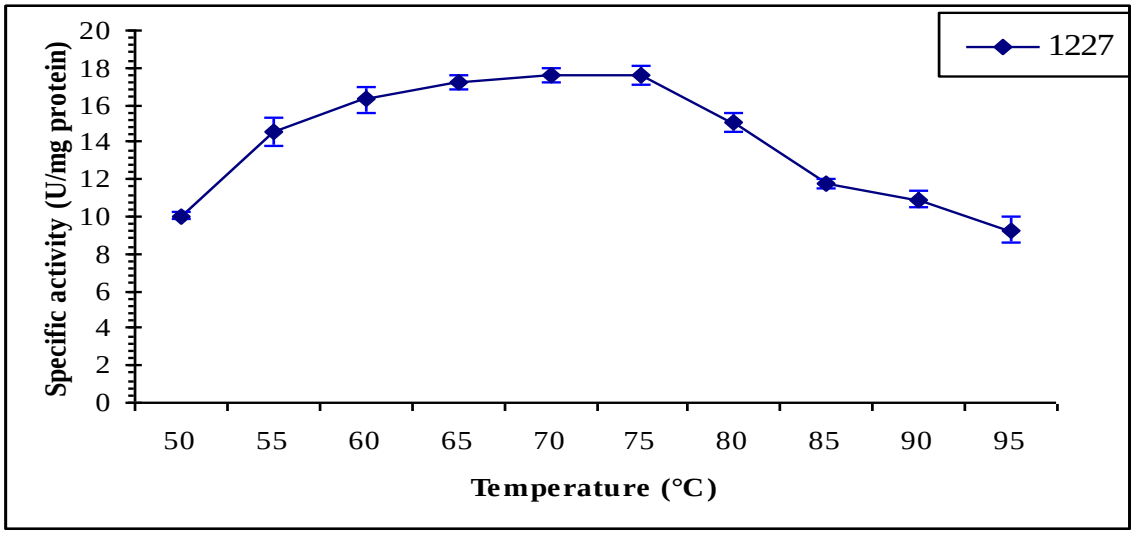

Fig 3. Effect of temperature on the amylase activity of wild-type strain of *T. vulgaris*.

Effect of pH on Amylase Activity

A pH range between 4.0 and 11.0 was used to study the effect of pH on the amylase activity. It was observed that the specific activity was found to be maximum at pH 6.0 showing 17.735 U/mg protein activity for wild-type strain 1227. This observation indicated that the pH optima of amylase was same (i.e. pH 6.0) in the wild-type strain 1227 of *T. vulgaris* (Fig. 4).

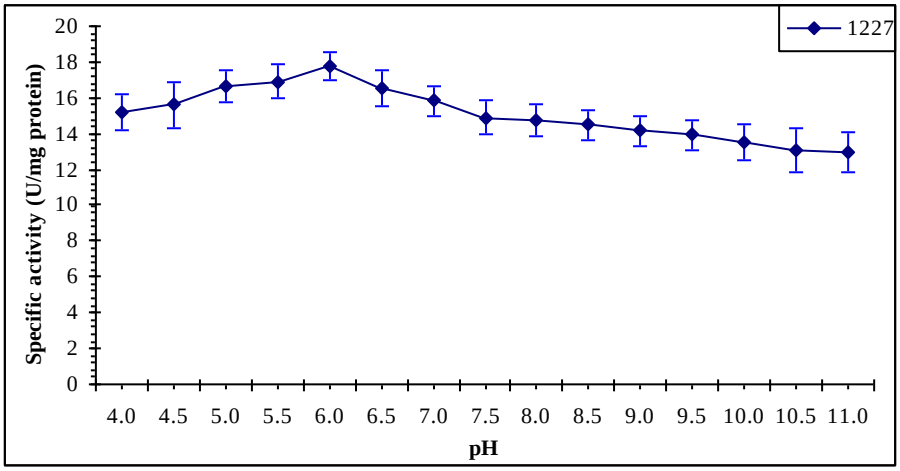

Fig 4. Effect of pH on the amylase activity of wild-type strain of *T. vulgaris*.

Substrate Specificity of Amylase

The substrate specificity of amylase was checked by using different substrates such as soluble starch, corn starch and potato starch at 1% concentration each in the reaction mixture, and the specific activity was determined under standard conditions. The specific activity of amylase was found to be maximum (17.474 U/mg protein) in wild-type strain (1227), when soluble starch was used as substrate (Fig. 5). Considering this, further characterization of enzyme was done using soluble starch as the substrate for enzyme assays.

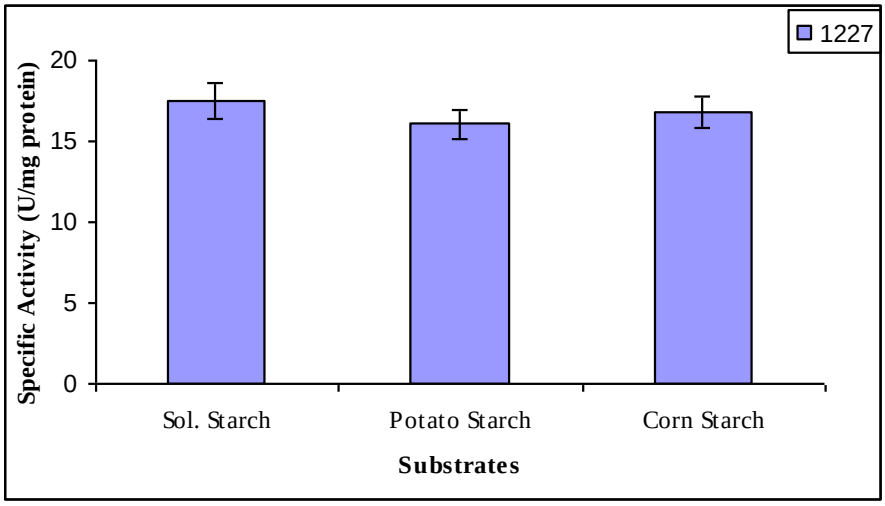

Fig 5. Effect of different substrates on amylase activity of wild-type strain of *T. vulgaris*.

Effect of Metal Ions on Amylase Activity

For studying the effects of metal ions on amylase activity, enzyme assays were done in the absence (control) as well as in the presence (1 mM and 5 mM) of different metal ions in the form of their respective chlorides.

In the wild-type strain (1227), Mn^{2+} was found to enhance the amylase activity by 18% with specific activity of 20.219 U/mg protein at 1 mM concentration and by 214% with specific activity of 53.709 U/mg protein at 5 mM concentration of Mn^{2+} with respect to control (17.128 U/mg protein). Co^{2+} also increased the activity of amylase by 14% with specific activity of 19.469 U/mg protein at 1 mM concentration and by 18% with specific activity of 20.143 U/mg protein at 5 mM concentration of Co^{2+}. The addition of Hg^{2+} decreased the activity of amylase by 15% with specific activity of 14.594 U/mg protein at 1 mM concentration and by 79% with specific activity of 3.512 U/mg protein at 5 mM concentration of this divalent cation with respect to control (17.128 U/mg protein). Also, at 5 mM concentration, Cr^{3+}, Cu^{2+} and Zn^{2+} inhibited the activity of amylase by 11% (15.208 U/mg protein), 40% (10.341 U/mg protein) and 18% (14.097 U/mg protein), respectively. Mn^{2+} (5 mM) was most stimulatory and Hg^{2+} was most inhibitory to the amylase activity of wild type strain of *T. vulgaris* (Fig. 6).

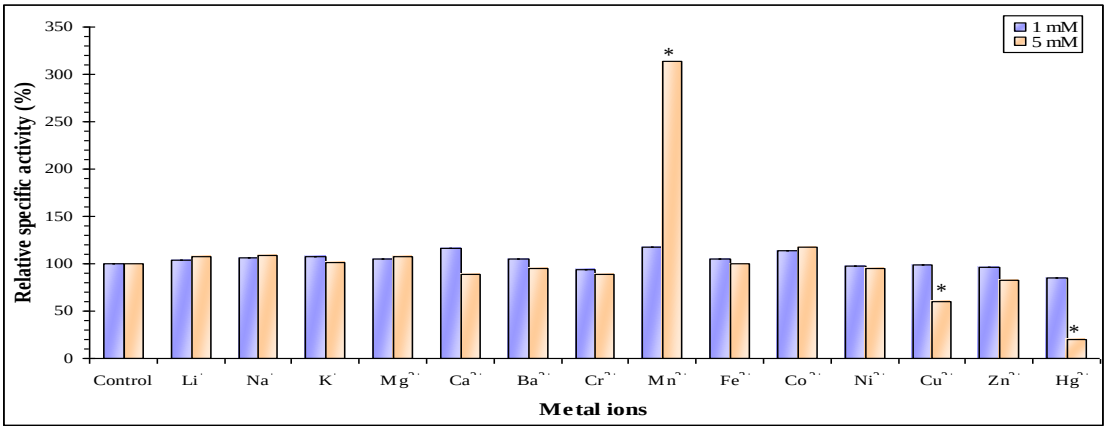

Fig 6. The relative specific activity of amylase of wild-type strain of *T. vulgaris* in the presence of 1 mM and 5 mM concentrations of metal ions with respect to control.

Effect of Metal Chelating Compound (EDTA) on Amylase Activity

In order to check the metal ion specificity of amylase, the effect of different concentrations of a metal chelating agent, ethylene-diaminetetraacetic acid (EDTA) on the specific activity of amylase of *T. vulgaris* was investigated in the absence and in the presence of 5 mM of the stimulatory divalent cation (Mn^{2+}). The increasing concentration of EDTA decreased the specific activity of amylase in the wild-type strain 1227 both in the absence as well as in the presence of Mn^{2+}. However, the specific activity of amylase was more in the presence of 5 mM Mn^{2+} (Fig. 7).

In the wild-type strain 1227, the specific activity of amylase in control was found to be 17.416 U/mg protein and 49.913 U/mg protein in the absence and presence of Mn^{2+} (5 mM), respectively. As the concentration of EDTA increased from 1 mM to 10 mM, the activity of amylase was found to decrease from 17.416 U/mg protein (in control) to 2.924 U/mg protein (at 10 mM EDTA) in the absence of Mn^{2+}; while in the presence of 5 mM of this divalent cation, the activity decreased from 49.913 U/mg protein (in control) to 16.243 U/mg protein (at 10 mM EDTA) (Fig. 7).

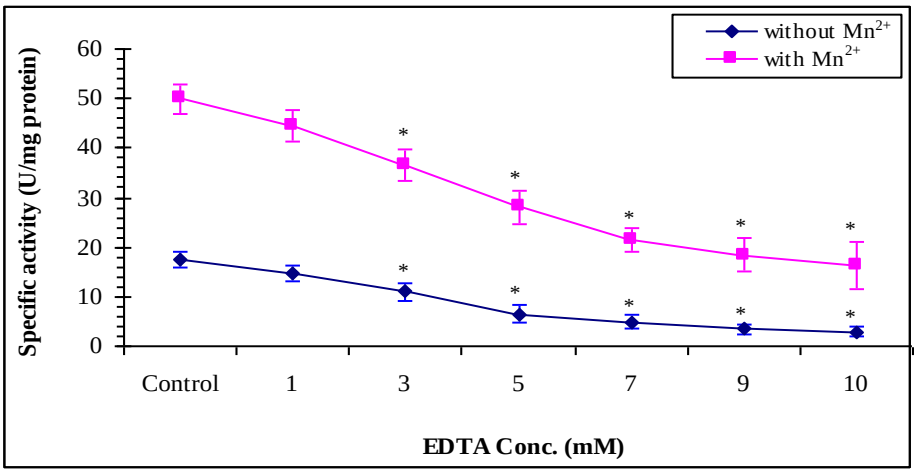

Fig 7. Effect of metal chelating agent (EDTA) on the specific activity of amylase in the wild-type strain of *T. vulgaris*, in the absence and in the presence of 5 mM Mn^{2+}.

The effect of different concentrations of stimulatory divalent cation (Mn^{2+}) on the specific activity of *T. vulgaris* amylase was studied in the absence and presence of 10 mM of the metal chelating agent (EDTA).

In the wild-type strain (1227), the specific activity of amylase in control was found to be 17.306 U/mg protein and 3.163 U/mg protein in the absence and presence of metal chelating agent EDTA (10 mM), respectively (Fig. 8).

In the absence of EDTA, the specific activity increased with increasing concentration of Mn^{2+}; and at 10 mM of this divalent cation the activity reached 55.245 U/mg protein. But, in the presence of fixed concentration (10 mM) of EDTA, the specific activity increased upto 21.061 U/mg protein in the presence of same concentration (10 mM) of Mn^{2+}.

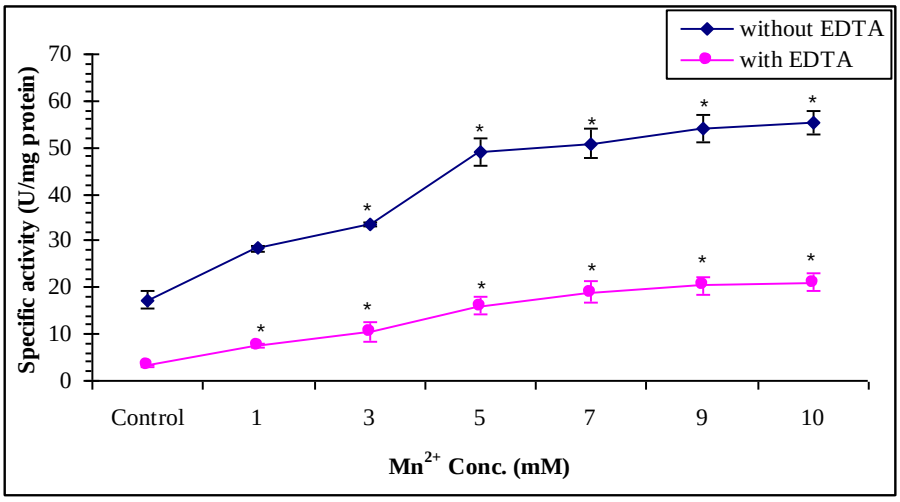

Fig 8. Effect of varying concentrations of the divalent cation (Mn^{2+}) on the specific activity of amylase in wild-type strain 1227 of *T. vulgaris*, in the absence and in the presence of 10 mM of metal chelating agent (EDTA).

The increasing concentration of divalent cation (Mn^{2+}) increased the specific activity of amylase in the wild-type strain of *T. vulgaris*. However, metal chelating compound (EDTA) at 10 mM concentration in the absence of Mn^{2+} decreased the amylase activity in the wild-type strain 1227, from 17.416 U/mg protein (in control) to 2.924 U/mg protein (Fig. 8). The stimulatory divalent cation (Mn^{2+}) recovered the activity of amylase from inhibition caused by 10 mM of EDTA. A concentration of 10 mM of Mn^{2+} was able to recover about 38% amylase activity (Fig. 8).

Further, the observations pertaining to the inhibition of amylase of *T. vulgaris* strains by the metal chelating compound (EDTA) in the absence as well as in the presence of the stimulatory divalent cation (Mn^{2+}) indicated that, even 10 mM of EDTA was not able to inhibit the enzyme completely, and that too in the absence of Mn^{2+}. The presence of Mn^{2+} in the assay mixture, on the other hand, was able to protect the enzyme against EDTA-dependent inhibition (Figs 8, 9). This indicated that Mn^{2+} is firmly bound to the enzyme.

The data suggests that the thermophilic amylase of *T. vulgaris* exhibits a high degree of metal ion specificity and is, therefore, a metalloenzyme, requiring Mn^{2+} for its enhanced rate of catalysis.

DISCUSSION

Temperature is an important factor which has a direct effect on the catalytic functions of enzymes. Many enzymes from a variety of thermophiles function optimally at elevated temperatures (Singleton and Amelunxen 1973; Zuber 1976). In the present investigation concerning the effect of temperature on the catalytic activities of amylase in the wild-type strain 1227 of *T. vulgaris* reveal that the enzyme is highly thermophilic, exhibiting the optimal activities at 75ºC in (Fig. 3). Mamo et al. (1999) also reported optimal temperature of 75-80ºC for amylase from *Bacillus* sp. WN11. The optimum pH for amylase activities was found to be 6.0 in wild-type strain 1227, showing specific activity of 17.735 U/mg protein. The enzyme from *Bacillus* sp. WN11 was optimally active and stable at pH 5.5 (Mamo et al., 1999). α-Amylase from *Thermomonospora curvata* also exhibited its optimal activity at pH 5.5 to 6.0 (Glymph and Stutzenberger, 1977). Similar to these, the pH optimum (pH 5.0-6.0) of amylase of *T. vulgaris* was also in the acidic range. The use of liquefying amylases that are active relatively at lower pH could reduce the amount of acid used to lower the pH from a liquefying to saccharifying range of various industrialized enzymatic processes.

The enzymes are highly substrate-specific, and the substrate specificity of amylase varies from microorganism to microorganism. In general, amylase displays highest specificity towards starch, followed by amylose, amylopectin, cyclodextrin, glycogen and maltotriose. The amylase of wild-type strain 1227 of *T. vulgaris* showed maximum specific activity when soluble starch was used as the substrate (Fig. 5). Sivasakthi et al. (2012) used cassava as a substrate for the production of amylase by *Aspergillus niger*.

Maximum activity was observed in the presence of 5 mM of Mn^{2+}, that enhanced the catalytic activity of amylase of *T. vulgaris* wild-type strain 1227 to 314 % (i.e., about 3.1-fold over the control) (Fig 6). Hg^{2+} was found to inhibit the activity of amylase in the wild-type strain 1227 of *T. vulgaris* by 79 % (Fig 6). Similarly, Mn^{2+}-dependent activation of amylase has been reported in *Halobacter* sp. MMDO47 (Shanmughapriya et al., 2009). Hg^{2+} strongly inhibited the amylase activity by 73 % in *Bacillus subtilis* (Ashger et al., 2007). It was also found to inhibit the amylase activity in *Halobacter* sp. MMDO47 (Shanmughapriya et al., 2009).

In order to elucidate the metal ion specificity of *T. vulgaris* amylase, investigations were carried out to observe the effect of the metal chelating compound (EDTA) in the absence as well as in the presence of the stimulatory divalent cation (Mn^{2+}). The increasing concentration of EDTA decreased the specific activity of amylase in the wild-type strain 1227 of *T. vulgaris* (Fig 7) both in the absence as well as in the presence of Mn^{2+}. However, the specific activity of amylase was more in the presence of 5 mM Mn^{2+}. Further, the observations pertaining to the inhibition of *T. vulgaris* amylase by the metal chelating compound (EDTA) in the absence as well as in the presence of the stimulatory divalent cation (Mn^{2+}) indicated that even 10 mM of EDTA was not able to inhibit the enzyme completely and that too in the absence of Mn^{2+}. The presence of Mn^{2+} in the assay mixture, on the other hand, was able to protect the enzyme against EDTA-dependent inhibition in wild-type strain of *T. vulgaris* (Fig 8). This indicated that Mn^{2+} is firmly bound to the enzyme. Thus, the thermophilic amylase of *T. vulgaris* exhibits metal ion specificity and is, therefore, a metalloenzyme, requiring Mn^{2+} for its enhanced rate of catalysis.

The effect of ethylene-diaminetetraacetic acid (EDTA) on α-amylase from alkaliphilic *Bacillus* sp. varies considerably, with some being unaffected in its presence at concentration as high as 100 mM (Hagihara et al., 2001). However, amylase of *Bacillus* sp. IMD 370 is completely inhibited by 1 mM EDTA (Kelly et al., 1995). The amylolytic activity of *Bacillus licheniformis* NH1 is strongly inhibited by the chelating agent (EDTA) at 5 mM concentration and about 75 % of its original activity was lost (Hmidet et al., 2009).

It is concluded that amylase of *T. vulgaris* is a thermophilic metalloenzyme, requiring Mn^{2+} for its high-temperature catalysis, which can be exploited for amylase-based industries of diverse interests.

ACKNOWLEDGEMENT

We are grateful to Professor D. A. Hopwood of John Innes Centre, Norwhich, UK for kindly providing strains of *Thermoactinomyces vulgaris*, and to the University of Delhi for financial support under R & Programme. One of us (Archana Singh) is thankful to UGC for providing financial assistance in the form of Junior research Fellowship.

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PHENOTYPIC STABILITY OF YIELD AND ITS COMPONENT TRAITS IN LENTIL (*LENS CULINARIS* MEDIK)

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Abstracts: Thirty genotypes of lentil were evaluated under four diverse environments for stability analysis for yield and its related traits. Pooled analysis of variance for all the eleven characters indicated significant differences among the genotypes and environments. The linear component was observed to be significant for all the characters suggesting that the prediction of performance of genotypes were possible across the environments. Genotype L-4676 and L-4594 were observed to be desirable and stable for seed yield as well as other characters like number of primary and secondary branches/plant, plant height, 100 seed weight and biological yield. Further, the genotype L-415 was having high yield, $S^2d_i=0$ and b>1 indicating that this genotype would perform better in favourable environmental conditions.

Keywords: Lentil, G × E interaction, Phenotypic stability, Seed yield

INTRODUCTION

The effects of genotype and environment on phenotype may not be always independent. The phenotypic response to change in environment is not same for all genotypes, the consequences of variation in phenotype depend upon the environment. Since G×E interaction has masking effect on genotype (Comstock and Moll, 1963) hence these interactions are of considerable importance to plant breeders in identifying the genotypes suitable for favourable location/ environment and assumes importance for potential expression of characters under interest. Evaluation of genotypes over several years appears to improve genotypic evaluation and it would enable characterization of each genotype for intra-location variance to evaluate the non-predictable part of the GE interactions, due to annual effects (Lin and Binns, 1988). The importance of G×E interactions is recognized well and these are known to be heritable and statistical techniques are available to estimate them. The main efforts of geneticists are to reduce them or to scale them out. The genotypes adjusting their phenotypic state in response to environment so that they are able to give their maximum yield or near maximum economic returns are called "well buffered" genotype (Allard and Hansche, 1964). Hence present investigation was carried out utilizing 30 genotypes over four diverse environments to assess the stability of seed yield and its component traits in lentil.

MATERIAL AND METHOD

The present experiment was conducted during two years (2004-05 and 2005-06) with early and late sowing under rainfed condition. The thirty genotypes procured from Division of Genetics, IARI, New Delhi, were grown in randomized block design with three replications under four environments. Each entry was sown in single row of 3 m length with a distance of 25 cm and 10 cm between rows and plants, respectively. In each replication the observations were recorded on five randomly selected plants in each plot on eleven characters days to days to 50% anthesis, days of maturity, number of primary branches, number of secondary branches, number of pods per plant, plant height (cm), number of seeds per pod, biological yield per plant (g), seed yield per plant (g), 100-seed weight (g) and harvest index (%). Plot means were subjected to stability analysis as per model given by Eberhart and Russell (1966).

RESULT AND DISCUSSION

Pooled analysis of variance for all the 11 characters studied, indicated that highly significant differences exist among the genotypes and environments (Table 1). Kumar and Bajpai (1993), Solanki (2001), El-Saied and Afiah (2004), Dehghani *et al.* (2008), Sabaghnia *et al.* (2012) and Abo-Hegazy *et al.* (2013) also recorded highly significant variances amongst the genotypes and environments for all the characters studied.

The results of the present study clearly indicated that the linear component of G×E interaction played an important role in the expression of days to anthesis, number of secondary branches, number of pods per plant, plant height, number of seeds per pod, biological yield, grain yield and 100-seed weight. The non-linear components of genotype × environment (G×E) interaction were significant only for days to maturity and harvest index. For days to anthesis, number of secondary branches, number of pods per plant, plant height, seeds per pod, biological yield per plant, seed yield per plant and 100-seed weight, the linear component was more important than that of non-linear one suggesting thereby that major portion of G×E interaction was attributable to linear components in respect to these traits. The significant variance due to environment (linear)

indicated differences among environmental conditions under study. Kumar *et al.* (2005) revealed that most of the genotypes exhibited predictable linear type of genotype × environment interaction in terms of mean performance and response to changing environment for the traits.

Eberhart and Russell (1966) suggested that both linear sensitivity coefficient (b_i) and non-linear sensitivity coefficient (S^2d_i) should be considered in assessing the phenotypic stability of a genotype and considered three stability parameters viz., mean performance ($\overline{X}$), regression coefficient (b_i) and deviation from regression (S^2d_i). Based on stability parameters the genotypes L-396, L-416 and L-4661 were found to be stable and desirable for days to anthesis (Table 2). Mean number of days taken to maturity ranged from 125.0 days (L-4677) to 156.0 days (L-381) over environment with a general mean of 142.91 days. The genotypes L-4661 and L-4620 with low mean, unit regression (b_i) and non-significant (S^2d_i) were identified as desirable and stable for days to maturity (Table 2).

The genotypes L-415, L-4674, L-4676, L-4618, L-381, L-4594, L-4598, L-4147, L-4596, L-414, L-4661 and L-417 for number of primary branches; L-4676, L-4618, L-381, L-4598, L-4147, L-414, L-4661 and L-4677 for number of secondary branches; L-396, L-381, L-4594, L-4147, L-414, L-4597and L-310 for plant height showed high mean performance, b=1 and S^2d_i=0 indicating stable performance over environments. Further, the genotypes L-415, L-396, L-308, L-386, L-4672, L-4598, L-4147, L-4596, L414, L-4597 and L-471 for seeds/pod and L-4674, L-4676, L-4618, L-381, L-4148, L-4596, L-414, L-4661, L-417 and L-4620 for 100-seed weight showed high mean performance, b=1 and S^2d_i=0 indicating stable performance over environments.

The genotype L-395 for seed yield and L-307, L-4595, L-4674, L-396, L-309, L-386, L4620 and L-310 for biological yield showed below mean performance, unit regression coefficient and non-significant S^2d_i (Table 2). This indicated that the performance of these genotypes can be improved by adopting suitable management practices and can also used as one of the parents along with high mean performance and wider adaptation. Further, the genotype L-415 was observed to be high yielding and stable but their corresponding bi value were significantly than greater unity. This showed that this genotype would perform better in favourable conditions and hence could be recommended for cultivation in high fertility areas and management practices. Furthermore, genotypes L-4676 and L-4594 had mean seed yield greater than population mean and was stable (S^2d_i=0) but their b_i values were significantly lower than unity (b_i <1). It indicated that these genotypes would perform better in poor environmental conditions and hence these genotypes can be used as a donor parent to breed a suitable genotype for poor environment (Table 2).

The results of the present study indicated that none of the genotype studied was found superior for all the characters in all the environments. The stable genotypes identified could be used as parents in future breeding programme for developing suitable genotypes with wider adaptability. Dehghani *et al.* (2008) recommended that yield and stability of performance should be considered simultaneously to exploit the useful effect of GE interactions and to make genotype selection more precise and refined. Further Abo-Hegazy *et al.* (2013) also concluded in lentil breeding programs, which the performance of genotypes under each location should be evaluated firstly and those reliable ones will be tested for stability across various environmental conditions prior to recommendations.

Table1. Joint regression analysis for seed yield and its components in lentil (Eberhart and Russell, 1966)

Source of variation	d.f.	Mean squares										
		Days of anthesis	Days to maturity	Primary branches	Secondary branches	No. of pods per plant	Plant height (cm)	No. of Seeds per pod	Biological yield (g)	Seed yield (g)	100-seed weight (g)	Harvest index (%)
Genotype (G)	29	1349.97**	236.38**	0.56**	1.78**	815.03**	34.44**	0.096**	90.32**	10.09**	4.79**	1.59
Environment (E)	3	175.29**	187.79**	0.42**	1.77**	143.96**	52.01**	0.059**	81.86**	9.12**	0.90**	8.78**
G × E	87	4.96	7.25**	0.03	0.08	10.88	1.89	0.004	1.95	0.17	0.03	1.07*
E + G × E	90	10.63	13.27**	0.04	0.14	15.31	3.57	0.006	4.62	0.46	0.06**	1.33**
E (linear)	1	525.39**	563.88**	1.26**	5.30**	432.22**	156.03**	0.177**	243.58**	27.37**	2.71**	26.29**
G × E (linear)	29	8.00**	2.14	0.03	0.12*	16.03*	3.42*	0.007**	2.87**	0.29**	0.05**	0.86
Pooled deviation	60	3.01	9.47**	0.2	0.06	8.02	1.09	0.002	1.44	0.11	0.02**	1.14**
Pooled error	232	11.99	3.81	0.10	0.37	60.80	7.78	0.010	7.69	0.79	0.03	0.72

*,** = significant at P = 0.05 and P = 0.01 levels, respectively.

Table 2. Estimates of stability parameters in 30 genotypes

Genotypes	Days to anthesis			Days to maturity			Primary branches			Secondary branches		
	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d
L-415	65.25	0.36**	-3.66	143.75	0.97	6.21+	4.23	1.01	0.00	6.83	0.22**	-0.11
L-307	102.92	0.93	-3.98	142.25	1.72	7.15+	3.80	1.26	-0.03	7.38	0.79	-0.12
L-4595	98.17	0.69	10.26	144.75	0.73	0.14	3.92	1.26	-0.01	7.04	0.38	-0.08
L-4674	80.58	2.46**	-1.02	151.33	0.96	0.35	4.28	1.49	-0.02	7.27	0.93	-0.11
L-396	63.00	0.73	-3.48	143.92	0.86	7.23+	4.13	1.16	-0.03	6.68	0.46	-0.10
L-308	103.67	0.99	-1.85	144.83	0.67	0.37	4.04	-0.34	0.14	7.00	-1.42*	0.15
L-306	103.33	0.65	-3.13	148.33	1.15	3.55	3.86	0.38	-0.03	7.62	-0.33	-0.03
L-309	103.67	1.56	15.36	147.92	1.34	25.90++	4.04	-0.82	0.17+	6.67	0.80	-0.10
L-4676	97.17	0.35**	-3.23	148.83	0.59	12.82++	4.23	0.49	-0.03	8.23	0.56	-0.09
L-4618	90.67	1.40	0.27	145.75	0.33**	-0.91	4.26	1.32	-0.01	7.74	1.51	-0.12
L-4671	73.42	0.16*	-0.97	149.17	0.71	2.25	3.43	0.57	-0.02	6.90	0.87	-0.12
L-395	104.08	0.79	-3.78	146.58	0.86	2.10	3.57	0.29	-0.03	6.62	0.96	-0.12
L-386	96.92	1.21	-0.47	149.83	0.91	22.57++	4.44	0.04**	-0.03	8.63	0.36*	-0.11
L-381	103.33	0.67**	-3.22	150.50	1.30	81.01++	4.39	0.36	-0.02	8.55	1.05	-0.05
L-4594	94.33	1.73**	-2.86	147.58	0.52	34.83++	4.26	0.54	-0.03	7.63	0.95	-0.11
L-4672	85.42	0.50	-3.66	148.92	1.05	7.50+	3.52	0.28	-0.03	6.48	1.26	-0.06
L-4148	103.75	0.85	-3.23	143.92	1.47**	-0.81	4.13	0.30	-0.02	7.25	0.63	-0.02
L-4598	94.83	0.78	-0.11	142.83	1.62	1.92	4.50	0.51	-0.02	8.02	0.73	-0.11
L-32225	61.75	0.61*	-3.48	126.00	1.26**	-1.10	4.11	1.49	-0.03	7.68	0.26**	-0.12
L-4147	104.58	0.79	-3.76	143.83	1.22	-0.10	4.41	0.98	-0.01	8.44	2.05	-0.01
L-4596	104.50	0.76	-3.14	144.33	1.02	-0.73	4.48	1.80	0.06	7.90	1.78**	-0.11
L-414	94.92	1.94**	-2.65	144.17	0.99	0.77	5.13	1.25	-0.03	8.67	1.91	-0.04
L-412	49.42	2.36**	-2.78	126.00	1.36**	-1.16	4.11	3.18**	-0.02	7.95	1.76**	-0.12
L-4597	73.58	1.39**	-3.66	145.58	0.39**	-0.81	4.57	0.39*	-0.03	7.62	2.96	0.63+
L-416	82.08	1.14	13.76	145.83	0.73	2.91	4.28	3.35*	0.04	7.23	1.77	-0.08
L-4661	61.92	0.50	-1.79	127.42	1.02	4.95	4.44	1.64	0.00	7.95	1.58	-0.02
L-417	62.42	0.44**	-3.95	144.75	0.88	-1.18	4.64	1.31	-0.03	8.40	2.06**	-0.10
L-4677	44.75	0.35*	-2.68	127.50	1.27	16.07++	4.88	2.32**	-0.02	8.66	1.22	-0.05
L-4620	71.33	0.01*	-0.33	127.25	1.14	5.89	3.91	1.03	-0.02	7.12	0.80	-0.11
L-310	90.00	2.92**	-2.51	143.75	0.97	6.21+	4.12	1.15	-0.02	7.35	1.12	-0.11
Pop Mean **S.E. of Mean**	85.53 1.00	1.00 0.41		142.91 1.78	0.99 0.71		4.204 0.01	0.99 0.82		7.58 0.15	1.00 0.62	

Genotypes	No. of Pods per plant			Plant height			No. of Seeds per pod			Biological yield		
	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d
L-415	79.82	1.10	8.12	27.95	0.60	-2.08	1.73	1.14	0.00	24.23	2.11	4.54
L-307	52.63	0.46	-19.06	26.35	0.78	-1.88	1.33	0.00	0.00	17.08	0.43	-1.79
L-4595	82.12	1.03	-18.86	28.72	0.91	-2.22	1.66	1.96	0.00	18.06	1.01	-1.47
L-4674	55.73	1.21	-17.62	30.99	0.78	-2.40	1.67	0.74	0.00	18.16	1.26	-1.44
L-396	89.91	1.42	3.55	36.25	1.08	-2.52	1.80	0.30	0.00	19.32	0.76	-1.74
L-308	85.76	0.50**	-19.92	31.17	0.84	-2.12	1.82	-0.36	0.00	18.64	0.55**	-2.34
L-306	80.74	0.62**	-20.13	31.54	0.56	-1.99	1.53	2.28	0.00	16.92	0.54**	-2.54
L-309	70.13	0.07	27.08	31.57	1.55**	-2.36	1.33	0.63	0.00	20.74	0.91	1.36
L-4676	81.22	0.52*	-19.75	32.02	0.26**	-2.29	1.44	0.19	0.00	22.56	0.29**	-2.36
L-4618	83.77	0.79	-19.63	31.14	0.67	-1.77	1.62	1.63	0.00	21.91	1.13	-2.43
L-4671	59.42	-1.70*	1.95	31.87	0.80	-1.63	1.56	2.31	0.00	12.35	-0.01**	-1.51
L-395	54.12	0.57*	-	27.30	0.62**	-2.51	1.73	-0.39*	0.00	10.91	0.63**	-

			19.70									2.40
L-386	95.37	-0.18	-12.38	33.07	0.27**	-2.29	1.76	1.61	0.00	20.28	0.49	-1.67
L-381	96.47	0.88	-19.92	33.19	1.03	-2.53	1.52	0.11	0.00	24.84	1.15	-2.04
L-4594	100.50	0.77	-18.34	34.83	0.23	-1.54	1.49	0.32	0.00	22.24	1.32	-1.88
L-4672	64.03	0.32	-11.76	28.35	0.02	-1.04	1.83	1.32	0.00	9.73	0.12**	-2.10
L-4148	87.73	0.51	-18.10	35.29	0.29**	-2.23	1.51	0.68	0.00	23.82	1.02	-2.12
L-4598	97.03	0.57	-17.01	35.67	0.27**	-2.41	1.87	0.90	0.00	26.15	0.82	-1.99
L-32225	87.37	0.69	-19.26	30.82	1.47**	-2.44	1.62	1.33	0.00	18.56	0.57**	-2.53
L-4147	96.29	0.89	-16.98	35.83	0.63	-2.24	1.86	1.92	0.00	24.77	0.89	-1.35
L-4596	73.17	1.16	-19.70	32.54	-0.30	1.41	1.77	-0.09	0.00	21.71	1.14	-2.27
L-414	93.46	0.74	-18.52	36.33	1.06	-2.03	1.81	-0.20	0.00	28.30	1.02	-1.26
L-412	96.24	3.62*	-1.63	37.77	2.03**	-2.51	1.54	4.33**	0.01	20.33	2.41*	0.89
L-4597	86.41	1.08	-16.80	34.03	2.95	4.61	1.72	0.87	0.00	22.72	1.52	-1.55
L-416	87.35	1.37	-17.12	33.93	1.84*	-2.04	1.65	1.09	0.00	21.70	1.98**	-2.05
L-4661	94.91	1.42**	-20.14	30.62	2.49	3.12	1.47	0.57	0.00	23.12	1.14	-0.84
L-417	95.32	2.11**	-19.92	32.03	1.17	-2.51	1.88	-0.17	0.00	28.71	0.40	-1.20
L-4677	92.72	4.28*	0.53	33.07	2.98*	0.64	1.77	-0.39*	0.00	30.00	1.64	4.95
L-4620	64.23	2.00*	-16.71	28.62	1.57	-1.50	1.57	2.28	0.00	19.21	1.97	0.98
L-310	90.30	1.18	10.19	35.30	0.55	-1.46	1.73	3.06*	0.00	19.17	0.77	-1.43
Pop Mean **S.E. of Mean**	82.46 1.63	0.99 0.75		32.27 0.61	1.00 0.46		1.65 0.03	.99 0.71		20.87 0.69	1.00 0.42	

Genotypes	**Seed yield**			**100-seed weight**			**Harvest index**		
	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d	$\overline{X}$	b_i	S^2d
L-415	7.84	2.51**	0.20	5.63	3.70**	0.00	32.27	0.99	0.23
L-307	5.53	0.57	-0.20	7.88	1.92**	-0.01	32.40	0.91	0.62
L-4595	5.83	1.21	-0.21	4.26	0.70	-0.01	32.25	0.45	0.13
L-4674	5.83	1.11	-0.21	6.28	0.68	0.02	32.17	1.49	0.46
L-396	6.25	0.58*	-0.23	3.87	0.50	0.00	32.44	1.81	0.03
L-308	5.93	0.37*	-0.18	3.78	0.79	-0.01	31.84	2.06	0.59
L-306	5.49	0.86	-0.21	4.43	0.70	-0.01	32.39	-1.27	2.29++
L-309	6.48	0.63*	-0.25	7.01	2.39	0.36++	31.53	4.30	2.74++
L-4676	7.20	0.50**	-0.23	6.16	0.37	-0.01	31.90	0.78	-0.02
L-4618	7.07	1.18	-0.21	5.16	0.85	-0.01	32.27	1.42	0.27
L-4671	3.88	-0.07**	-0.17	4.21	0.42	-0.01	31.44	0.40**	-0.23
L-395	3.37	0.39	-0.26	3.60	0.57	0.01	31.01	0.65	1.75++
L-386	6.59	0.72	-0.23	3.94	0.97	0.00	32.50	0.72	0.67
L-381	8.07	0.92	-0.22	5.49	1.60	0.00	32.52	0.70	0.74
L-4594	7.47	0.68**	-0.26	4.99	0.68	0.00	33.80	0.38	6.16++
L-4672	3.13	0.18**	-0.24	2.68	0.25**	-0.01	32.29	1.56	0.23
L-4148	7.68	1.05	-0.21	5.82	1.77	0.01	32.25	0.90	-0.15
L-4598	8.56	0.96	-0.26	4.73	0.78	-0.01	32.73	0.40	0.53
L-32225	5.90	0.53**	-0.24	4.17	0.15	-0.01	31.83	-0.22	0.29

L-4147	8.24	1.07	-0.03	4.63	0.79	0.01	33.27	0.46	0.64
L-4596	7.09	1.11	-0.26	5.49	1.25	0.01	32.73	1.32	0.62
L-414	9.16	1.31	-0.24	5.43	1.28	0.01	32.36	0.24	0.54
L-412	6.48	1.96	-0.03	4.36	0.58	0.04	32.09	2.32	0.60
L-4597	7.30	1.36	-0.22	4.91	1.68	0.01	32.15	1.54	-0.01
L-416	6.87	1.65	-0.26	4.75	1.81	0.03	31.75	-0.10	0.67
L-4661	7.50	1.07	-0.13	5.35	0.65	-0.01	32.49	0.23	0.54
L-417	9.28	0.86	-0.09	5.20	0.50	0.00	32.32	0.55	0.60
L-4677	9.97	2.08	0.44	6.07	0.35**	-0.01	33.22	1.40	0.73
L-4620	6.36	1.49	0.06	6.29	0.75	-0.01	33.34	2.07	1.47+
L-310	6.48	1.18	-0.09	4.22	0.54*	-0.01	33.76	1.59	3.32++
Pop Mean	6.76	1.00		5.03	0.99		32.38	1.00	
S.E. of Mean	0.19	0.34		0.09	0.53		0.62	1.14	

*, ** = significantly deviating from unity at P = 0.05 at P = 0.01 level, respectively.
+, ++ = significantly deviating from zero at P = 0.05 and P = 0.01 level, respectively.

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IN VITRO SALT INDUCED STRESS RESPONSES IN *CAPSICUM ANNUUM* CV. PUSA JWALA

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Abstract: The research work was carried out to study the effect of salt stress on biochemical aspects of different type of explants of cultivar Pusa Jwala of *Capsicum annuum*. Leaf, hypocotyls, cotyledonary leaf and stem explants were cultured on MS medium containing 2,2,4-D and various concentrations of NaCl (50, 100, 150 and 200mM) Data on fresh and dry weights of callus tissue were recorded monthly. Different biochemical parameters such as moisture percentage, proline accumulation, ascorbate, protein and phenolics were tested in order to put forward the relative tolerance to salinity. Present finding suggest that, the response of *capsicum* calli to salt stress may be accomplished by increasing the capacity of antioxidative system and the synthesis of new protein which could be in turn contribute to select a salt resistant in *Capsicum*.

Keywords: *Capsicum*, Ascorbate, Proline, Protein, Phenolics

INTRODUCTION

The morphological and biochemical changes in plant tissues in response to salinity stress are not completely understood. Saline solutions impose both ionic and osmotic stresses on plant tissues. In the present investigation, sodium chloride is used for inducing salt stress response in different experimental sets. Earlier studies on salt stress effects have shown the following general trends in plant tissues: retardation of growth (Thomas *et al*., 1992), increased level of proline accumulation (Rudulier *et al.*, 1984, Gangopathyaya *et al.*, 1997 a), increased level of phenolics, ascorbic acid and protein. The function of ascorbic acid is presumed to be protective, with a role in scavenging free radicals. Increased synthesis of a wide variety of proteins occurs in response to salt stress. Many of these such as the osmotins and dehydrins, have properties similar to chaperones, and appear to be involved in the maintenance of protein structure in the face of elevated salts and other conditions in which protein – water interactions are disrupted (Ingram and Bartels, 1996; Compbell and Close, 1997).

In the present study, the calli of *capsicum annuum* cv. Pusa Jwala were raised on MS nutrient medium (solid) containing various concentrations of NaCl. Relationship between accumulation of studied metabolites under salt environment has been discussed.

MATERIAL AND METHODS

Aseptic seedlings were raised on MS (1962) medium from the seeds of *capsicum annuum* cv. Pusa Jwala to obtain the different explants for raising callus. The explants were cultured on MS medium with different hormonal adjuants. Seeds of *capsicum annuum* cv. Pusa Jawala were soaked in sterile distilled water for 24h, surface sterilized with 0.1% $HgCl_2$ solution for 3-5 min and were finally rinsed thrice with sterile distilled water before inoculaton on MS medium (1962) for aseptic germination. Root, hypocotyl, cotyledonary leaf, stem and leaf of 2-3 weeks old seedlings served as explants.

All types of explants were inoculated on MS basal medium supplemented with 3% sucrose, 100mgl^{-1} meso inosital and different concentration of IAA, IBA, 2, 4-D, NAA, Kn, BAP how-ever, the best result for callus growth was obtained from medium with 2, 2-4D and hence further experiments were performed in this medium. The pH of the medium was adjusted to 5-8, the medium solidified with 8 gm l^{-1} agar – agar and dispensed into conical flasks (with each flask containing 30-35 ml medium for three or four explants) before autoclaving at 121^{0}C and 103.4 kpa for 15-20 min. Roots failed to induce callus. All cultures were maintained at 25 ± 1^{0}C under 16 h photoperiod at 40-50 µ mol m^{-2} S^{-1} light intensity produced from cool – white fluorescent tubes.

The calli raised on BMS supplemented with 2, 2, 4-D were then transferred on the same nutrient medium supplemented with NaCl salt in the concentration of 50 mM, 100 mM, 150mM and 200mM.

Biochemical Estimations

Proline : Proline was determined spectrophotometrically by the method of Bates *et al.* (1973).

Protein : Protein was estimated by Lowry *et al.* (1951) method.

Phenolics : Phenolics was estimated by Bray and Thorpe (1954).

Ascorbic acid : Ascorbic acid was estimated by Fuzita *et al.*, (1935)

RESULT AND DISCUSSION

All the callus tissues grown on NaCl containing media showed a increased proline content in

comparison to non – NaCl containing medium. Maximum proline content was observed at 200 mM NaCl by hypocotyl induced callus. Proline content was lowest in without NaCl containing media by cotyledon induced callus (Table 1).

In fact, a general response to salinity seems to be reduction in water content (Table - 2). There is evidence that plants may respond to high salinity by osmotic adjustment through the accumulation of low-molecular – weight organic compatible solutes, such as sugars, some amino acids and quaternary ammonium compounds, which are believed to be essential for adaptation of plant cells to high solinity (Bonhert *et al.*, 1995). One of the most common compatible solutes is proline. Several studies have described a correlation between proline accumulation and salt stress (Almansouri *et al.*, 1999; savoure *et al.*, 1999; Meloni *et al.*, 2001). Proline may also play a role in the antioxidant adaptation of plant cells against the presence of hydroxyl radicals, as previously demonstrated by *in vitro* studies (Smirnoff & Cumbes, 1989).

Ascorbate is among the most important non enzymatic antioxident molecules. Our results show an increase in ascorbate in salt treated calli (Table -3) as found in plants of other species subjected to water or salt stress (Meneguzzo *et al*., 1999; savoure *et al*., 1999; Benavides *et al*., 2000). In contrast, decrease was reported in the acerbate content in salt exposed plants of *Pisum sativum* and *setaria italica* (Gogorcena *et al.*, 1995; Iturbe – Ormaetxe *et al*., 1998; sreenivasulu *et al*., 2000). The increased ascorbic acid content is a stress protecting mechanism of plants under salinity conditions (Shalata *et al*. 2001). A high level of endogenous ascorbic acid is essential for maintaining the non enzymatic scavenging system that protects plants from oxidative damage due to salinity stress (Shigeoka *et al*. 2002).

Protein content also increased under the increasing levels of salt concentration but maximum protein increase occurs at 150 mm NaCl by cotyledonary leaf induced callus. Minimum protein increase at 50 mM NaCl by stem induced callus (Table-4). Under high water stress, some plants produce low-molecular-weight substances in abundance that lower the salute potential, such as amino acids and polyamines. The lower solute potential would cause an overall drop in water potential, so that water would still move into the cells and restore turgour (Marvel, 2003). Camara *et al*. (2000) observed an increase in proline, arginine, g-amino butyric acid, alanine, glutamine and glutamate in maize calli subjected to NaCl concentrations higher that 100 mol. m^{-3}. Salinity modulates the production of selected groups of proteins named "salt stress proteins" (Dell' Aquila and Spada, 1993). These results suggested that the pattern of "salt stress proteins" synthesis or protein turnover is different, according to the NaCl concentration and salt stress duration.

The effect of NaCl on total phenolics is shown in Table 4. NaCl at 200mM gave the highest content of total phenolics. Phenol accumulation could be a cellular adaptive mechanism for scavenging oxygen free radicals during stress (Mohamed and Aly, 2008). Several studies have reported that total phenol production is stimulated by NaCl (Hanen *et al*., 2008; Muthukumarasomy *et al*., 2000).

Table-1. Proline (mg proline/gfw±SD) in four week old callus of *C. annuum*

S.N.	BASAL MEDIUM SUPPLEMENTED WITH GROWTH REGULATOR (mgl^{-1}) AND SALTS (mM)	EXPLANT USED			
		HYPOCOTYL	COTYLEDONARY LEAF	STEM	LEAF
1.	BMS + 2.0,2,4-D	7.36 ± 1.46	0.96 ± 0.67	2.24±0.27	5.28±1.73
2.	BMS + 2.0,2,4-D + 50 mM NaCl	26.17 ± 6.46	6.40 ± 0.73	4.16±1.81	7.52±0.73
3.	BMS + 2.0,2,4-D + 100 mM NaCl	145.59±6.49	14.08 ± 2.26	7.36±1.46	16.16±2.93
4.	BMS + 2.0,2,4-D + 150 mM NaCl	85.64 ± 8.53	16.56 ± 5.77	15.67±4.09	21.28±2.93
5.	BMS + 2.0,2,4-D+ 200 mM NaCl	202.82±7.10	15.60 ± 3.72	24.17±1.54	41.77±5.76

Table-2 Moisture % in four week old callus of *C. annuum*

S.N.	BASAL MEDIA SUPPLEMENTED WITH GROWTH REGULATORS (mgl^{-1}) AND SALTS (mM)	EXPLANT USED			
		HYPOCOTYL	COTYLEDONARY LEAVES	STEM	LEAF
1.	BMS + 2.0,2,4-D	92.30	91.80	92.80	93.1

2.	BMS + 2.0,2,4-D + 50 mM NaCl	82.19	91.20	92.42	78.36
3.	BMS + 2.0,2,4-D + 100 mM NaCl	80.33	90.95	91.68	94.17
4.	BMS + 2.0,2, 4-D + 150 mM NaCl	77.27	90.50	89.38	89.67
5.	BMS + 2.0,2, 4-D + 200 mM NaCl	76.34	90.40	84.67	89.05

Table-3. Ascorbic Acid (mg ascorbic acid eq gfw^{-1} ± SD) in four week old callus of *C. annuum*

S.N.	BASAL MEDIUM SUPPLEMENTED WITH GROWTH REGULATORS (mgl^{-1}) AND SALTS (mM)	EXPLANT USED			
		HYPOCOTYL	STEM LEAVES	COTYLEDONARY LEAVES	LEAF
1.	BMS + 2.0,2,4-D	5.15 ± 0.22	4.83±0.02	5.11±0.06	2.47±0.12
2.	BMS + 2.0,2,4-D + 50 mM NaCl	4.11 ± 0.14	4.90±0.04	5.18±0.14	2.96±0.33
3.	BMS + 2.0,2,4-D + 100 Mm NaCl	12.50 ± 0.19	5.11±0.07	5.26±0.24	2.47±0.03
4.	BMS + 2.0,2,4-D + 150mM NaCl	15.00 ± 0.91	5.15±0.18	5.09±0.09	3.40±0.48
5.	BMS + 2.0,2,4-D + 200 mM NaCl	8.07 ± 0.75	5.08±0.08	3.06±0.16	2.95±0.16

Table-4. Protein (mg casein eq gfw^{-1} ±SD) in four week old callus of *CAPSICUM annuum* cv. P.J.

S.N.	BASAL MEDIA SUPPLEMENTED WITH GROWTH REGULATORS (mgl^{-1}) AND SALTS (mM)	EXPLANT USED			
		HYPOCOTYL	COTYLEDONARY LEAVES	STEM	LEAF
1.	BMS + 2.0,2,4-D	3.18 ± 0.64	5.00 ± 0.85	5.00 ±1.90	11.55 ±0.79
2.	BMS + 2.0,2,4-D + 50 mM NaCl	6.78 ± 0.70	8.61 ± 0.29	4.71 ±0.38	11.55 ±0.19
3.	BMS + 2.0,2,4-D + 100 mM NaCl	8.48 ± 0.54	11.20 ± 2.95	10.82 ±1.11	12.73 ±0.00
4.	BMS + 2.0,2, 4-D + 150 mM NaCl	11.90 ± 0.65	15.55 ± 1.35	7.15 ±0.21	14.31 ±1.09
5.	BMS + 2.0,2, 4-D + 200 mM NaCl	11.50 ± 1.31	11.33 ± 2.00	7.66 ±0.29	14.88 ±0.86

Table-5. Phenolics X 1000 (mg trans cinnamic acid eq gfw^{-1} ±SD) in four week old callus of *C. annuum*

S.N.	BASAL MEDIUM SUPPLEMENTED WITH GROWTH REGULATORS (mgl^{-1}) AND SALTS (mM)	EXPLANT USED			
		HYPOCOTYL	COTYLEDONARY LEAVES	STEM	LEAF
1.	BMS + 2.0,2,4-D	6.10 ± 0.82	5.52 ± 0.75	6.91±0.51	3.23±0.24
2.	BMS + 2.0,2,4-D + 50 mM NaCl	5.45 ± 0.78	22.02 ± 10.09	21.41±11.35	7.88±1.44
3.	BMS + 2.0,2,4-D + 100 mM NaCl	12.83 ± 0.99	23.91 ± 9.06	25.41±11.49	10.52±0.93
4.	BMS + 2.0,2,4-D + 150 mM NaCl	3.63 ± 0.54	22.06 ± 9.07	20.73±10.01	13.16±5.56
5.	BMS + 2.0,2,4-D + 200 mM NaCl	6.65 ± 0.68	21.02 ± 8.15	26.39±9.84	26.35±12.26

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RELATIVE DOMINANCE OF WEED FLORA IN WETLAND RICE ECOSYSTEM OF THIRUVANANTHAPURAM DISTRICT

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Abstract: The field survey on floral diversity and dominance was carried out to develop a database on the floral diversity and relative species dominance in wetland rice ecosystem of Thiruvananthapuram district during the first and second crop seasons, in both cultivated and fallow fields. The results revealed that in the cultivated fields during both seasons, the most prominent weed species among the three classes of weeds (grasses, sedges and broad leaved weeds) were *Isachne miliacea*, *Cyperus iria* and *Monochoria vaginalis* respectively. The relative dominance of the weeds in the fallows was found slightly different. While *Isachne miliacea* remained to be the dominant grass weed, the dominant sedge weed in the fallows was *Cyperus distans* during the first crop season while it was *Fimbristylis miliacea* during the second crop season. *Monochoria vaginalis* and *Ludwigia perennis* topped the list of broad leaved weeds in the rice fallows during first and second crop seasons respectively.

Keywords: Relative dominance, Weed flora, Wetland, Rice ecosystem, Rice fallow

INTRODUCTION

Weeds have been able to reproduce, survive and compete with the cultivated species of plants primarily due to its diversity and aggressivity. A thorough understanding of the ecological relationship between the crops and the distribution and prevalence of weed flora in a region is of great importance in planning the weed management strategies for the locality. Mapping of the weed profiles in space and time and relating dominant species shifts to changes in management practices and environmental factors in all rice growing areas are needed for sustained rice production (Auld and Kim, 1996).

In rice, the floristic composition, abundance and aggressivity are found to vary with agro-climatic situations, seasons and type of rice culture. Biodiversity in weeds occur as a result of differential survival mechanism of individual plant species. Heterogeneous weed populations exploit weakness in weed management strategies and adapt well to remain competitive with crop plants. This successful behavior in a weed population is the aggregate of diverse, individual plant behaviors and understanding this weed diversity in a field is essential for effective management of weeds (Rao, 2000). Suarez *et al.* (2001) found relationship between environment and weed vegetation and proposed that species composition may be used as an indicator of environment. The weed flora differs widely depending on the soil as well as environmental conditions and hence detailed information on the spectrum of weed flora is essential for the formulation of effective weed management strategies (Vidya *et al.*, 2004). With this background, an investigation was carried out to develop a database on the floral diversity and relative species dominance in wetland rice ecosystem of Thiruvananthapuram district.

MATERIAL AND METHODS

The field survey on floral diversity and dominance was carried out in rice fields of 30 panchayaths in Thiruvananthapuram district having more than 50 hectares of net sown area, covering all the four thaluks of the district *viz.*, Thiruvananthapuram, Chirayinkizhu, Neyyattinkara and Nedumangadu during the first and second crop seasons, in both cultivated and fallow fields. The design adopted was stratified multistage random sampling. Weed flora in wetland rice ecosystems were identified and quantified by census quadrate method using 0.5 X 0.5 m^2 quadrate. The quadrate was thrown at random by standing at the north - eastern corner of each field. The plants within the individual quadrate were collected and a total of 480 such bulk samples were taken both from the cultivated and fallow lands giving adequate representation to the area surveyed.

In the present study, the relative dominance of the weed flora was determined by working out the following vegetation analysis parameters proposed by Philips (1959). Importance Value was obtained by adding the relative density (Rd*)* and relative frequency (Rf) of a given species (Kent and Coker, 1992).

$$\text{Absolute density (Ad)} = \text{Total number of weeds of a given species m}^{-2}$$

$$\text{Relative density (Rd)} = \frac{\text{Absolute density of a species}}{\text{Total absolute densities of all the species}} \times 100$$

$$\text{Absolutefrequency Af} = \frac{\text{Number of quadrates in which a given species occurred}}{\text{Total number of quadrates used}} \times 100$$

$$\text{Relativefrequency Rf} = \frac{\text{Absolute frequency of a species}}{\text{Total of absolute frequencies of all the species}} \times 100$$

$$\text{Importance Value (IV)} = \text{Relative density (Rd)} + \text{Relative frequency (Rf)}$$

RESULT AND DISCUSSION

The results revealed that *Isachne miliacea* was the most dominant grassy weed in cultivated and fallow rice fields during both first and second crop seasons (Table 1 & 4). Among the sedges *Cyperus iria* recorded the maximum dominance in cultivated rice fields (Table 2) while *Fimbristylis miliaceae* was most dominant in rice fallows all throughout (Table 5). Among broad leaved weeds (BLW), *Monochoria vaginalis* recorded the maximum absolute and relative densities during first crop season in cultivated rice fields. *Alternenthera sessilis* was the most frequent BLW while *Bacopa moneri* recorded the maximum importance value. During the second crop season *Monochoria vaginalis* was the most dominant weed in cultivated rice fields (Table 3). In the rice fallows *Monochoria vaginalis* recorded the maximum absolute and relative densities and was the most frequent weed in first crop season. In second crop season *Ludwigia perennis* recorded the maximum absolute and relative densities while *Ammania baccifera* was the most frequent in rice fallows. *Alternenthera sessilis* recorded the maximum importance value in first crop season while *Ammania baccifera* recorded the maximum importance value in second crop season in rice fallows. During both the seasons *Monochoria vaginalis* was the most abundant BLW in rice fallows(Table 6).

As mentioned earlier, *Isachne miliacea*, definitely was the most dominant weed species during both seasons as well as under both cultivated and fallow situations and their absolute density was much higher than that of all the other weeds. According to Gopinath and Jithendra Pandey (2004) *Echinochloa colona* and *E. crus-galli* were the dominant weeds in transplanted rice in India. Sasidharan *et al*. (1990) and Thresiamma *et al.* (1990) studied the weed diversity in rice ecosystem of Kuttanad, Kerala and observed the predominance of *Echinochloa* spp. However in the present study *Isachne miliacea*, recorded weed dominance indices much ahead of that recorded for all other weed species while among other classes of weeds, the dominance varied with season as well as agronomic practices. *Isachne miliacea*, with its perennial nature and mat forming growth habit (above and below ground) was predominating and suppressing all other weed species in the wetland rice ecosystem in the study area. Such deviation from the general species distribution is in conformity with the observations of Vidya *et al*. (2004) and Sasidharan *et al.* (1990) that the weed flora differs widely depending on the soil as well as environmental conditions

It could also be elucidated that while season as well as agronomic practices had significant influence on the relative dominance of sedges and broad leaved weeds, the growth of *Isachne miliacea* was not found much influenced by these factors. It was evident that the perennial weed adapted well and persisted under the diverse wetland ecosystems in the district from the results of other vegetative parameters. As expected, the absolute weed density values of the weeds recorded in the fallows was substantially higher than that in the cultivated fields which could be attributed to the undisturbed ecosystem prevailing in the rice fallows.

Isachne miliacea spreads through seeds as well as through stem bits making it one of the most troublesome weed even under better managed situations. The weed is resistant to the prevalent farmer's practice of hand pulling and its mat forming roots interfere with the movement of wheels of small implements like rotary weeder restricting their efficient use. As observed by Rao (2000) manual weeding is effective against annuals and biennials, but do not control perennials and is expensive in areas where labour is scarce. The selective herbicides available in the market at present are also not effective in controlling this noxious grass. Clements *et al.* (1994) observed that integrated weed management (IWM) strategies can increase species diversity, reducing dominance of specific noxious weeds in any agro – ecosystem. In the present crop- weed scenario also such an integration of good agricultural practices (GAP) alone can be recommended as a viable strategy to restrict and manage *Isachne miliacea*

Table 1. Absolute Density (Number . m^{-2}), Relative Density (%), Absolute Frequency (%), Relative Frequency (%) and Importance value of Grasses in the cultivated wetland ecosystem of Thiruvananthapuram district during the first and second crop seasons

Sl. No	Scientific name	Ad		Rd		Af		Rf		IV	
		Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop
GRASSES											
1	*Isachne miliacea*	73.3	83.3	47.51	52.36	30.60	45.80	7.3	11.6	54.8	64.0
2	*Ischaemum indicum*	2.38	7.40	1.54	4.65	10.30	16.70	2.4	4.2	4.0	8.9
3	*Paspalam distichum*	4.68	1.03	3.03	0.65	8.10	3.80	1.9	1.0	5.3	3.2
4	*Brachiaria milliformis*	2.19	2.08	1.42	4.45	9.20	12.30	3.70	3.10	5.2	4.4
5	*Sporobolus diander*	2.12	1.36	1.37	0.85	5.60	5.20	1.3	1.3	4.9	1.7
6	*Echinochloa colona*	1.58	1.79	1.02	1.12	18.0	8.10	4.3	2.1	2.9	2.9
7	*Eleusine indica*	1.58	1.27	1.02	0.79	5.60	5.60	1.3	1.4	2.4	2.7
8	*Dactyloctenium aegyptium*	1.22	1.28	0.79	0.80	8.80	8.10	2.1	2.1	2.7	2.2
9	*Digitaria ciliaris*	0.93	1.55	0.60	0.97	7.50	6.70	1.8	1.7	2.3	2.2
10	*Sacciolepis interrupta*	0.92	1.11	0.60	0.70	5.20	4.40	1.2	1.1	1.8	1.8
11	*Ischaemum rugosum*	0.63	0.33	0.41	0.21	2.50	1.70	0.6	0.4	0.7	2.0
12	*Eragrostis uniloides*	0.46	0.32	0.30	0.20	3.80	3.10	0.9	0.8	1.2	1.0
13	*Hygrorhyza aristata*	0.38	0.36	0.25	0.23	3.80	2.90	0.9	0.7	1.2	0.9
14	*Eragrostis viscosa*	0.35	0.33	0.23	0.21	1.90	3.10	0.5	0.8	0.7	1.0
15	*Rottboellia exaltata*	0.52	0.03	0.34	0.02	1.70	0.40	0.4	0.1	1.0	0.6
16	*Oryza spontanea*	0.06	0.35	0.04	0.22	0.60	2.10	0.1	0.5	0.7	0.1
17	*Leersia hexandra*	0.26	2.00	0.17	1.26	1.90	2.90	0.5	0.7	0.1	0.7

Table 2. Absolute Density, Ad (Number . m^{-2}), Relative Density, Rd (%), Absolute Frequency, Af (%) and Relative Frequency, Rf (%)and Importance value, IV of Sedges in the cultivated wetland ecosystem of Thiruvananthapuram district during the first and second crop seasons

Sl. No.	Scientific name	Ad		Rd		Af		Rf		IV	
		Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop
1	*Cyperus iria*	9.35	9.22	6.05	5.80	43.3	41.0	9.75	9.6	16.3	16.1
2	*Fimbristylis miliacea*	3.08	4.05	1.99	2.54	10.4	10.4	2.5	2.6	5.3	4.6
3	*Cyperus distans*	4.13	2.89	2.67	1.82	10.8	11.0	2.6	2.8	5.3	4.4
4	*Cyperus difformis*	3.21	2.23	2.08	1.40	13.3	11.7	3.2	3.0	4.5	5.1
5	*Cyperus exaltatus*	1.39	1.80	0.90	1.13	8.1	9.8	2.9	1.8	4.2	2.5
6	*Schoenoplectus articulatus*	1.34	1.79	0.87	1.12	4.2	4.0	1.0	1.0	2.8	3.6
7	*Cyperus compressus*	1.97	1.06	1.28	0.67	12.3	7.1	2.9	1.8	2.5	2.7
8	*Cyperus pilosus*	1.11	1.16	0.72	0.73	7.5	7.7	1.8	2.0	2.2	2.6

9	Eleocharis dulcis	0.93	1.23	0.60	0.77	6.9	7.3	1.6	1.8	1.9	2.1
10	*Eriocaulon quinquangulare*	0.65	0.74	0.42	0.46	6.7	5.4	1.6	1.4	2.0	1.9
11	*Fuirena ciliata*	0.35	0.34	0.23	0.21	2.9	3.1	0.7	0.8	0.9	1.0
12	*Fimbristylis cymosa*	0.33	0.34	0.21	0.21	3.1	2.5	0.7	0.6	0.9	0.8

Table 3. Absolute Density, Ad (Number . m^{-2}), Relative Density, Rd (%), Absolute Frequency, Af (%) and Relative Frequency, Rf (%)and Importance value, IV of BLW in the cultivated wetland ecosystem of Thiruvananthapuram district during the first and second crop seasons

Sl. No.	Scientific name	Ad		Rd		Af		Rf		IV	
		I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop
1	*Monochoria vaginalis*	6.00	4.11	3.88	2.58	25.8	22.8	5.2	7.0	9.1	9.6
2	*Dopatrium junceum*	3.07	3.35	1.99	2.10	7.1	7.5	1.7	1.9	6.1	5.4
3	*Ammania baccifera*	3.00	3.02	1.94	1.90	17.5	4.2	3.5	2.9	4.7	4.4
4	*Bacopa monnieri*	4.22	1.69	2.73	1.06	13.8	8.8	3.3	2.2	5.2	3.3
5	*Alternanthera sessilis*	1.74	2.33	1.13	1.46	15.2	11.5	3.6	2.9	5.0	3.2
6	*Commelina benghalensis*	2.48	1.30	1.61	0.82	14.4	9.4	3.4	2.4	3.7	4.0
7	*Salvinia molesta*	1.78	1.74	0.04	0.02	7.9	7.7	1.9	2.0	3.8	3.0
8	*Wedelia calendulacea*	1.92	0.93	1.24	0.58	7.9	7.7	1.2	0.9	3.1	3.1
9	*Alternanthera tenella*	1.53	1.28	0.99	0.80	7.9	6.9	2.8	1.2	3.4	2.3
10	*Commelina diffusa*	1.41	1.09	0.91	0.68	7.1	7.5	2.5	1.6	2.5	2.3
11	*Marsilea quadrifoliata*	1.02	1.21	0.66	0.76	5.0	6.5	1.2	1.6	1.9	2.4
12	*Desmodium heterophyllum*	0.99	0.89	0.64	0.56	7.9	6.9	1.9	1.7	2.4	1.5
13	*Limnophila repens*	0.37	0.69	0.24	0.43	2.7	4.8	0.6	1.2	0.8	1.6
14	*Lindernia pusilla*	0.53	0.38	0.34	0.24	2.5	2.7	0.2	0.5	0.9	0.9
15	*Rotala indica*	0.43	0.40	0.28	0.25	1.9	2.9	0.5	0.7	0.8	1.0
16	*Impatiens oppositifolia*	0.36	0.33	0.23	0.21	1.9	1.9	0.5	0.5	0.9	0.7
17	*Hydrolea zeylanica*	0.38	0.25	0.25	0.16	2.7	2.1	0.6	0.5	1.0	0.5
18	*Rotala macrandra*	0.21	0.41	0.14	0.26	1.5	1.7	0.4	0.4	0.7	0.7
19	*Limnophila heterophylla*	0.33	0.16	0.21	0.10	3.3	1.5	0.8	0.4	0.5	0.7
20	*Lindernia crustacea*	0.15	0.27	0.09	0.17	0.8	2.1	0.6	0.7	0.3	0.7
21	*Sphaeranthus indicus*	0.06	0.03	0.04	0.02	0.4	0.4	0.09	0.1	0.1	0.1

Table 4. Absolute Density, Ad (Number . m^{-2}), Relative Density, Rd (%), Absolute Frequency, Af (%) and Relative Frequency, Rf (%)and Importance value, IV of Grasses in the rice fallows of Thiruvananthapuram district during the first and second crop seasons

Sl. No.	Scientific name	Ad		Rd		Af		Rf		IV	
		I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop
1	*Isachne miliacea*	91.86	87.61	56.02	53.68	30.0	43.8	7.9	11.5	63.92	69.18
2	*Ischaemum indicum*	5.43	19.94	3.31	12.22	8.3	20.0	2.2	5.3	5.51	17.52

3	*Paspalam distichum*	7.84	1.27	4.78	0.78	8.5	4.4	2.2	1.2	6.98	1.98
4	*Sporobolus diander*	1.73	1.58	0.60	0.97	7.3	5.4	1.9	1.4	4.02	2.79
5	*Sacciolepis interrupta*	2.63	0.54	1.60	0.33	5.4	4.0	1.4	1.1	3.03	2.62
6	*Eleusine indica*	0.83	1.87	0.51	1.15	4.8	4.8	1.3	1.3	2.50	2.37
7	*Panicum repens*	1.62	0.93	0.99	0.57	3.5	4.0	0.9	1.1	2.47	2.32
8	*Dactyloctenium aegyptium*	1.36	1.18	0.83	0.72	8.5	7.1	2.2	1.9	2.32	2.46
9	*Brachiaria milliformis*	1.35	1.12	0.82	0.69	12.3	8.1	3.2	2.1	3.0	1.43
10	*Digitaria ciliaris*	1.10	0.84	0.67	0.52	6.9	6.9	1.8	1.8	1.81	2.45
11	*Echinochloa colona*	0.69	1.08	0.42	0.66	7.1	6.9	1.9	1.8	1.89	1.67
12	*Eragrostis tef*	0.64	0.97	0.39	0.59	4.8	4.8	1.1	0.9	1.49	1.49
13	*Eragrostis unioloides*	0.50	0.66	0.30	0.40	2.1	2.7	0.8	1.3	1.10	1.70
14	*Ischaemum rugosum*	0.42	0.46	0.26	0.28	2.7	2.1	0.7	0.6	0.96	0.88
15	*Eragrostis viscosa*	0.30	0.48	0.18	0.29	2.1	2.7	0.6	0.7	0.78	0.99
16	*Leersia hexandra*	0.20	0.28	0.12	0.17	1.5	2.1	0.4	0.6	0.57	1.09
17	*Hygrorhyza aristata*	0.11	0.33	0.07	0.20	1.9	2.7	0.5	0.8	0.52	0.77
18	*Oryza spontanea*	0.18	0.20	0.11	0.12	0.6	1.5	0.2	0.4	0.31	0.52
19	*Rottboellia exaltata*	0.32	0.01	0.19	0.01	1.3	0.2	0.3	0.05	0.49	0.06

Table 5. Absolute Density, Ad (Number . m^{-2}), Relative Density, Rd (%), Absolute Frequency, Af (%) and Relative Frequency, Rf (%)and Importance value, IV of Sedges in the rice fallows of Thiruvananthapuram district during the first and second crop seasons

Sl. No.	Scientific name	Ad		Rd		Af		Rf		IV	
		I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop	I^{st} crop	II^{nd} crop
1	*Fimbristylis miliacea*	2.63	4.06	1.60	2.49	10.8	10.4	2.8	2.7	4.40	5.19
2	*Cyperus distans*	3.05	2.13	1.86	1.31	11.5	10.4	3.0	2.7	4.86	4.01
3	*Cyperus iria*	2.44	1.78	1.49	1.09	11.7	11.0	3.1	2.9	4.59	3.99
4	*Cyperus difformis*	2.41	1.75	1.47	1.07	12.3	10.2	3.2	2.7	4.67	3.77
5	*Cyperus compressus*	1.75	0.93	1.07	0.57	11.0	5.8	2.9	1.5	3.18	3.23
6	*Chara gymnopitys*	1.12	1.19	0.68	0.73	9.6	9.4	2.5	2.5	3.97	2.07
7	*Cyperus pilosus*	0.83	0.95	0.51	0.58	5.8	7.1	1.5	1.9	2.88	2.47
8	*Cyperus exaltatus*	0.79	0.97	0.48	0.59	8.3	7.3	2.2	1.9	2.68	2.49
9	*Eleocharis dulcis*	0.63	0.93	0.38	0.57	9.6	7.1	2.5	1.9	2.01	2.48
10	*Cyperus haspan*	0.25	0.80	0.15	0.49	5.4	7.3	1.4	1.9	1.55	2.39
11	*Eriocaulon quinquangulare*	0.56	0.45	0.34	0.28	5.0	4.4	1.3	1.2	1.64	1.48
12	*Fimbristylis cymosa*	0.23	0.69	0.14	0.42	2.3	2.9	0.6	0.8	0.74	1.22
13	*Fuirena ciliata*	0.40	0.46	0.24	0.28	2.5	2.7	0.7	0.7	0.91	1.05
14	*Schoenoplectus articulatus*	0.32	0.48	0.19	0.29	2.3	2.3	0.6	0.6	0.94	0.98

15	*Fimbristylis monostachya*	0.34	0.40	0.21	0.25	10.8	10.4	0.7	0.8	0.79	0.89
16	*Scirpus grossus*	0.49	0.50	0.29	0.31	4.0	4.6	1.1	1.2	1.39	1.51

Table 6. Absolute Density, Ad (Number . m^{-2}), Relative Density, Rd (%), Absolute Frequency, Af (%) and Relative Frequency, Rf (%)and Importance value, IV of Broad leaved weeds in the rice fallows of Thiruvananthapuram district during the first and second crop seasons

Sl. No.	Scientific name	Ad		Rd		Af		Rf		IV	
		Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop	Ist crop	IInd crop
1	*Ammania baccifera*	3.52	2.02	2.15	1.24	15.6	13.1	4.1	3.4	6.25	4.64
2	*Monochoria vaginalis*	2.30	1.92	1.40	1.18	10.6	10.0	2.8	2.6	5.25	3.63
3	*Commelina diffusa*	2.47	1.36	1.51	0.83	10.8	6.5	2.8	1.7	4.20	3.78
4	*Ludwigia perennis*	1.54	2.22	0.94	1.36	6.5	12.5	1.7	3.3	4.70	3.10
5	*Bacopa monnieri*	1.96	1.30	1.20	0.80	13.1	8.8	3.5	2.3	4.01	3.61
6	*Limnophila heterophylla*	2.22	0.90	1.35	0.55	8.3	4.2	2.2	1.1	2.64	4.66
7	*Alternanthera sessilis*	1.72	1.36	1.05	0.83	10.8	6.5	4.2	2.8	4.31	2.53
8	*Desmodium heterophyllum*.	1.13	1.82	0.69	1.12	7.3	9.0	1.9	2.4	2.59	3.52
9	*Dopatrium junceum*	1.13	1.76	0.69	1.08	5.8	7.5	1.5	2.0	2.88	2.45
10	*Commelina benghalensis*	1.50	1.33	0.91	0.81	11.7	10.6	3.1	2.8	2.19	3.08
11	*Impatiens oppositifolia*	1.86	0.61	1.13	0.37	2.1	2.9	0.6	0.8	3.55	1.65
12	*Marsilea quadrifoliata*	0.80	0.92	0.49	0.56	4.2	6.0	1.1	1.6	1.94	2.56
13	*Wedelia calendulacea*	0.99	0.69	0.60	0.42	4.8	4.0	1.3	1.4	1.59	2.16
14	*Alternanthera tenella*	0.78	0.73	0.48	0.45	9.0	7.5	2.4	2.0	1.90	1.82
15	*Salvinia molesta*	0.72	0.75	0.44	0.46	5.6	5.0	1.5	2.1	1.73	1.17
16	*Limnophila repens*	0.53	0.77	0.32	0.47	1.9	5.8	0.5	1.5	0.82	1.97
17	*Rotala macrandra*	0.63	0.55	0.38	0.34	2.5	2.3	0.7	0.6	1.08	0.94
18	*Hydrolea zeylanica*	0.15	0.72	0.09	0.44	1.7	2.3	0.4	0.6	0.67	1.22
19	*Rotala indica*	0.28	0.53	0.17	0.32	1.9	3.5	0.5	0.9	0.49	1.28
20	*Sphaeranthus indicus*	0.02	0.20	0.01	0.12	0.2	0.6	0.05	0.1	0.49	1.04
21	*Lindernia pusilla*.	0.03	0.11	0.09	0.38	0.6	1.0	0.2	0.3	0.22	0.37
22	*Lindernia crustacea*	0.03	0.11	0.02	0.07	1.5	3.5	0.4	0.9	0.06	0.14

CONCLUSION

The results of the present study revealed substantial floral diversity in wetland rice ecosystem of Thiruvananthapuram district. It was also evident that the relative dominance differed substantially with season and management practices adopted in the field.It must be mentioned that the predominance of *Isachne miliacea* specifically in the southern tracts of the state, warrants more detailed studies on the ecological requirements and preferences of the weed.

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EFFECT OF OPTIMAL, SUB-OPTIMAL AND INTEGRATED NUTRIENT MANAGEMENT ON SOIL PROPERTIES AND NUTRIENT UPTAKE ON RICE (*ORYZA SATIVA*)

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Abstract: The present investigation entitled "Effect of optimal, sub optimal and integrated nutrient management on soil properties and nutrient uptake on rice (*Oryza sativa*)" was carried out at the Research Cum Instructional Farm IGKV., Raipur (C.G.) during *kharif* season of 2010. The soil of experimental field was '*Inceptisols*' locally known as *Matasi*. It was neutral in reaction, low in nitrogen, medium in available phosphorus and potassium. The experiment was laid out in randomized block design with 3 replications. The results revealed that amongst the different optimal, sub-optimal and integrated nutrient management practices using green manure, farmyard manure and chemical fertilizers, T_{10} consisting of 50% RDF + 50% N through green manuring recorded the highest growth , energy output (178.38 MJ x 10^3) and NPK content in soil. Application of 100% RDF (80:60:40 kg NPK ha^{-1}) also proved superior over other integrated nutrient management systems consisting farmyard manure and rice residues for energy output (176.75 MJ x 10^3). Sub-optimal doses of nutrients failed to provide considerable yield advantage and build-up of nutrients in soil as compared to optimal level or integrated nutrient management options.

Keywords: Nutrient management, Nutrient uptake, Soil properties, Energy

INTRODUCTION

Rice-wheat is the super most cropping system adopted in Indian sub continent spreading over 13.5 million ha. In Chhattisgarh rice is the predominant crop grown in approximately 3.50 m. ha, which is around 77 % of the net cultivated area. The state is considered as "rice bowl" and the livelihood of almost 83% of rural population is depending only on rice cultivation. Although, during favorable monsoon years, the state relishes good production of with an ever time record of 60 lakh tones and 1.7 $t.ha^{-1}$ productivity in the year 2010-11; the long-term productivity of rice in the state is remained low (1.3 $t.ha^{-1}$) below to the national average. The main reasons for low productivity even in irrigated areas are application of inadequate and unbalanced quantity of fertilizers to this nutrient exhaustive crop, which not only resulted in low yield (Sharma *et al*., 2003) but also consequently declined the soil organic carbon and soil health.

Application of organic manure not only improves the soil organic carbon for sustaining the soil physical quality but also increases the soil N. Crop residues have potential for improving soil and water conservations, sustaining soil productivity and enhancing crop yields (Das *et al*., 2003). The most effective mean of arranging natural supply of N and organic matter to soil is *in situ* cultivation of legumes and their incorporation at appropriate stages of crop growth. The use of green manure in combination with chemical fertilizer tends to increase the fertility of rice field. Although green manure, is well known for its role in soil fertility and it supplies a part of nutrient requirement of the rice crop, at present the use of the green manure is became limited. Amongst the different green manure crop, *Sesbania aculeata* and sun hemp (*Crotolaria juncea*) find an important place in the rice based cropping system because of faster growth, low C: N ratio, high N (ranging from 80 to 220 kg ha^{-1}) and P, K and micronutrients contents.

The replacement of external inputs *viz.*, chemical fertilizers by farm-derived organic inputs normally leads to a reduction in variable input costs under organic management. In Chhattisgarh, by virtue of using less quantity of chemical fertilizers, integration of organic manures being an available sources of nutrients, could have better opportunity towards high remuneration with inherent lesser cost advantage. Therefore, keeping these points in view, a field experiment was carried out at Research cum Instructional farm, I.G.K.V., Raipur, during *kharif* season of 2010.

MATERIAL AND METHOD

The present investigation entitled "Effect of optimal, sub optimal and integrated nutrient management on soil properties and nutrient uptake on rice (*Oryza sativa*)" was carried out at the Research Cum Instructional Farm IGKV., Raipur (C.G.) during *kharif* season of 2010. The soil of experimental field was '*Inceptisols*' locally known as *Matasi*. It was neutral in reaction, low in nitrogen, medium in available phosphorus and potassium. The experimental area comes under dry moist to sub humid climatic condition. The region receives on an average of 1200-1400 mm rainfall annually, out of which about 87 percent received during the rainy season (June to September) and the rest of 13 percent during winter season (October to February). January is the coolest and May is the hottest month. The maximum temperature ranges from 26.7^0Cto 42.5^0C. The soil of experiment field was '*Inceptisols*' which is locally known as '*Matasi*'. The soil was neutral in

reaction and medium in fertility having low N, medium P and K. The experiment was laid out in randomized block design with three replications. The 12 treatments consisted of different nutrient levels some of them having integrated nutrient management.

Physico-chemical properties of the experimental site (initial in 1991-92)

No.	Particulars	Values	Rating	Methods used
A. Textural properties				
1.	**Mechanical composition**			
	Sand (%)	23		International pipette method (Black, 1965)
	Silt (%)	46	Silty clay	
	Clay (%)	31	(*Inceptisol)*	
B. Chemical composition				
1.	Organic carbon (%)	0.51	Medium	Walkey and Black's rapid titration method (Black, 1965)
2.	Available N (kg ha^{-1})	234	Medium	Alkaline permanganate method (Subbiah and Asija, 1956)
3.	Available P (kg ha^{-1})	11.5	Medium	Olsen's method (Olsen, 1954)
4.	Exchangeable K (kg ha^{-1})	280	Medium	Flame photometric method (Jackson, 1967)
5.	pH (1:2.5, Soil : water)	7.36	Neutral	Glass electrode pH meter (Piper, 1967)
6.	Electrical conductivity (m mhos m^{-1} at 25°C)	0.20	Normal	Solubridge method, (Black, 1965)
C. Physical composition				
3.	Bulk density (Mg m^{-3})			Soil Core Method (Black,
	0-15 cm, soil depth	1.12		1965)
	15-30 cm, soil depth	1.28		

Treatment details of the experiment

No	***Kharif* (Rice)**	**Notation**
T_1	No fertilizer, no organic manure (control)	No fertilizer, no manure (control)
T_2	50% recommended NPK dose through fertilizers(40:30:20)	50% RDF
T_3	50% recommended NPK dose through fertilizers.	50% RDF
T_4	75% recommended NPK dose through fertilizers	75% RDF
T_5	100% recommended NPK dose through fertilizers (80:60:40)	100% RDF
T_6	50% recommended NPK dose through fertilizers +50%N through farmyard manure	50% RDF+50% N (FYM)
T_7	75% recommended NPK dose through fertilizers +25%N through farmyard manure	75% RDF+25% N (FYM)
T_8	50% recommended NPK dose through fertilizers +50% N through composted rice residue	50% RDF+50% N (RR)
T_9	75% recommended NPK dose through fertilizers +25% N through composted rice residue	75% RDF+25% N (RR)
T_{10}	50% recommended NPK dose through fertilizers +50% N through green manure	50% RDF+50% N (GM)
T_{11}	75% recommended NPK dose through fertilizers +25% N through green manure	75% RDF+25% N (GM)

T_{12}	Conventional farmer's practice (50:30:20)	Farmers' practice 50:30:20 NPK kg ha^{-1}

- RDF: 80:60:40 $N:P_20_5:K_2O$ kg/ha.

RESULT AND DISCUSSION

1. Uptake studies

It is very clear from the data given in the Table-1&2 that NPK content and uptake in rice grain and straw at harvest was significantly affected by different optimal, sub-optimal and integrated nutrient management system. The higher yields enhanced the nutrient uptake.

1.1 Uptake of nitrogen

It is evident from the Table-2 that total uptake of N by rice was the minimum under control treatment, but increased significantly by applying fertilizers with different levels and/or supplemented with different organic manures such as FYM (T_6 and T_7), rice straw residue (T_8 and T_9) and GM (T_{10} and T_{11}). The total N uptake was maximum (97.21 kg ha^{-1}) with 50% N through GM + 50% RDF, closely followed by 100% NPK through RDF (96.90 kg ha^{-1}) and 50% N through FYM + 50% RDF (90.78 kg ha^{-1}). Application of nutrients as per farmers' practice also showed significantly more N uptake than the control. Higher uptakes of N with 100% RDF were also reported by Kumari *et al*. (2010) and with integrated nutrient management by Gupta *et al*. (2006).

1.2 Uptake of phosphorus

As regards to the uptake of P in rice grain and straw it is clear from the data presented in Table -1&2 that the P uptake by rice grain was recorded significantly highest under 50% N through GM + 50% RDF i.e. T_{10} over control (T_1), sub-optimal doses of nutrients (T_2, T_3 and T_4) and over T_8 and T_9 where N was supplemented through composted rice residues. While, uptake of P by rice straw and total P uptake (grain + straw) was recorded significantly maximum under 100% RDF where optimum dose of nutrients was applied. Sub-optimal doses of nutrients (T_1, T_2, T_3 and T_4) and N supplementation through composted rice residues (T_8 and T_9) failed to record higher uptake due to lesser amount of soil applied P and lower yield. P uptake in grains by the treatments having N supplementation through FYM and GM was higher to that of 100% RDF treatment.

Table -1: N, P and K content (%) in grain and straw of rice under different nutrient supply system in rice

Treatment		N		P		K	
		Grain	Straw	Grain	Straw	Grain	Straw
T1	No fertilizer, no manure (control)	0.90	0.31	0.17	0.037	0.160	1.72
T2	50% RDF	0.95	0.35	0.18	0.040	0.187	1.71
T3	50% RDF	0.99	0.35	0.18	0.047	0.193	1.78
T4	75% RDF	0.97	0.37	0.19	0.043	0.197	1.75
T5	100% RDF	1.20	0.40	0.23	0.060	0.233	1.94
T6	50% RDF+50% N (FYM)	1.16	0.35	0.24	0.040	0.200	1.89
T7	75% RDF+25% N (FYM)	1.13	0.32	0.22	0.040	0.200	1.83
T8	50% RDF+50% N (RS)	1.10	0.31	0.21	0.040	0.190	1.79
T9	75% RDF+25% N (RS)	1.06	0.33	0.20	0.047	0.187	1.76
T10	50% RDF+50% N (GM)	1.13	0.44	0.23	0.040	0.227	1.91
T11	75% RDF+25% N (GM)	1.10	0.38	0.21	0.040	0.190	1.85
T12	Farmers' practice 50:30:20 NPK kg ha^{-1}	0.97	0.32	0.19	0.037	0.173	1.78
	SEm±	0.05	0.06	0.009	0.006	0.008	0.04
	CD 5%	0.14	0.22	0.029	0.017	0.028	0.11

1.3 Uptake of potassium

Like P, the total uptake of K by rice was significantly increased with the use of 100% RDF (T_5) or in combination with organic manures like FYM (T_6 and T_7), composted rice residue (T_8 and T_9) and green manures (T_{10} and T_{11}) over sub-optimal doses, control and farmers' practice (T_{12}). The total K uptake was the maximum with the treatment T_5 (161.28 kg ha^{-1}, total uptake) followed by 50% N-substitution through GM +50% RDF (159.35 kg ha^{-1}). The results are in conformity with the findings of Gupta *et al*. (2006).

Table -2: N, P and K uptake (kg ha^{-1}) in grain and straw of rice under different nutrient supply system in rice

	Treatment	Nitrogen			Phosphorus			Potassium		
		Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T1	No fertilizer, no manure (control)	12.22	7.06	19.34	2.27	0.83	3.10	2.18	39.09	41.27
T2	50% RDF	32.85	17.66	50.51	6.25	2.00	8.25	6.48	85.62	92.10
T3	50% RDF	39.10	18.30	57.28	7.00	2.42	9.42	7.66	92.29	99.95
T4	75% RDF	41.45	22.81	64.28	8.23	2.65	10.88	8.37	106.84	115.21
T5	100% RDF	66.04	30.87	96.90	12.69	4.59	17.28	12.88	148.40	161.28
T6	50% RDF+50% N (FYM)	63.92	26.87	90.78	13.22	3.07	16.29	11.02	145.05	156.07
T7	75% RDF+25% N (FYM)	60.54	23.71	84.24	11.75	2.96	14.71	10.68	135.29	145.97
T8	50% RDF+50% N (RR)	59.54	22.68	82.21	11.22	2.89	14.11	10.32	129.29	139.60
T9	75% RDF+25% N (RR)	56.58	23.61	80.15	10.71	3.33	14.04	9.99	125.98	135.97
T10	50% RDF+50% N (GM)	63.49	33.65	97.21	12.74	3.07	15.80	12.74	146.61	159.35
T11	75% RDF+25% N (GM)	60.13	29.29	89.43	11.63	3.08	14.71	10.36	142.65	153.00
T12	Farmers' practice 50:30:20 NPK kg ha^{-1}	29.26	15.65	44.87	5.75	1.80	7.55	5.25	87.46	92.71
	SEm±	3.30	1.52	3.32	0.66	0.42	0.66	0.65	3.68	3.62
	CD 5%	9.68	4.47	9.73	1.94	1.24	1.94	1.91	10.80	10.62

Table -3: Soil organic carbon and Available nutrients (kg ha^{-1}) under different nutrient supply system in rice

	Treatment	OC (%)	N	P	K
T1	No fertilizer, no manure (control)	0.48	172	11.60	172
T2	50% RDF	0.52	208	18.33	220
T3	50% RDF	0.60	232	20.13	230
T4	75% RDF	0.61	246	20.60	241
T5	100% RDF	0.69	263	27.87	276
T6	50% RDF+50% N (FYM)	0.66	260	24.73	280
T7	75% RDF+25% N (FYM)	0.66	256	26.33	285
T8	50% RDF+50% N (RS)	0.59	253	23.07	263
T9	75% RDF+25% N (RS)	0.57	247	20.13	260
T10	50% RDF+50% N (GM)	0.70	272	29.47	297
T11	75% RDF+25% N (GM)	0.69	265	25.27	280
T12	Farmers' practice 50:30:20 NPK kg ha^{-1}	0.59	228	21.00	241
	Initial value	0.51	234	11.5	232
	SEm±	0.01	5	1.01	5
	CD 5%	0.04	15	2.95	16

2. Soil properties

Continuous application of green manuring or adding of rice residues or FYM over a long period of time offer the twin benefits of soil quality and fertility enhancement while meeting a part of nutrient need of crops, not only sustain the higher yields of crop but also cut the expensive fertilizers on the other hand.

2.1 Organic Carbon

Data presented in Table-3 clearly reveal that exclusion / omission of inorganic fertilizers from system (control plots) lowered the organic carbon (0.48%) even it was remained lesser than the initial values (0.51%) as compared to all the other treatments. Incorporation of FYM, RR or GM in conjunction with fertilizer increased significantly organic carbon (OC) content of surface soil. While, among the inorganic fertilizer treatments, only 100% RDF was found capable to those which have received integrated nutrient management practices and improved the OC content (0.69%) even more than 50% or 75% N through RR. Application of FYM (50% RDF + 50%N through FYM and 75% RDF + 25%N through FYM in T_6 and T_7 respectively), composted RR (50% RDF + 50% N through RR and 75% RDF + 25% N through RR in T_8 and T_9 respectively) and GM (50% RDF + 50% N through GM and 75% RDF + 25% N through GM in T_{10} and T_{11} respectively) significantly improved the organic carbon over initial status. Improvement in OC status in FYM/RR/GM treated plots after a continuous 31 cropping cycles was also reported by Sharma *et al*. (2007).

2.2 Available N

Available N content of surface soil varied significantly with application of FYM/RR/GM in combination with fertilizers over initial status. The highest available nitrogen in surface soil (272 kg ha^{-1}) was recorded with *in situ* application of GM for 50% N supplementation + 50% of RDF (T_{10}) followed by 25% N through GM + 75% of RDF (T_{11}) (265 kg ha^{-1}). Adding *Sesbania aculeata* as green manure favoured the soil conditions and might have helped in the mineralization of soil N leading to build-up of increased available N (Bajpai *et al*., 2006). On the other hand, increase in supply of available nitrogen from 50% to 75% FYM (T_7) and RR (T_9) failed to adding of nitrogen to the available pool of the soil and did not recorded the comparable values to that of GM. Among the inorganic fertilizer treatments, 100% RDF have maintained the available N level of soil. It was significantly improved the N status (263 kg ha^{-1}) over suboptimal doses as well as to those of T_7, T_9 and the initial values of 234 kg ha^{-1}. This also indicates that if balanced fertilizer is used or integrated with manures rationally, substantial improvement in soil health can be expected (Table - 3).

2.3 Available P

Incorporation of 50% N through GM + 50% RDF (T_{10}) and 100% RDF (T_5) recorded significantly higher available P (29.47 and 27.87 kg ha^{-1} respectively) than farmers' practice, T_2, T_3, T_4, T_6, T_8, T_9 and off-course over control (Table-3). Available P content of the soil was also increased with incorporation of varying level of FYM (both 25 and 50% N) and added comparable P to that of T_{10} and T_5. Incorporation of RR at both 25 and 50% N substitution with chemical fertilizer not succeeded to improve P status markedly as compared to sub-optimal and farmers' practice might be due to lesser P content of RR which failed to add more P in the soil. It is an established fact that crops only use 25 to 30% of applied phosphorus and rest remains in soil. Increase in available P with FYM application might also be due to solubilization of the native P in the soil through release of various organic acids. This is more pronounced at the higher moisture level under irrigated conditions. Organic manures enhanced the labile P in soil through complexation of cations like $Ca^{2+}$and Mg^{2+} which are mainly responsible for fixation of P when it is applied in combination with inorganic fertilizer. Tolanur and Badanur (2003) also supported that organic matter like FYM and GM with inorganic fertilizer had the beneficial effect on increasing the phosphate availability.

2.4 Available K

The available K content of surface soil in rice in rice-wheat crop rotation differed significantly due to various levels of organic manures in combination with inorganic sources of nutrients. GM in conjunction with fertilizer (50% N + 50% of RDF) could only increase the available potassium (297 kg ha^{-1}) significantly over other treatments and to that of initial status (Table-3). Interestingly, like N and P status, 100% RDF level (T_5) could not maintain comparable K level as much to that of T_{10}. Even, incorporation of FYM to meet 25% N + 50% RDF recorded the significantly higher available K over sub-optimal dose of fertilizers, rice residue integration and slightly over 100% RDF level. Increase in available potassium due to GM application may be attributed to the direct addition of potassium to the available pool of the soil. Kharub and Chander (2010) also reported less negative K balance where organic sources of nutrients applied in parts or full. The beneficial effect of GM and FYM on available potassium may be ascribed to the reduction of potassium fixation and release of potassium due to interaction of organic matter with clay, besides the direct potassium addition to the potassium pool of the soil. But, the available K content in the soil could not rise in RR incorporation over control and graded inorganic fertilizer treatments as in GM/FYM. This could be attributed

to more K removal than small addition in rice in rice-wheat cropping system (Kumar *et al*., 2008).

3. Energy analysis

The data related to energy input, energy output and energy parameters viz. energy output -input ratio and energy productivity are presented in Table- 4. The data revealed that energy output and energy parameters of rice were significantly affected due to different nutrient management options used. The lowest values of all energy parameters were obtained under control where rice was grown without fertilizers and manures.

As regard to the response of energy parameters to different optimal, sub-optimal and integrated nutrient management adopted in rice, in general, owing to the higher yields the total output energy, recorded significantly the maximum (178.38 MJ x 10^3) where integration of 50% N through GM with 50% RDF (T_{10}) were opted and closely followed by 50% N integration with FYM (T_6) and 75% N through GM (T_{11}). However, in case of 100% RDF level (T_5), input: output energy ratio was significantly lower (9.50) as compared to integrated nutrient management options due to higher energy input in terms of inorganic fertilizers. Interestingly, despite of lowest grain and straw yield and output energy recorded, the input; output ratio and energy productivity were significantly maximum under T_1 as compared to all the other optimal, sub-optimal and integrated treatments due to not applying any of the nutrient under this treatments which resulted in smaller amount of energy.

Table- 4: Energy analysis of different nutrient management systems

	Treatment	Input energy (MJ x 10^3)	Output energy (MJ x 10^3)	Input: output energy ratio	Energy productivity
T1	No fertilizer, no manure (control)	3.58	48.44	13.55	381.12
T2	50% RDF	11.09	113.61	10.25	313.83
T3	50% RDF	11.09	123.18	11.11	357.43
T4	75% RDF	14.84	139.06	9.37	286.93
T5	100% RDF	18.60	176.75	9.50	296.74
T6	50% RDF+50% N (FYM)	16.29	176.94	10.86	338.19
T7	75% RDF+25% N (FYM)	17.45	171.10	9.81	306.20
T8	50% RDF+50% N (RR)	16.29	170.26	10.45	333.20
T9	75% RDF+25% N (RR)	17.45	168.01	9.63	306.92
T10	50% RDF+50% N (GM)	16.29	178.38	10.95	344.84
T11	75% RDF+25% N (GM)	17.45	176.50	10.12	312.41
T12	Farmers' practice 50:30:20 NPK kg ha^{-1}	12.39	105.80	8.54	244.36
	SEm±	-	3.23	0.30	18.66
	CD 5%	-	9.48	0.90	54.74

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POST-FERTILIZATION OVULE ABORTION IN *VIGNA RADIATA* (L) WILCZEK

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Abstract: *Vigna radiata* (L.) Wilczek is a promising and widely used pulse crop in India. Unfortunately, the yield of this crop has been low. One of the reasons for this low yield has been the occurrence of as much as 50 per cent ovule abortion. The position of the abortive ovules varies from the first to the fourteenth position in the pod. To gain an insight into the cause(s) that lead to ovule abortion, developmental changes in ovules have been studied at light and ultramicroscopic level. Besides, behaviour of chromosomes in two sex mother cells i.e. embryo-sac mother cell and pollen mother cell has also been studied. Although the chromosomal studies in female sex mother cells did not reveal any abnormality in the behaviour of chromosomes thus ruling out its involvement in inducing abortion, the detailed ultrastructural studies revealed ovule abortion in *V. radiata* to be taking place at proembryo stage. Degeneration of cellular components particularly in integumentary cells was a common feature observed in these ovules. This study reveals that besides the endosperm failure, which is generally regarded as the main cause of ovule abortion, changes in integumentary cells may also lead to abortion of ovules.

Keywords: *Vigna radiata*, Ovule abortion, TEM, Autophagy, Integument degeneration, Female meiosis, Myelin bodies

INTRODUCTION

Represented by about 150 species all over the world, the members of genus *Vigna* occur mostly in old world particularly the African subcontinent (Kochhar, 2009). Some of its species are economically important and one among those is *Vigna radiata* (L) Wilczek. *V. radiata* is popularly known as green gram or 'Mung' in India and is an important pulse crop. Together with other legumes, it occupies an important place in the overall scheme of solving the problem of protein malnutrition. *V. radiata* has been an excellent source of protein, mineral and vitamins. Its seeds are used as pulse and 4-day old seedlings are eaten as vegetable. In view of its tremendous utility, several attempts have been made by plant breeders and plant physiologists to improve the yield of this pulse crop (Baldev and Jain, 1986). One of the major reason(s) for sharp decline in yield has been the failure of some ovules to mature into a well developed seed after fertilization in most of the pods. Detailed account of embryological changes that lead to normal seed development is available for a number of legumes (Marinos, 1970; Salgare, 1973; Deshpande and Bhasin, 1974; Johri, 1984; Tilton *et al.*, 1984). It has been a known fact that integumentary cells transport nutrients to developing embryo (Kapil and Tiwari, 1978; Offler *et al.*, 2003). The events occurring after fertilization is the proliferation of endosperm, which promotes the transfer of nutrients from integuments to the embryo. During embryo development, nucellar cells degenerate. The nutrients from these cells as well as endosperm cells are consumed by developing embryo (Mansfield and Briaty, 1992).

Crop yield affected by abiotic stresses has been reported as much as 20 fold below their optimum (Boyer, 1982; Bray *et al.*, 2000). The ovule abortion results occasionally from developmental program that limits the number of seeds/fruits (Pimienta and Polito, 1982, 1983; Raju *et al.*, 1996). It may also results from resource limitations attributed to environmental conditions (Miller and Chourey, 1992; Stephenson, 1992; Suzuki *et al.*, 2001). In Glycine max, pre-anthesis water deficits caused defects in ovule development (Kokubun *et al.*, 2001). The hypothesis which explains that plants maximize maternal fitness by aborting a portion of developing flowers, ovules or seeds (Lloyd, 1980) is derived from the observation of stress-induced senescence or PCD (Liu *et al.*, 2010) of reproductive organs in many plant species. In view of the lack of information on developmental changes that lead to ovule abortion, in *Vigna radiata*, the present study was initiated. Moreover, during the present course of investigations, meiotic studies, particularly the female meiosis, were conducted to find out the probable role of chromosomal behavioral changes, if any, in inducing seed abortion.

MATERIAL AND METHODS

Seeds of *Vigna radiata* (L.) Wilczek var. PS 16 were obtained from Indian Agricultural Research Institute (IARI), New Delhi and sown in the Botanical Garden of Delhi University. To find out the time of anther dehiscence and anthesis, a large number of fully grown buds were tag marked during the day and fixed in the evening on the same day at one hour intervals till the midnight hour. Anther dehiscence was first encountered in the buds fixed between 10.30-11.00 p.m. Pollination followed immediately after anther dehiscence. Anthesis took place early next morning. The open flowers picked up during that day were taken to be one day old after pollination (l DAP).

For ultrastructural studies, the ovules were dissected out from ovaries collected 1-3 days after pollination. They were transferred to a freshly prepared solution of 5% glutaraldehyde (Taab laboratories, Reading,

U.K./Fluka, AG Buchs SG, Switzerland). The fixative was made by diluting the commercially available 25% glutaraldehyde with 0.05 M Sörensen's phosphate buffer (pH 6.8). The material was placed under vacuum in order to remove air from the ovules to facilitate the penetration of the fixative. The material was washed in cold buffer (4 changes at 3 hours intervals) and post-fixed in 2% w/v aqueous osmium tetroxide (Ladd Research Industries, Vermont, U.S.A.) solution for 2 hours at 4°C. Specimens were then washed in phosphate buffer (3 changes of 30 min. each) at 4°C prior to dehydration in order to remove traces of osmium.

The material was dehydrated in a graded acetone series, infiltrated and embedded in resin/Epon 812 (Ladd Research Industries, Vermont, U.S.A.) using 'Beem ' polyethylene capsules. Thin sections (500 – 800 Å) were cut on a Sorvall Porter Blum MT -2 ultramicrotome. The sections were stained with alkaline lead citrate (Reynolds, 1963). The stained grids were observed in Philips EM 300 transmission electron microscope operated at 80 KV. Photographs were taken on 35 mm Kodak roll film (Type 5302) on Kodak Sheet Film (Type 4489).

To know whether the chromosomes behaved normally during the microsporogenesis and megasporogenesis or showed abnormal behaviour that could lead to defective development of seed, both male and female meiosis was studied in the anthers and ovules of young unopened buds, respectively. The buds of appropriate size, taken from 5-6 plants, were fixed separately in 1:3 acetic alcohol for 24 hrs. These were then preserved in 70 percent alcohol till further use.

For meiotic studies anthers and ovaries, isolated from the same plant used for TEM studies, were hydrolyzed together in 5N HCI at room temperature for 20 min and then stained in Leucobasic Fuchsin. While male meiotic studies were carried out by squashing feulgen stained anthers in a drop of 1 percent acetocarmine, for female meiotic studies ovules were first dissected out of ovaries using dissection microscope and then stained in a drop each of acetocarmine and 45 percent acetic acid. All the ovules taken out together from a single ovary, were gently tapped under the coverslip ensuring that the large sized megaspore mother cell did not break and/or slipped under nucellar tissue. All the observations were made from the temporary slides and photomicrographs of selected cells were taken using Olympus CH30 microscope with photomicrographic attachment.

RESULT

Vigna radiata var. PS 16 is an erect, annual, profusely branched plant which produces yellow flowers in clusters on axillary and terminal racemes. The flowers are self-pollinated. Pollination occurs immediately after anther dehiscence and fertilization takes place a few hours after pollination with zygote dividing immediately after its formation. The ovary initially measures 0.9-1.2 cm on one day after pollination (DAP) and its size increases to 7-10 cm by 12 DAP. As the growth of pods proceed, some of the ovules attached to marginal placenta, abort on the way and fail to reach maturity. The difference in the size of normally growing ovule and the one destined to abort is easily discernible even at early stages during pod development. Interestingly, the aborted ovules are not restricted to the proximal or distal ends of the fruit. The ovary generally produces 10-14 ovules and abortive one could be located anywhere between the first and the fourteenth position (Fig. 1). To gain an insight into the events leading to abortion of ovules, anatomical studies were carried out at light and ultrastructural level. Male and female meiotic studies were also carried out to find out if any anomalous chromosomal behaviour had led to ovule abortion.

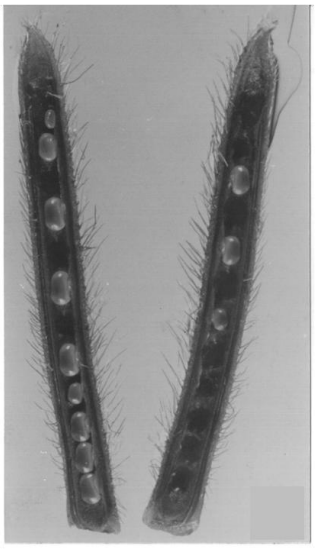

Figure 1: Split open pods 2DAP showing normal and abortive ovules . x 6.

Ultrastructural Studies

Detailed account of embryological changes leading to the development of normal seed is very well documented in a number of legumes and more or less follow same course of events in all legumes. In *V. radiata* cellular changes occurring during the development of normal ovule very much synchronize with the observations made earlier on *Phaseolus* species (Lorenzi *et al.*, 1978; Mishra and Sahu, 1970; Salgare, 1973; Savithri and Ganapathy, 1978; Yeung and Clutter, 1979). However, wherever necessary a brief mention of anatomical changes occurring in normal ovules has been made to facilitate comparison of cellular events leading to abortion of ovules.

Study of anatomical changes at ultrastructural level revealed that ovule abortion was occurring at pro-

embryo stage. The ovule abortion was characterized by the presence of following features:

The ovules collected from pods 1 DAP showed zygote and primary endosperm nucleus (Fig. 2).

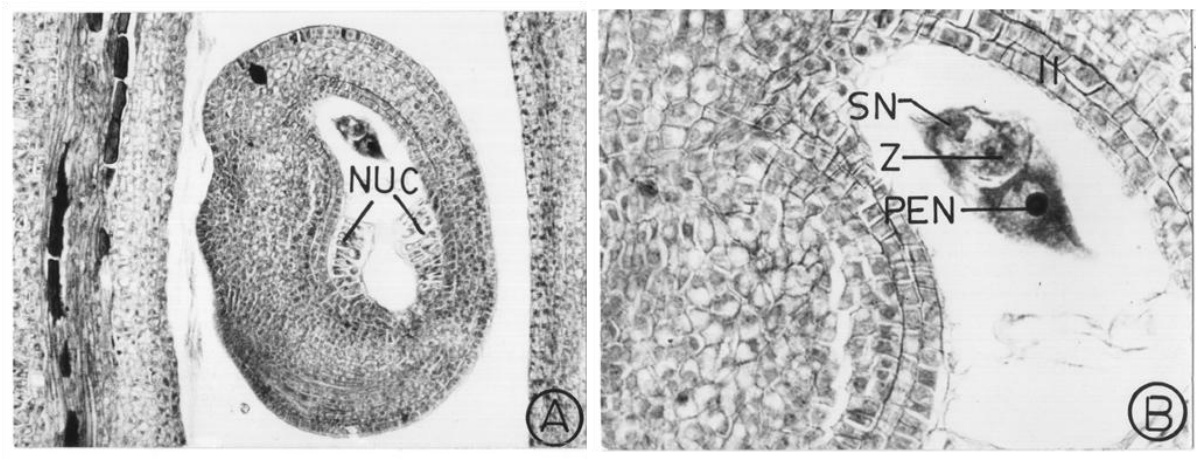

Figure 2: A. L.S. of abortive ovule 1 DAP showing zygote, primary endosperm nucleus and synergid cell . x 140. **B.** A portion enlarged. x 280.

However, in this type of aborting ovule on 2 DAP, though the zygote divides to form a few-celled proembryo, the primary endosperm nucleus remains undivided (Fig. 3). The cells in the outer integument (inner layers) showed vacuolated cells with thin walls and plasmodesmatal connections. Besides, cells also showed the presence of multivesicular structures; the cell organelles other than nucleus were not discernible.

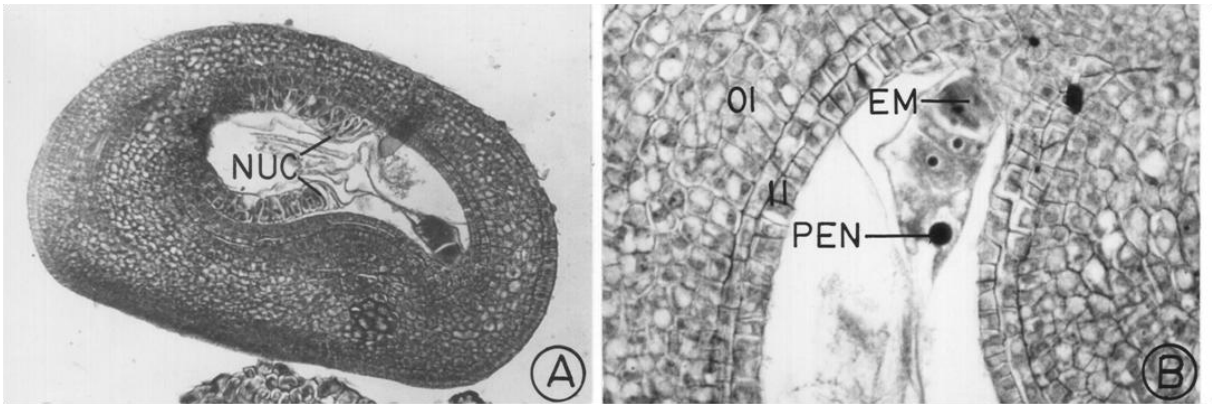

Figure 3: A. L.S. of abortive ovule 2 DAP showing a few-celled proembryo and undivided primary endosperm nucleus. x 160. **B.** A portion enlarged. x 450.

A very common and curious feature of the cells of the outer and inner layers of outer integument was the formation of concentric, membranous bodies (myelin-like bodies) in the vacuoles (Fig. 4). The various stages in the formation of complete myelin-like bodies could be traced in these cells. In some cells, cytoplasmic contents were seen included in the vacuoles. On 2 DAP, the cells had fully formed myelin-like bodies with many concentric rings of membranes (Fig. 5) and later these became highly vacuolated (Fig. 6). These type of myelin-bodies were also observed in degenerating nucellar cells of normal ovule (Fig. 7).

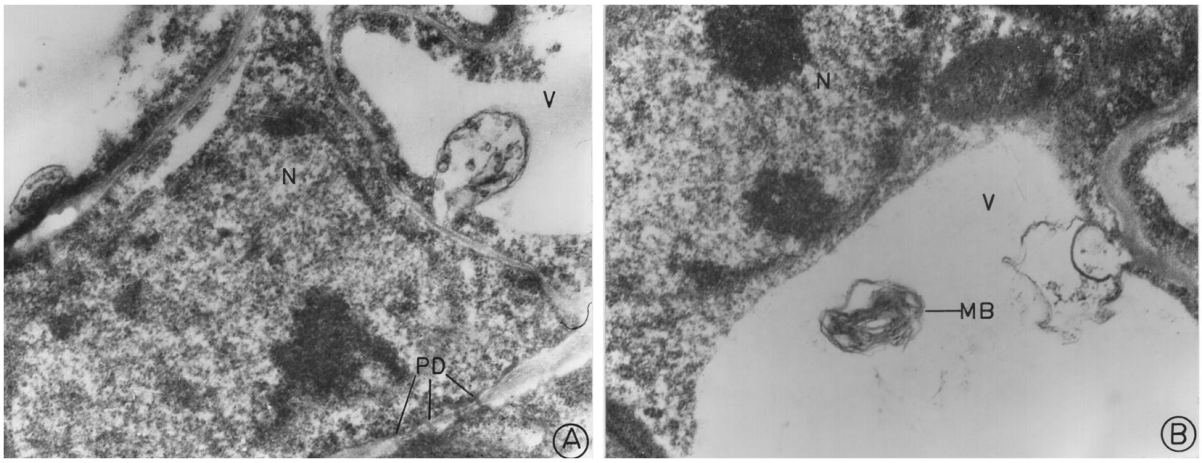

Figure 4: Longisections of portions of post-fertilization abortive ovules (1 DAP) to show cellular details of outer integument. **A.** A cell from the outer layer shows the release of cytoplasmic contents into the vacuole (autophagy) in the form of a multivesicular body. x 36,000. **B.** A cell from the inner layers showing the presence of a myelin-like body in the vacuole. x 36.000. (MB – Myelin-like body, N – Nucleus, PD – Plasmodesmata, V – Vacuole).

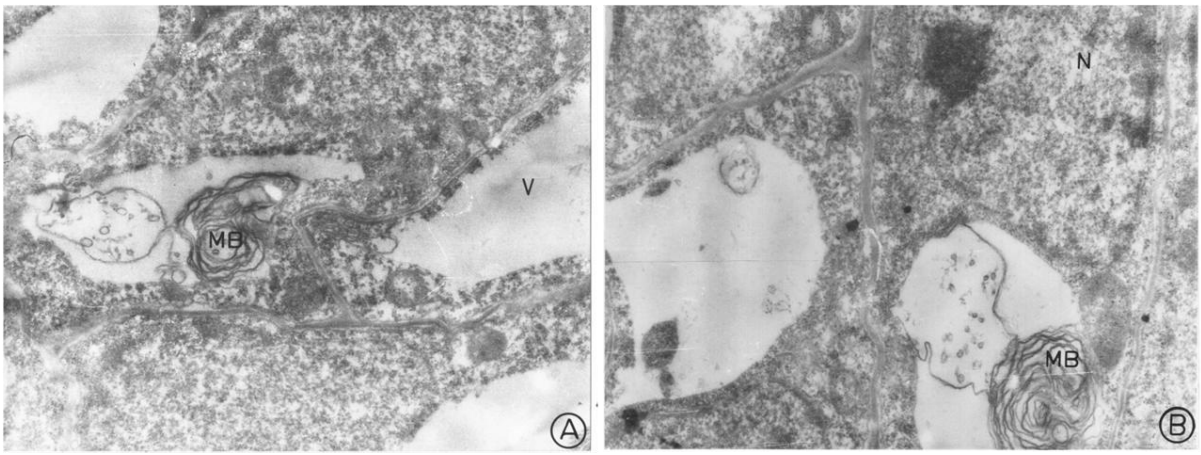

Figure 5: Longisections of portions of post-fertilization abortive ovules (2 DAP) to show changes in the outer integument. **A.** Cells from the outer layers of the outer integument (2 DAP) show well-formed myelin-like bodies and pronounced vacuolation. x 28,200. **B.** Inner layers of outer integument also have vacuolated cells with myelin-like body formation. x 28,200. (MB – Myelin-like body, N – Nucleus, V – Vacuole).

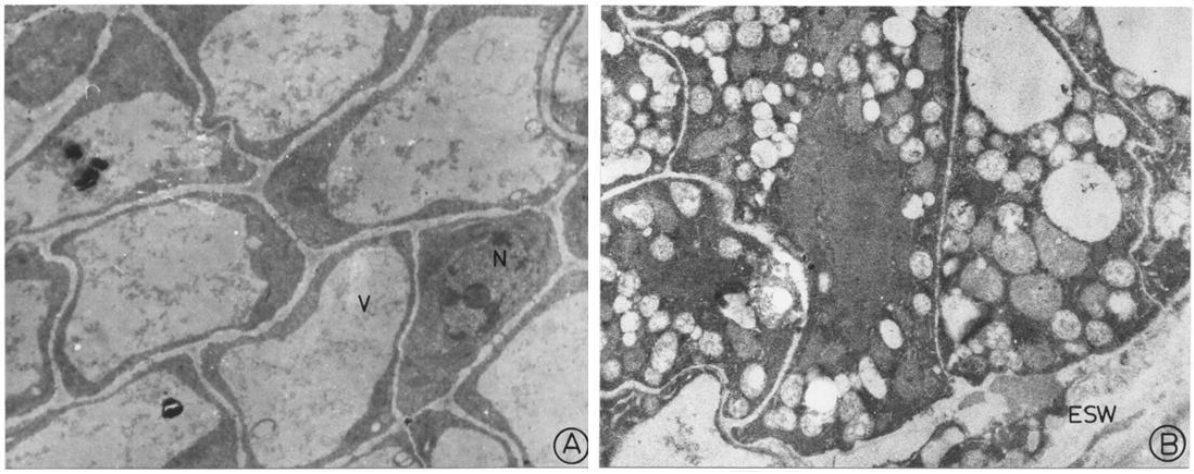

Figure 6: **A.** Longisection of portion of post-fertilization abortive ovule (3 DAP) to show cellular details of outer integument. Low-power profile of a group of cells from the outer integument showing highly vacuolated cells. x 6,600 (N – Nucleus, V – Vacuole). **B.** Longisection of portion of post-fertilization abortive ovule (2 DAP) to show embryonal cells. Some of the vacuoles are filled with cytoplasmic contents. Embryo sac wall

shows only a few small wall ingrowth. Remnants of endosperm remain as a thin parietal layer in the embryo sac cavity. x 9,600. (ESW – Embryo sac wall).

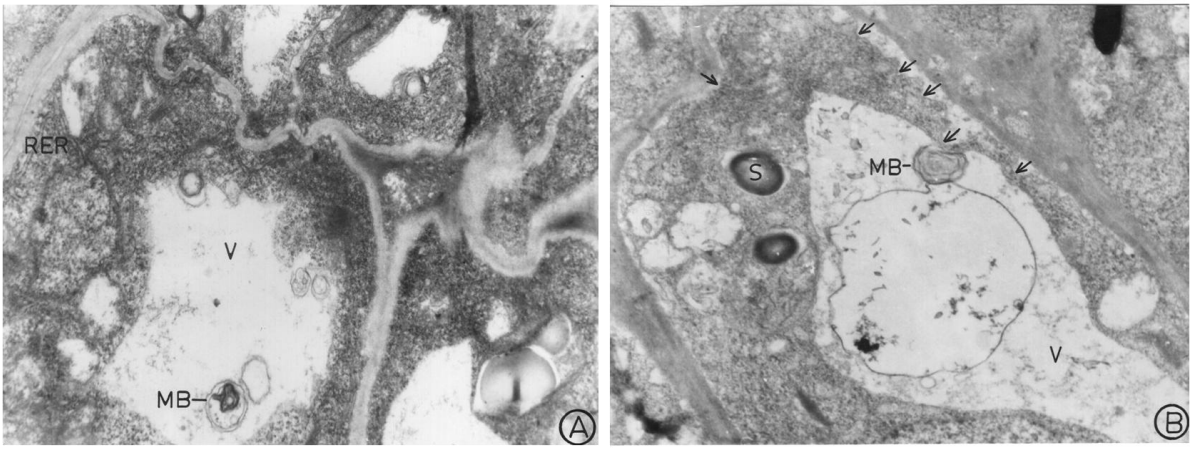

Figure 7: Longisections of chalazal portion of post-fertilization normal ovule (1-2 DAP) showing nucellar cells. **A.** Nucellar cells (1 DAP) at chalazal end.showing most of the plasmodesmatal connections obliterateed. Myelin-like bodies can be seen in the vacuoles. x 16,000. **B.** A nucellar cell (2 DAP) shows myelin-like body in the large vacoule. The cytoplasm has started shrinking (arrows). A few dictyosomes can be seen. Plastids are loaded with starch. x 14,400. (S – Starch, RER – Rough endoplasmic reticulum, MB – Myelin-like body, V – Vacuole)

Some abnormalities were also seen in the nucleus of integumentary cells. Many dark, round, membrane-bound bodies were seen protruding from the nucleus which was and pinched off as vesicles having nuclear material into cytoplasm (Fig. 8). The cytoplasm was very scant and only a thin layer could be seen surrounding the embryo.

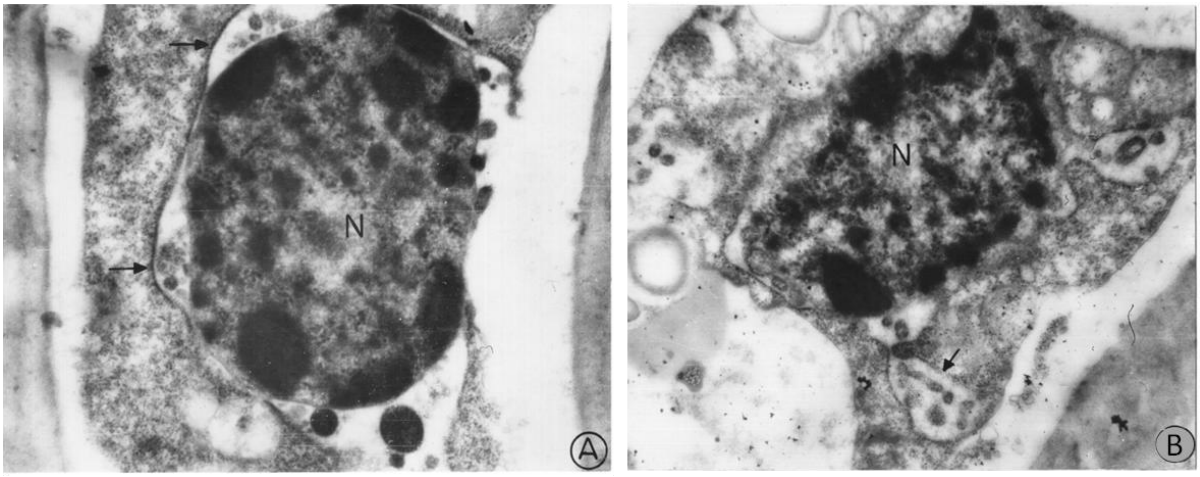

Figure 8: Longisections of portions of post-fertilization abortive ovules (2 DAP) to show cellular details of inner integument. **A.** The nucleus of cells of the inner layer of inner integument enlarged to show the nuclear blebs attached to the nucleus and further out in the cytoplasm (arrows). x 36,000. **B.** Part of the nucleus in the cell of the inner integument shows the extensive separation of membranes. Protuberances of these membranes are producing vesicles which on detachment lie in the cytoplasm (arrows). x 27,600. (N – Nucleus)

Cytology

Meiotic studies conducted on male and female sex mother cells revealed the presence of 22 chromosomes which resolved into 11 perfect bivalents at diplotene/diakinesis and metaphase-I stage of meiosis in the two sex mother cells. The chromosome behaviour was normal and similar in the two sex cells with respect to the position, distribution and frequency of chiasmata. The average chiasmata frequency in the pollen mother cells (PMC) and embryosac mother cell (EMC) at diplotene and metaphase-I, respectively, work out to be 22 ± 2.13 and 15 ± 1.26 (for EMC) and 21 ± 2.06 and 15 ± 1.09 (for PMC). The anaphase-I segregation of chromosomes was normal i.e. 11 chromosomes moved to each pole. None of the sex mother cells studied showed any abnormality (Fig. 9).

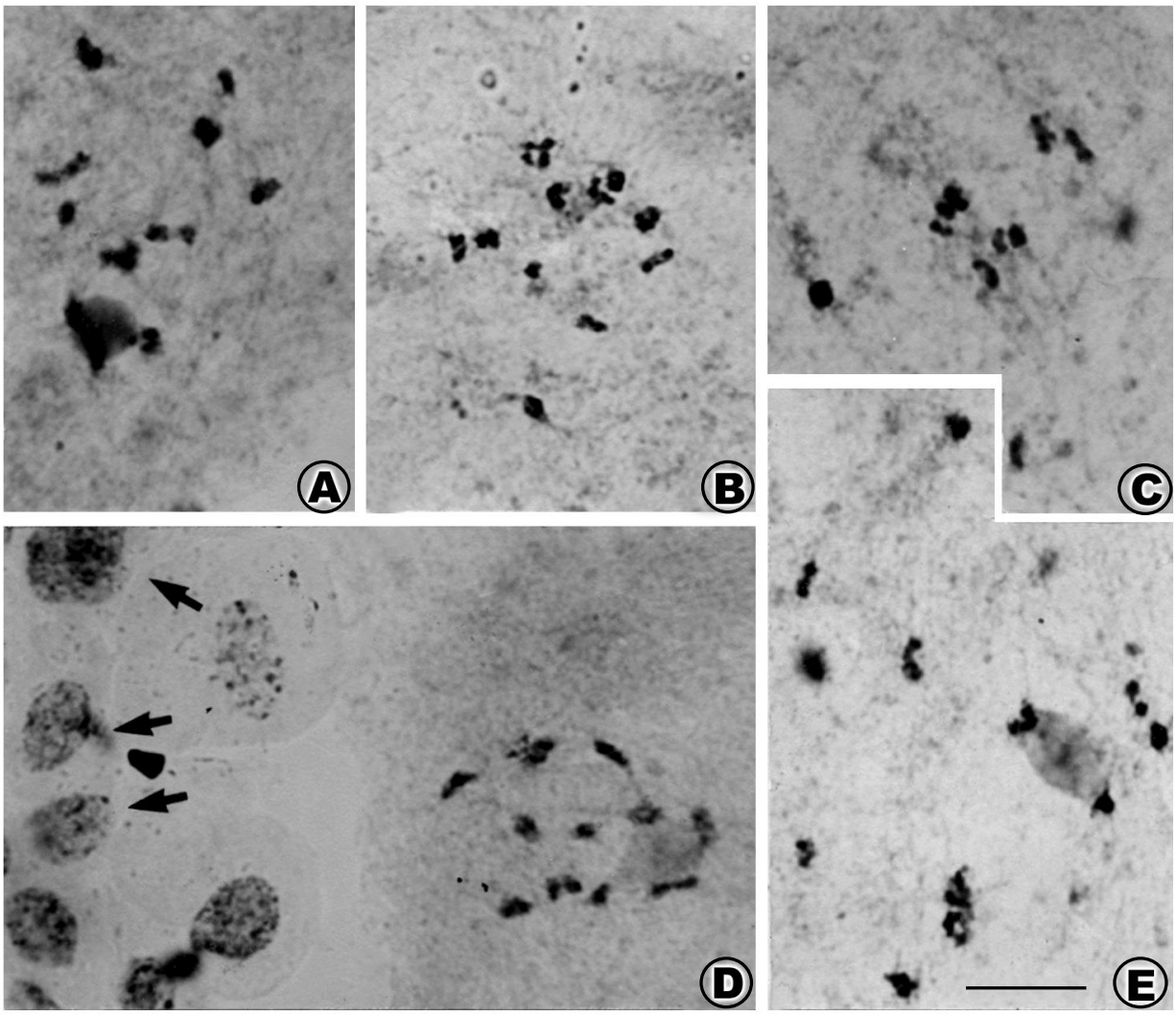

Figure 9: Male and female meiosis in *Vigna radiata* (2n=22). **Figs. A-C**. pollen mother cells at diplotene (Fig. A), diakinesis (Fig. B) and metaphase-I (Fig. C) showing 11 bivalents. **Figs. D-E**. embryo-sac mother cells at diplotene stage. Note the nucellar tissue at arrows. Scale = 10 µm.

DISCUSSION

Most plants do not experience optimal growth conditions, and as a result ovules abort. In such cases resource limitation is the most common cause of ovule abortion. In a number of species/hybrids ovule abortion is mainly attributed to the retarded growth of endosperm (Atwood and Grun, 1951; Beasley, 1940; Brink and Cooper, 1941; Cooper *et al.*, 1937; Sansome *et al.*, 1942; Williams and White, 1976), proliferation of nucellus cells (Renner, 1914) and overgrowth of endothelium (Kostoff, 1930; Sansome *et al.*, 1942). Sometimes stress conditions, which lead to the accumulation of reactive oxygen species (ROS) in the cells of the gametophyte, result in programmed cell death (PCD) of the tissue (Hauser *et al.*, 2006; Liu *et al.*, 2010). Sun *et al.* (2004), reported the DNA fragmentation as a possible cause of PCD and ovule abortion in *Arabidopsis*.

As far as the present material is concerned this report of ovule abortion is the first one and highlights the involvement of degenerating integument in the ovule abortion in *Vigna radiata* (L.) Wilczek. Our observation is supported by the ultrastructural studies which revealed abortion to be taking place at pro-embryo stage. The ovular cells showed features characterizing degeneration processes. The degeneration process begins with the lysis of integumentary cells as evidenced by an increase in the number of myelin-like bodies, the tonoplast invaginations and sequestration of cytoplasmic portions along with cellular organelles as seen in degenerating nucellar cells of normal ovule.

The nuclear degeneration in integuments was recognized by separation or dilatations of the nuclear membranes, at first along small sectors of the periphery but later increasing and widening to produce broad cisternae which appeared as extensive vacuoles within the cytoplasm. These cisternae are angular, and always contained inclusions of various sizes, some of which appeared to originate as evaginations from the inner nuclear membrane and

invaginations of outer nuclear membrane. These single membrane-bound blebs got detached as vesicles and appeared within the widening vacuolar system of the cell. The continued budding-off of fragments from these vesicles progressively reduced their size and definition. Later, in the advanced stages of degeneration, the cells were filled with a network of small vacuoles suspended in a fibrillar-like matrix which in turn was subjected to lysis.

The involvement of integuments in inducing abortion of embryo/seed has been reported in *Medicago sativa* (Cooper and Brink, 1940a), *Nicotiana* hybrid seed (Cooper and Brink, 1940b) and in 2n x 4n and 4n x 2n hybrids of *Lycopersicon pimpinelifolium* (Cooper and Brink, 1945), in all such cases proliferation of integument has been the root cause of abortion and in none of these cases integument degeneration was observed. Presence of myelin-like bodies, though not seen in integument cells, has earlier been reported in autolysis of embryo-suspensor of *Phaseolus* and *Trapaeolum* (Nagl, 1976, 1977). Further, vacuole disorganization has been reported in senescing corolla of *Ipomoea* (Matile and Winkenbach, 1971). During the degeneration process the hydrolases diffuse in the whole enclave and perform lysis of its contents. The sequestration vacuole becomes an autophagic vacuole and digestive reactions sometimes give rise to rearrangements of transitory products such as myelin-like bodies (Buvat, 1968; Coulomb, 1968; Coulomb and Buvat, 1968). Finally the internal membrane disappears, thus the autophagic vacuole is bound only by the external membrane. As hydrolysis gives rise to smaller and more numerous molecules, a water deficit is created which determines hypertrophic growth, and fusion of new vacuoles occurs (Buvat and Robert, 1979).

According to Mesquita (1972), in *Allium cepa* and *Lupinus albus* besides the normal vacuoles which seem to be empty, or else contain a very light precipitate, there are other autophagic vacuoles which display dense and heterogeneous contents that are either amorphous or formed by ribosome-like granules or multi lamellar bodies. Sometimes these contain cellular debris. While studying these residues one may be able to recognize several organelles in several stages of degradation/disorganization.

After the degeneration of all the sequestered organelles by the lytic enzymes of the membrane components of vacuoles, the appearance of myelin figures in the autophagic vacuoles is in agreement with the detection of lytic activity (Coulomb, 1973). After the degeneration of the mitochondrial population of a cell has occurred, all the other organelles quickly disorganize and the cell becomes reduced to an empty cavity (Oliviera, 1976). Matile (1975) suggested that the loss of compartmentalization was considered initially as an indicator of the moment of cell death. According to Gahan (1981) a series of events such as the loss of control lead to loss of compartmentalization. Events leading to loss of compartmentalization include ultrastructural changes such as those related to nucleus, nucleolus, ribosomes, endoplasmic reticulum and golgi bodies. Inactive golgi bodies are abundant in cells of the aborting ovules of *V. radiata.* So relative inactivity of the dictyosomes and ER in these cells suggests failure of nitrogen metabolism and transport in all nutritive tissues including nucellus, integumentary tapetum and endosperm as reported by Sangduen *et al*. (1983a, b).

The abnormal behavior of chromosome in the female sex mother cell may also lead to ovule abortion (Koul *et al.*, 2000). Thus, chromosomal studies were also conducted in the two sex mother cells to assess their possible role, if any, in inducing ovule abortion; the studies did not reveal anything that could help in pinpointing a cause for ovule abortion.

In view of the foregone account, it can be concluded that the embryo/seed abortion does not always point towards the involvement of endosperm; instead developmental abnormalities in other mother tissue, like integument, can also be instrumental in inducing seed abortion.

ACKNOWLEDGEMENT

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IMPACT OF SUPPLEMENTAL UV-B RADIATION ON FLOWER AND POD FORMATION IN CHICKPEA (*CICER ARIETINUM* L).

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Abstract: Surface level ultraviolet radiation (280-320nm) and ozone are components of the global climate and any increase in their levels can lead to adverse effects on crop growth and productivity on a broad geographic scale. The object of this study was to determine the effect of season long exposure of supplemental UV-B on flower and pod formation in *Cicer arietinum* L. The study revealed that supplemental UV-B radiation promoted the number, fresh weight and dry weight of flower and pod if it was given for 1 hr and 2 hr however 3 hr supplemental UV-B radiation inhibited number, fresh weight and dry weight of flower and pod in *Cicer arietinum* L.

Keywords: *Cicer arietinum*, Supplemental UV-B radiation, Flower, Pod

INTRODUCTION

Sensitivity to increased UV-B radiation varies significantly among plant species. According to previous studies, approximately two-third of 300 species and their varieties are vulnerable to damage from amplified UV-B levels. The extent of damage may vary seasonally and can be affected by microclimate and soil fertility. Enhanced UV-B radiation was generally characterized as harmful for plants and its effects were species specific (Teramura and Sullivan, 1993). The impact of increased solar ultraviolet-B (UV-B) exposure due to stratospheric ozone depletion can negatively affect plant growth and physiology which ultimately decrease crop productivity. While some effects of prolonged elevated UV-B exposure on plants is clear, relatively little is known about the short-term effects of UV-B exposure, although there are evidence of short-term UV-B radiation increases that likely occur during summer. The level of increase in UV-B radiation at a certain locations depends on several factors including the amount of ozone, position of the sun (latitude and longitude), cloud cover and land cover of sand, snow or water. Based on models that predict UV level increased relative to 1979-1992 levels, 2010-2020 may receive UV doses increased by 14% in the Northern hemisphere and up to 40% in the Southern hemisphere. A 30% increase in UV-B radiation levels is expected to have significant impact on crop productivity (Kakani *et al*., 2003).

Field investigations have focused on seed yields of economically important cultivated species with characteristically variable results. Enhanced UV-B radiation can have many direct and indirect effects on plants including inhibition of photosynthesis, DNA damage, changes in morphology, phenology and biomass accumulation (Caldwell *et al.,* 1995). Pea (*Pisum sativum)* yield was reduced by UV-B radiation (Mepsted *et al.,* 1996). Gwynn-Jones *et al.,* (1997) found an increase in berry production in the sub-arctic *Vaccinium myrtilus*. However, the seed yield was not measured in these investigations. In another study with the Mediterranean shrub *Cistus creticus*, the number of flowers was not affected, yet pollination success was improved and seed yield increased (Stephanou and Manetas, 1998). In the few wild plants studied so far under field conditions and with realistic ozone depletion scenarios, a consistent trend towards an increase in flower number was observed in the Mediterranean *Mentha spicata* (Grammatikopoulos *et al.*,1998) and in *Colobanthus quitensis* and *Deschampsia antarctica* in the Antarctic Peninsula (Day *et al.,* 1999).

Surplus UV-B radiation, acting as a premature environmental signal, could alter the timing (Ziska *et al.,* 1992) or the number of flowers (Musil, 1995; Grammatikopoulos *et al.,* 1998; Day *et al.,* 1999).

Globally, studies have shown that there is a significant diminution of plant biomass and plant height when exposed to increased UV-B radiation. Arctic plant species are more tolerant of enhanced UV-B radiation than expected. Further, there was no simple relationship found between UV-B absorbing compounds to UV-B exposure level (Callaghan *et al*., 2004). This may suggest other unknown mechanisms that interact with UV-B tolerance. It also may be possible to genetically modify plant crops to resist effects of increased exposure to UV-B through UV-B absorbing compounds.

Ying Wang *et al.,* (2008) observed that fruit biomass was not affected by enhanced UV-B radiation in *Cerastium glomeratum* Thuill. Enhanced UV-B radiation delayed onset of flowering by 1 day and shortened duration of flowering by 5 days. But because of the long period of flowering time (83-88 days), this did not make any significant effect on flower number, seed number, pollination success (number of seeds per fruit) or reproductive success (fruit to flower ratio).

The chickpea (*Cicer arietinum*) is a legume of the family Fabaceae, subfamily Faboideae. Its seeds are

high in protein. It is one of the earliest cultivated legumes: 7500 year old remains have been found in the Middle East. The plant grows 20 to 50 cm (8-20 inches) high and has small feathery leaves on either side of the stem. Chickpeas are a type of pulse, with one seedpod containing two or three peas. It has white flowers with blue, violet or pink veins. Chickpea need a subtropical or tropical climate with more than 400 mm (16 in) of annual rain. They can be grown in a temperate climate but yields will be much lower. The *Desi* (meaning 'country' or 'local' in Hindi) is also known as Bengal gram or kala chana. *Kabuli* (meaning 'from Kabul' in Hindi, since they were thought to have come from Afghanistan when first seen in India) or *safed chana* is the kind widely grown throughout the Mediterranean.

India is the world leader in chickpea (Bengal gram) production followed by Pakistan and Turkey. Desi chickpeas have markedly higher fiber content than Kabulis and hence a very low glycemic index which may make them suitable for people with blood sugar problems. Chickpeas are a helpful source of zinc, folate and protein. Chickpeas are low in fat and most of this is polyunsaturated.

Based on the above perusal of literature and findings, a field experiment was conducted to investigate the effects of supplemental UV-B radiation on flowering, fruiting and their fresh and dry weight in *Cicer arietinum* L. The purpose of this study was to find out whether supplemental UV-B radiation was harmful, neutral or beneficial in this crop.

MATERIAL AND METHOD

The experiment was conducted in the Department of Botany, Govt. P.G. College, Noida, Gautam Buddha Nagar (U.P.). Seeds of chickpea (*Cicer arietinum* L.) were sown in soil, in rows spaced 0.1 meter a part in 4 plots of 1x1 meter square each. After seedling emergence, plants were irradiated daily with supplemental UV-B radiation supplied by sun lamps (300 watt) held in frames suspended 1 meter above the plants in the fields. The total supplemental UV-B irradiance received at the top of the plants beneath the lamps was 24.23 $Jm^{-2}s^{-1}$. Control plants (T_1) were not exposed to supplemental UV-B radiation. Plants of plots T_2, T_3 and T_4 were exposed to supplemental UV-B radiation for 1 hour, 2 hour and 3 hour daily till maturity of crop. The experiment was laid out in Completely Randomized Block Design with three replications. The samples for growth analysis were taken regularly at 15 days interval after the seedling emergence till maturity of the crop. The fifteen identical plants were transported to laboratory for the observation of flower and pod in terms of number, fresh and dry weight (Kumar, 1981). Data were analyzed statistically using SPSS 7.5 version. The mean values of fifteen plants were calculated, represented in results with standard deviation and test of significance at 5% level.

RESULT AND DISCUSSION

The effect of supplemental UV-B radiation on the number, fresh and dry weight of flower and pod has been shown in table 1 (graph 1-3) and in table 2 (graph 4-6) in *Cicer arietinum* L.

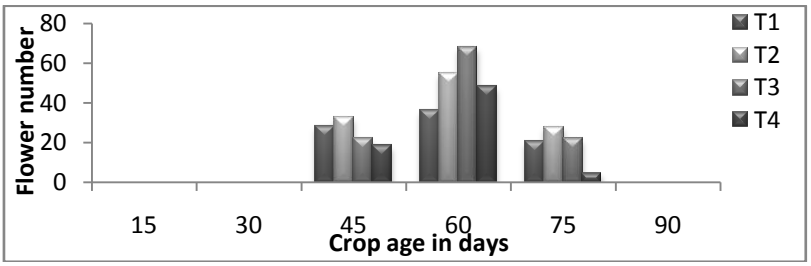
Table 1: Effect of supplemental UV-B radiation on flower formation in field grown *Cicer arietinum* L.

Daily UV-B irradiance	**CROP AGE IN DAYS**					
Parameters	**15**	**30**	**45**	**60**	**75**	**90(Maturity)**
Control						
Flower no.	----	----	28.60±0.894	36.20±2.167	20.60±2.408	----
fw, gm	----	----	0.269±0.009	0.381±0.025	0.066±0.010	----
dw, gm	----	----	0.049±0.004	0.083±0.009	0.025±0.005	----
1 hour						
Flower no.	----	----	*32.60±3.577	55.0±4.000	*28.0±2.549	----
fw, gm	----	----	0.248±0.025	0.258±0.018	0.218±0.023	----
dw, gm	----	----	0.047±0.009	0.083±0.005	0.078±0.009	----
2 hour						
Flower no.	----	----	*22.0±2.000	68.20±1.923	22.0±2.549	----
fw, gm	----	----	0.114±0.012	*0.343±0.011	0.157±0.019	----
dw, gm	----	----	0.022±0.002	*0.116±0.007	*0.035±0.003	----
3 hour						
Flower no.	----	----	18.80±1.303	*48.20±3.114	4.80±0.836	----
fw, gm	----	----	0.048±0.003	0.286±0.015	*0.030±0.006	----
dw, gm	----	----	0.010±0.004	*0.058±0.005	0.005±0.001	----

no.= number**, fw** =fresh weight**, dw** = dry weight, **gm**= gram, ± =Standard Deviation**,** * = Significant at 5% level.

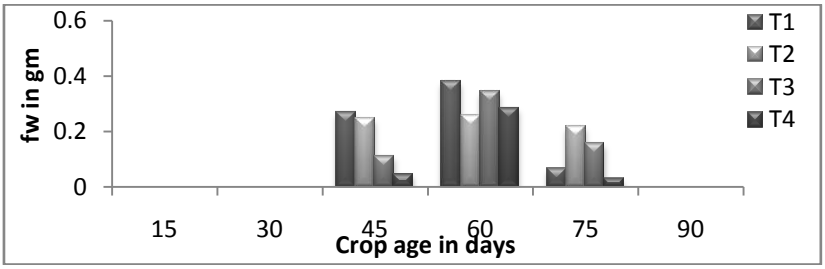
At 45 day stage of crop growth, number of flower was promoted 10% at 1 hr and inhibited 23% and 34% at 2 hr and 3 hr supplemental UV-B radiation. At 60 day stage, flower number was promoted 50%,

88% and 33% at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. At 75 day stage, flower number was promoted 36% and 6% at 1 hr and 2 hr however inhibited 77% at 3 hr supplemental UV-B radiation.



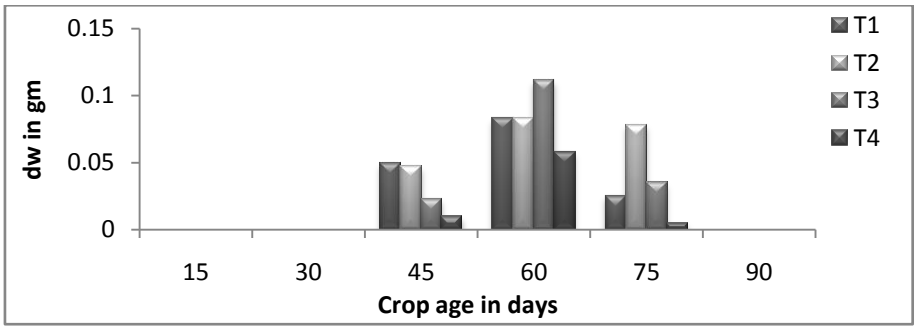
Graph: 1 Effect of supplemental UV-B radiation on flower number in *Cicer arietinum* L.

Fresh weight of flower was inhibited 8%, 58% and 83% at 45 day stage and 33%, 10% and 25% at 60 day stage at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. Fresh weight of flower at 75 day stage was promoted 230% and 137% at 1 hr and 2 hr however inhibited 55% at 3 hr supplemental UV-B radiation.



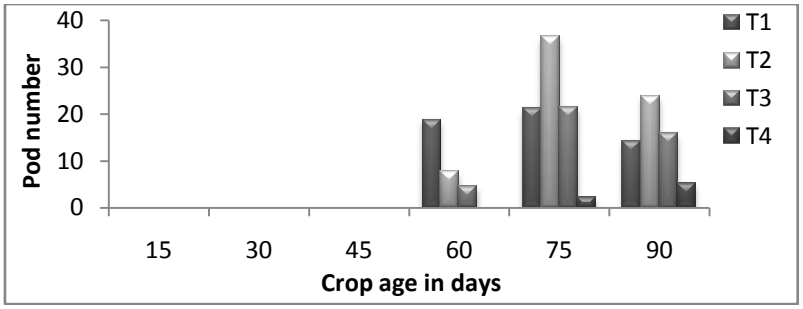
Graph: 2 Effect of supplemental UV-B radiation on fresh weight of flower in *Cicer arietinum* L.

Dry weight of flower was inhibited 4%, 53% and 80% at 45 day stage at 1 hr, 2 hr and 3 hr supplemental UV-B radiation respectively. At 60 day stage, dry weight of flower was promoted 33% at 2 hr however inhibited 30% at 3 hr and no inhibition in dry weight of flower was observed at 1 hr supplemental UV-B radiation. At 75 day stage of crop growth, dry weight of flower was promoted 212% and 40% at 1 hr and 2 hr however inhibited 80% at 3 hr supplemental UV-B radiation when compared with control. Response behavior of *Cicer arietinum* to supplemental UV-B is fluctuating stage to stage.



Graph: 3 Effect of supplemental UV-B radiation on dry weight of flower in *Cicer arietinum* L.

Pod formation was started at 60 day stage and it was observed first time in control plants. It shows that longer exposures of supplemental UV-B inhibited the pod formation in chickpea. At 60 day stage, number of pod was inhibited 59% and 76% at 1 hr and 2 hr however no flower was observed at 3 hr supplemental UV-B radiation. At 75 day stage, it was promoted 72% and 1% at 1 hr and 2 hr however inhibited 89% at 3 hr supplemental UV-B radiation. At 90 day stage, pod number was promoted 67% and 11% at 1 hr and 2 hr however inhibited 64% at 3 hr supplemental UV-B radiation.



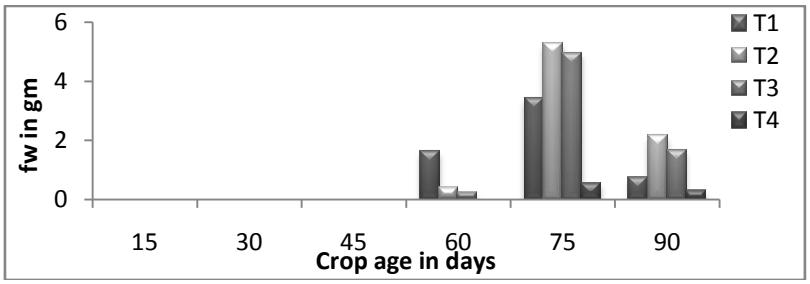
Graph: 4 Effect of supplemental UV-B radiation on pod number in *Cicer arietinum* L.

Table 2: Effect of supplemental UV-B radiation on pod formation in field grown *Cicer arietinum* L.

Daily UV-B irradiance	**CROP AGE IN DAYS**					
Parameters	**15**	**30**	**45**	**60**	**75**	**90(Maturity)**
Control						
Pod no.	----	----	----	18.80±1.303	21.20±1.923	14.20±0.836
fw, gm	----	----	----	1.636±0.112	3.420±0.299	0.754±0.046
dw, gm	----	----	----	0.274±0.018	1.374±0.118	0.732±0.047
1 hour						
Pod no.	----	----	----	8.40±1.341	36.60±2.073	23.80±1.923
fw, gm	----	----	----	0.390±0.065	5.286±0.304	2.146±0.176
dw, gm	----	----	----	0.084±0.013	1.434±0.082	*1.668±0.902
2 hour						
Pod no.	----	----	----	4.60±1.140	21.40±2.880	*15.80±1.303
fw, gm	----	----	----	0.228±0.054	*4.962±0.664	1.658±0.137
dw, gm	----	----	----	0.048±0.013	*1.686±0.100	1.412±0.119
3 hour						
Pod no.	----	----	----	----	2.40±0.547	5.20±1.788
fw, gm	----	----	----	----	0.562±0.125	0.292±0.100
dw, gm	----	----	----	----	0.200±0.054	0.236±0.080

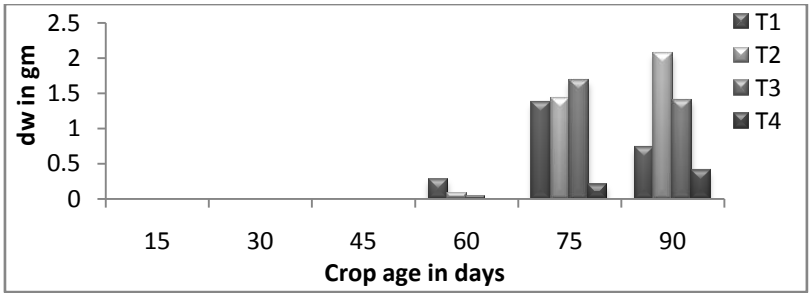
no.= number**, fw** =fresh weight**, dw** = dry weight, **gm=** gram**, ±** = Standard Deviation**, *=** Significant at 5% level.

Fresh weight of pod at 60 day stage was inhibited 76% and 86% at 1 hr and 2 hr and no pod was observed at 3 hr supplemental UV-B radiation. At 75 day stage, fresh weight of pod was promoted 54% and 45% at 1 hr and 2 hr however inhibited 84% at 3 hr supplemental UV-B radiation. At maturity of the crop, fresh weight of pod was promoted 185% and 120% at 1 hr and 2 hr however inhibited 62% at 3 hr supplemental UV-B radiation.



Graph: 5 Effect of supplemental UV-B radiation on fresh weight of pod in *Cicer arietinum* L.

Dry weight of pod at 60 day stage was inhibited 70% and 83% at 1 hr and 2 hr and no pod was observed at 3 hr supplemental UV-B radiation. At 75 day stage of crop growth, dry weight of pod promoted 4% and 23% at 1 hr and 2 hr and inhibited 86% at 3 hr supplemental UV-B radiation. At 90 day stage (maturity) of crop, dry weight of pod was promoted 182% and 92% at 1 hr and 2 hr however inhibited 45% at 3 hr supplemental UV-B radiation when compared with control. The poding was delayed to 10 days in 3 hour supplemental UV-B radiation when it was compared with control and other treatments.



Graph: 6 Effect of supplemental UV-B radiation on dry weight of pod in *Cicer arietinum* L.

Results indicated that supplemental UV-B radiation promoted the number, fresh weight and dry weight of flower and pod if it was given for shorter (1 hr and 2 hr) duration however longer exposures (3 hr) of supplemental UV-B inhibited number, fresh weight and dry weight of flower and pod in *Cicer arietinum* L. Saile *et al.,* (1996) observed the flowering delay up to a maximum of 5 days under higher UV-B radiation. Stephanou and Manetas, (1998) in *Cistus creticus* and Petropoulou *et al.,* (2001) in *Malcolmia maritima* observed that supplemental UV-B radiation had no effect on fruit biomass and flower number however flower diameter per flower was significantly increased by supplemental UV-B radiation. Kakani *et al.,* (2003) in *Gossipium hirsutum* observed the reduction in all floral parts due to UV-B radiation. Rajendiran and Ramanujam, (2004) in *Vigna radiata* L. and Ying Wang *et al.,* (2008) in *Cerastium glomeratum* observed the delay in flowering due to UV-B radiation.

Gwynn-Jones *et al.,* (1997) found an increase in berry production in the subarctic *Vaccinium myrtilus*. Stephanou and Manetas, (1998) observed increase in seed yield in *Cistus creticus* due to UV-B radiation. Murali and Teramura, (1986) and Teramura *et al.,* (1990) in *Glycine max* L. and Petropoulou *et al.,* (2001) in *Malcolmia maritima* and Ying Wang *et al.,* (2008) in *Cerastium glomeratum* observed that UV-B radiation had no effect on fruit biomass however Mepsted *et al.,* (1996) in *Pisum sativum* L. observed the significant decreases in the number of pods and dry weight of pods per plant but UV-B treatment had no effect on the number of peas per pod or average pea weight. Saile *et al.,* (1996) observed the flowering delay in several cultivars of maize (*Zea mays* L.) up to a maximum of 5 days under higher UV-B radiation. Probably due to this delay in the cob development the yield decreased under higher UV-B radiation at the first harvest after 12 and 14 weeks whereas at the second harvest after 14 and 16 weeks no reduction in yield was observed. Rajendiran and Ramanujam, (2004) observed that UV-B stresses delayed achievement of flowering in *Vigna radiata* (L.) by which yield and seed number were reduced significantly by enhanced UV-B radiation.

ACKNOWLEGMENT

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SALT TOLERANCE PROTEINS IN DEVELOPING CHILLI FRUIT

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Abstract: The influence of Nacl on different quality attributes such as protein and protease of the Chilli Fruits were investigated during the developmental stages. Electrophoresis analysis of total soluble protein (SDS-PAGE) profile was carried out in order to evaluate the response of chilli fruits to salt stress. Protein content increased with attainment of fruit maturity SDS-PAGE analysis has revealed that plant grown under Nacl (50 and 100mM) showed induction or repression in the synthesis of few polypeptides in green and red fruits. This increase in protein content with increase in fruit maturity indicates that these concentrations of Nacl enhance protein synthesis which increases the ability to cope with salinity.

Keywords: Chilli Fruit, Nacl, Protein Analysis

INTRODUCTION

In India, chilli is an important commercial crop grown as condiment cum vegetable crop in an area of 9.17 lack hac. With a production of 7.79 lakh tones (Anon., 1). There is about 8 million ha of salt affected soil (saline and sodic) in India (Mangal et al., 1990). Critically the problem of salinization is increasing, often due to bad agriculture practices. Increased synthesis of a wide variety of proteins occurs in response to salt stress. Proteolytic enzymes also called proteases, are the enzymes that catalyse the hydrolytic cleavage of specific peptide bonds in their target proteins. However, plants subjected to salt stress showed increased levels of total free amino acids (Dubey & Pessarakli, 1995). The present work was carried out to investigate the effect of salinity (50 and 100mM NaCI) on protease, protein and protein profile of fruits of Capsicum annum cv. Pusa Jwala.

MATERIAL AND METHOD

Capsicum seeds were obtained from Indian Agricultural Research Institute, New Delhi. Prior to experimentation they were selected for uniformity of size and mass.

Sowing and salt stress treatments

The seeds were sown in 6 sets of poly bags after filling them with pre analysed garden soil. Soil was air-dried, mixed thoroughly. The soil has pH 7.17 ±0.1, organic carbon 0.29 ±0.00% C ± SD, water holding capacity 65.5, phenolics 6.38 ±1.69 eq g fw^{-1} ±SD, Na+ 0.33 ± 0.00 K+0.09 ±0.00, Ca^{++}1.03 ±0.06 meq/ g d wt.

The poly bags with untreated distilled water irrigated soil were used as control and with 50 and 100 mM NaC1 treatment were used for developing salt stress. 10 seeds of chilli were sown in each poly bag. Subsequent irrigation was given using distilled water. After germination, one seedling was retained in each poly bag. Finally fruits were harvested at different levels of maturity (green 26 days after anthesis and red 40 days after anthesis) for experiment.

Protein

The total soluble protein concentration was determined in fresh tissues according to Lowry et al. (1951).

Protease

Protease was estimated according to Green and Newuath, 1954.

Protein profiling

The extracted protein samples were fractionated by sodium dodecy1 sulphate -polyacrylamide gel electrophoresis (SDS-PAGE). A solution of 12% SDS-polyacrylamide slab gel was prepared according to the method of Laemmli (1970) and equal volumes of proteins extracted were loaded. Scanning of the separated protein bands was analysed by the Gel Documentation System.

RESULTS AND DISCUSSION

An increase in Nacl concentration has been recorded to exhibit a stimulatory effect on protein content in different parts of fruits. Increase in salt concentration from 50 to 100 mM Nacl caused decrease in protease activity in fruit wall and seeds of green fruit stage but reverse in placenta compared with those of untreated fruits. With attainment of maturity, protease activity increased with salt stress compared to control (Fig. 2).

Generally, if protease activity is high then protein content is low, but at 50 mM Nacl treated sets synthesis of new proteins is indicated even with higher protease activity in seeds of green and red fruits and also in placenta of red fruit (Table 1, 2).

Proteases are enzymes that catalyse the hydrolytic cleavage of specific peptide bonds in their target proteins. Protease inhibitors regulate the activity of

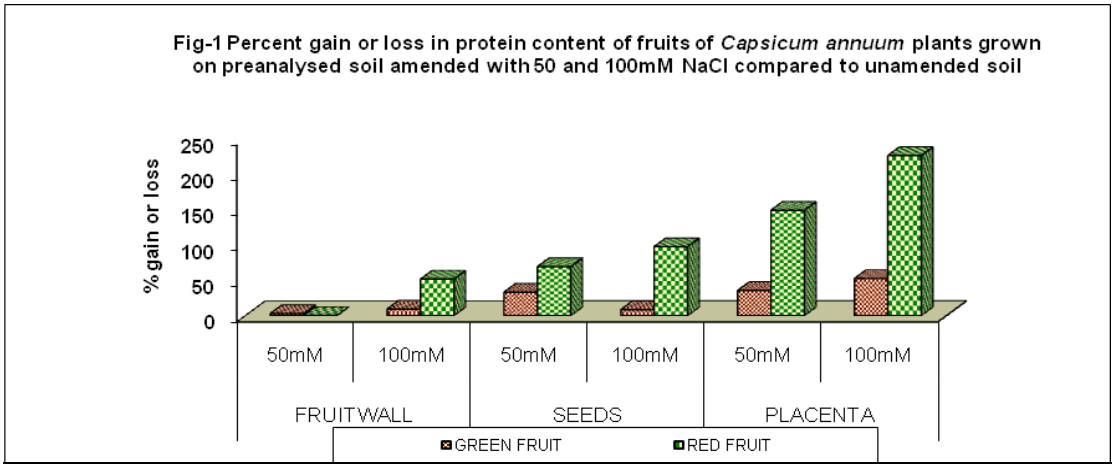
protease. Plant protease inhibitors generally small protein that have mainly been described as occurring in storage tissues, such as tubers and seeds. They are also induced in plants in response to injury. Based on the present study it may be possible that in new protein some may be protease inhibitor that check the protease activity in presence of higher protease the amount of protein was higher. Protease inhibitors are key players in the endogenous defense system, as they help regulate and balance protease activities. (Habib et al., 2007).

This increase in protein content with increase in fruit maturity indicates that these concentration of NaC1 enhance protein synthesis which increases the ability to cope with salinity.

It has been observed in the present work that three protein bands (M.wts: 26. 34.19 and 34.5 kDa) appeared in fruits of salts stressed plants. A protein band of molecular weight 34.19 kDa was denovo synthesized in placenta of green and red fruit in response to 100 mM Nacl (Table Fig 3), while protein band of molecular weights 26 and 34.5 kDa were newly synthesized as common salt adaptive protein in 100 mM Nacl treated fruits exhibits sustenance of plants to salt stress through either completing or synthesis of new proteins. These proteins may belong to chaperonin category protecting the required proteins from degradation.

34 kDa polypeptide has also been identified and reported in potato plants subjected to water deficit (Pruvot et al 1996 a). Since 26 kDa protein is specifically synthesized and accumulated in cells undergoing osmotic adjustment to salt stress, this protein is named osmotin (Singh et al., 1987). Osmotins have properties similar to chaperons. Under 50mM Nacl treatment more degradation of high molecular weight proteins is observed than under 100mM Nacl treatment. Besides, red fruits and their placenta appear to be more tolerant than green fruits. The most susceptible part appears to be the seeds (storage organ) with highest number of degraded proteins under 50 mM Nacl treatment.

This investigation points at accumulation of certain proteins to be instrumented in amelioration of the adverse effects of salinity stress. Also that 50mM Nacl induces shock responses against which all the tolerance indicators do not necessarily get synthesized. However, 100mM Nacl stabilizes and restores the degrading proteins with the help of synthesis of new high and low molecular weight proteins. Thus 50mM Nacl induces stress but 100 mM Nacl exhibits restoration tolerance from stress. 150 mM Nacl did not lead to germination, indicating it to be lethal dose for Capsicum not allowing the tolerance proteins to play their role.



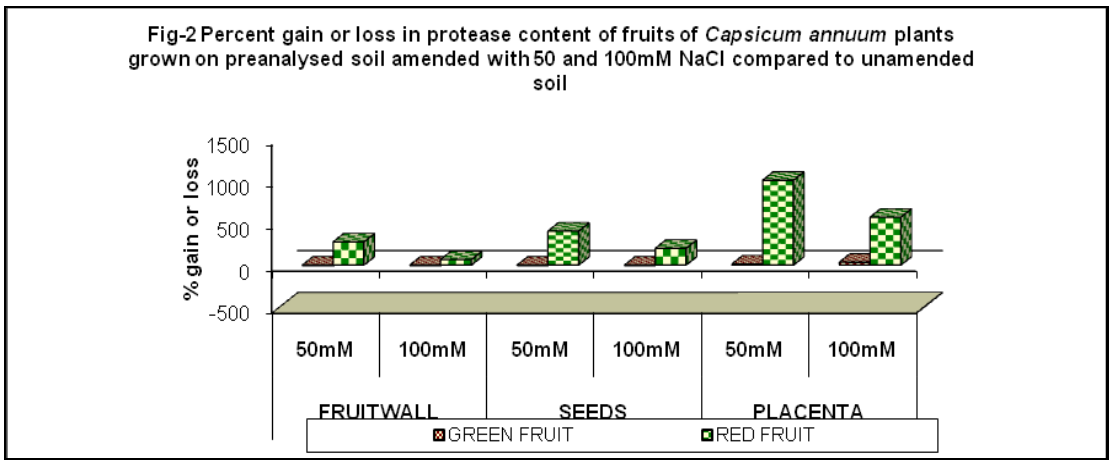


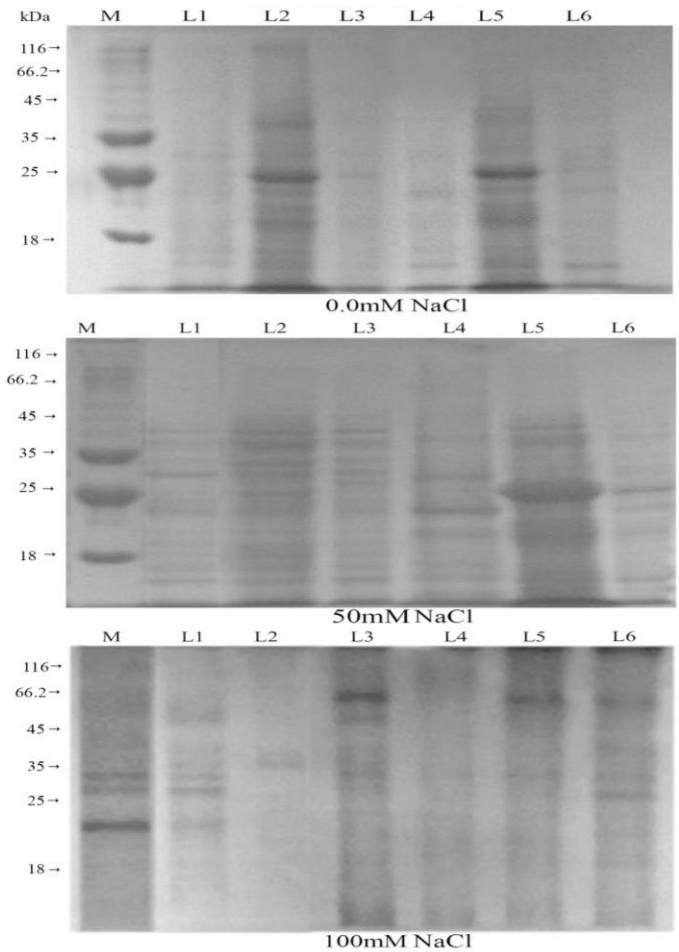
Table-1. Protein (mg casein eq gfw^{-1} ±SD) in fruits of C. annuum cv. P.J. under different salt concentration (mM Nacl)

S.N.	FRUIT STAGE	FRUIT WALL			SEED			PLACENTA		
		DW	50mM	100mM	DW	50mM	100mM	DW	50mM	100mM
1.	GREEN FRUIT	58.77 ±1.16	60.53 ±0.53	64.34 ±0.53	62.7. ±0.53	83.60 ±0.76	68.04 ±1.41	117.04 ±2.14	158.85 ±5.37	178.61 ±3.80
2.	RED FRUIT	91.2.5 ±1.31	91.45 ±0.43	138.43 ±3.83	100.82 ±4.38	170.75 ±4.56	199.30 ±2.92	163.66 ±3.16	407.76 ±7.53	534.23 ±2.46

Table-2. Protease (mg tyrosine eq gfw^{-1} ±SD) in fruits of c. annuum cv. P.J. under different salt concentration (mM Nacl)

S.N	FRUIT STAGE	FRUIT WALL			SEED			PLACENTA		
		DW	50mM	100mM	DW	50mM	100mM	DW	50mM	100mM
1.	GREEN FRUIT	5.37 ±0.05	4.95 ±0.12	4.98 ±0.21	5.49 ±0.06	5.19 ±0.04	5.223 ±0.04	9.95 ±0.11	11.15 ±10.00	13.33 ±0.55
2.	RED FRUIT	6.55 ±0.16	24.58 ±0.28	10.80 ±0.28	6.55 ±0.04)	33.01 ±0.73	19.55 ±1.46	14.49 ±1.52	160.43 ±2.14	96.79 ±1.04

Plate - 1



SDS-PAGE ANALYSIS OF PROTEIN PATTERN OF FRUITS OF *Capsicum annuum* CV. P.J. PLANTS TREATED WITH 0.0mM, 5OmM AND 100mM NaCl.
LANE(M) -PROTEIN MARKER
L(1) -FRUIT WALL (G) L(4) -FRUIT WALL(R)
L(2) -SEEDS (G) L(5) -SEEDS (R)
L(3) -PLACENTA (G) L(6) -PLACENTA(R)
(G) -GREEN FRUITS,(R) - RED FRUITS

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SEED PROTEIN PROFILING THROUGH ELECTROPHORESIS IN LENTIL [*LENS CULINARIS* MEDIC]

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Abstract: Lentil (*Lens culinaris* Medic) is an important pulse crop in India with advancement and development of hundreds of varieties and introduction of intellectual property rights it is necessary to identifying them individually for identification and registration purposes. The present investigation was carried out during 2012-2013 in biotechnology lab, Department of genetics & Plant Breeding, C.S. Azad university of agriculture and technology, Kanpur with 14 genotypes of Lentil PL-4, KLS-218, KLS-320, L4147, K-75, KLB-08-4, KLS-09-3, VL-126, JL-1, L84-8, PL-5, KLB-303, IPL-81, DPL-62 for protein profiling through SDS-PAGE.

In present investigation, 14 variety of Lentil were studied for varietal identification through electrophoresis. Protein was extracted from dry seed of lentil varieties and analysed by SDS-PAGE . On the basis of photographs, electrophoregrams, Rm values and dendograms (UPGMA cluster analysis) of banding patterns through SDS-PAGE, results found that the number of protein bands found in 14 genotypes ranged from 12 to 20 with Rm value 0.07 to 0.93 for tris soluble proteins. Protein banding pattern of tris soluble proteins was found more distinct in SDS-PAGE. In UPGMA cluster analysis all the genotypes fall in seven cluster groups. SDS-PAGE for tris soluble proteins found suitable for testing distinctness, uniformity, stability of varieties for registration and identification.

On the basis of results, this can be said for characterization and identification of genotypes of lentil, that electrophoretic profile for tris soluble proteins through SDS-PAGE was resulted distinct banding pattern and act as 'genotypic finger printing'. Therefore, electrophoregram of tris soluble protein in SDS-PAGE was found much better for identification of genotypes in lentil.

Keywords: Lentil, SDS-PAGE, Varietal identification, UPGMA

INTRODUCTION

Lentil *(Lens culinaris* Medic) is the second most important winter pulse crop in India. About half of the world production of lentils in from India. The important lentil growing countries are India, Turkey, Syria and Bangladesh, the lentil crop having high nutritive value 100 g of lentil contain 26 g protien. most of which is consumed in the domestic market with the advancement and development of thousands of improved new varieties and introduction of IPR, it is necessary to identifying them individually for identifications and registration purposes. For the purpose necessity of quick, reliable and reproducible laboratory techniques are required. Protein profiling through SDS-PAGE is an alternate techniques for distinguishing the genotypes. Protein markers are stable, reproducible and genetically controlled and can be conducted in relatively short time.the protein profiling of seed storage proteins in cultivated lentil and their significantly differences in banding patterns by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE).

In electrophoresis, substances in a mixture, which are ionisable, can be reported from others that are net, by subjecting the mixture to an electric field: SDS-PAGE is the most commonly methods used for studying protein differences between species, previously classified on the basis of their morphological characters. SDS is an anionic detergent which binds strongly and denatures proteins. The number of SDS molecule bound to a polypeptide chain is approximately half the no. of amino acid residues in that chain. The protein SDS complex carries net negative charges. Hence, more towards the anode and the separation is based on the size of the protein.

MATERIAL AND METHDOS

The study was conducted during 2012-13 at Biotechnology Lab, Department of Genetics and Plant breeding, C.S. Azad University of Agriculture and Technology, Kanpur (UP). For the study, genetically pure seeds of 14 lentil genotypes viz Lentil PL-4, KLS-218, KLS-320, L4147, K-75,

KLB-08-4, KLS-09-3, VL-126, JL-1, L84-8, PL-5, KLB-303, IPL-81, DPL-62 were procured from the lentil Breeder of the university on the basis of morphological characters. The soluble proteins were analysed through SDS-PAGE method recommended by Dadlani *et al.*, 1993 for variety identification

Preparation of Sample

About 1 g seed were grinded in mortar and pestle after removing the seed coat and defatted by defatting solution 4 times of all 14 genotypes were taken in tube separately 1 ml Tris-glysine extraction buffer (pH 8.3) was added to 0.5g of defatted powder and left over night. 10 % solution of SDS (10µl), 2-mercapto ethanol (10µl) with bromophenol blue (10 µl) was added. Mixed well and left over night in a refrigerator. The sample was heated in boiling water bath kept for 10 minutes in water bath for 10 minutes at 100ºC. . The tubes were cooled and centrifuged at 10000 rpm for 10 minutes. The clear supernatant was used for electrophoresis.

Preparation of gel

Seed protein were analysed through slab type SDS-PAGE followed by Laemmli (1970) using 12% polyacrylamide gel. Electrophoresis was conducted in Atto Electrophoresis Unit using fourteen well for loading the sample.fixed the gel cassette into the electrophoresis unit as per design of the equipment. Loaded 50 µl of clear supernatant with one drop of tracking dye (Bromophenol blue) was loaded to each well. The electrophoresis was conducted at a constant current of 1.5 mA per well [42 mA] till the tracking dye crossed the stacking gel than current was fixed @ 2 mA per well at 220 V. The electrophoresis was stopped after the tracking dye reached the bottom of the gel.

Fixing and staining

Removed the cassette from the unit and take out the gel gently. Placed it in a staining tray and incubate overnight in 15% Trichloroacetic acid solution. Wash thoroughly the excess SDS, which might precipitate on the surface. Sufficient 1% commassie brilliant blue solution, prepared in methanol was added to cover the gel uniformly and incubated for 16 hr to stain than rinsed with water. Destaining in water and 5% Acetic acid for two days clears the gel background, resulting in a better resolution. The gel was placed over a trans-illuminator to draw the electrophoregram for calculating Rm values.

RESULT AND DISCUSSION

Results obtained through SDS-PAGE showed that the method provided a powerful tool for reliable variety discrimination and identification based on genetic differences of seed storage protein composition. Genotypes were distinguished on the basis of presence and absence of protein bands at particular Rm value and total numbers of bands present.

In the electrophoregram of tris soluble protein through SDS-PAGE (Fig. 1 & 2) in 14 genotypes, the number of protein bands were ranged from 12 to 20 with Rm value 0.07 to 0.93.

The lentil genotypes based on similarity distance dendrogram of 14 genotype of tris soluble protein banding pattern using UPGMA clusters analysis (Fig. 3) were grouped in 7 clusters. Clusters first contain three genotypes in grouped namely ; PL-4, KLS-326 and K-75, in which KLS-320 and K-75 are more close than PL-4.cluster, second and third KLB 08-4 and DPL-62, respectively have wider distance to other genotypes.Cluster fourth, KLS-218 and VL-126 are grouped that are contain two genotypes which are close to each other.Cluster fifth contains two genotypes L 4147 and JL-1 are grouped that are close to each other.Cluster six contains three genotypes L84-8, PL-5 and KLB-303 are grouped in which PL-5 and KLB-303 are more close than L 84-8.Cluster seven contain two genotypes KLS 09-3 and IPL-81 that are close to each other.

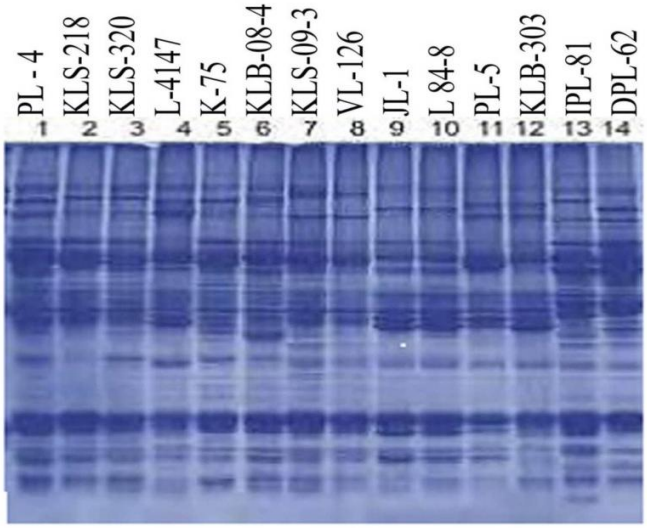

Fig1:SDS-PAGE Electrophoregrams of Tris Soluble Proteins in Lentil genotypes

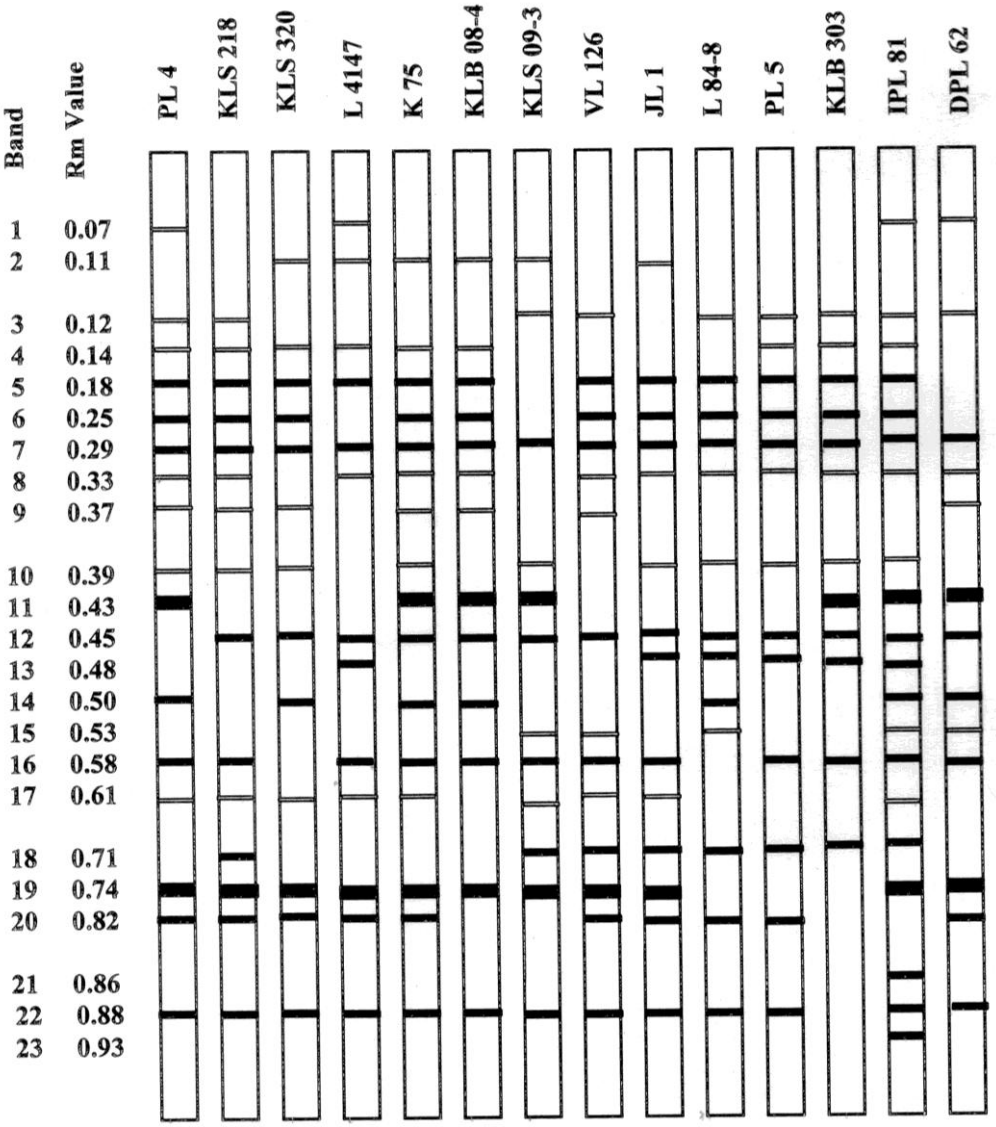

Fig. 2: Electrophoresis of Lentil varieties showing protein banding pat through SDS-PAGE

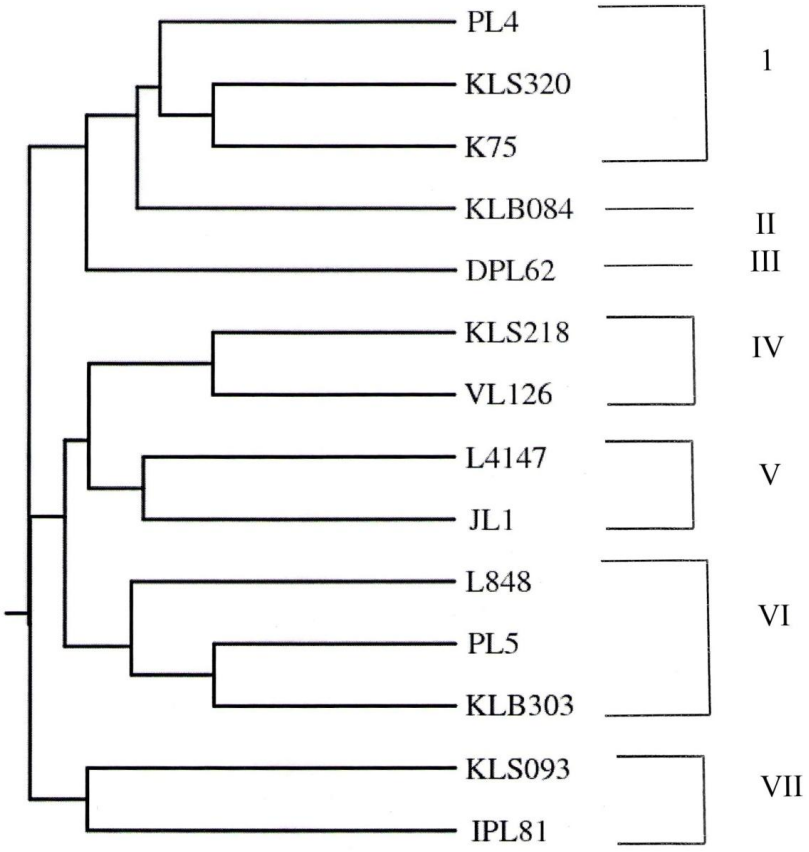

Fig. 3: SDS-PAGE Dendrogram of 14 varieties of lentil seed based on protein banding pattern using UPGMA cluster analysis

On the basis of photographs, electrophoregrams, Rm values and dendograms (UPGMA cluster analysis) of banding patterns through SDS-PAGE, variations were found in Rm value of protein bands, numbers of protein bands, similarity distance cluster analysis. These results are supported to the findings of and Singh *et al.,* (2006). Anuradha *et al.,* (2012) Protein banding pattern of tris soluble proteins were found more distinct. On the basis of results, this can be said for characterization and identification of genotypes of lentil, that electrophoretic profile for tris soluble proteins through SDS-PAGE was resulted distinct banding pattern and much better.

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VARIABILITY STUDIES IN EGGPLANT (*SOLANUM MELONGENA* L.) FOR CHHATTISHGARH PLAINS

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Abstract: Genetic variability in terms of genotypic and phenotypic coefficient of variances, heritability, expected genetic advance and expected genetic advance as per cent of mean, correlation and path coefficient were studied for fruit yield and its attributing traits in eleven hybrids, seven parents and a commercial check (Pusa Hybrid-6) of eggplant. In general it was noted that the value of phenotypic coefficient of variation were higher than genotypic coefficient of variation. The high GCV and PCV coupled for the traits number of fruits per plant per picking followed by average fruit weight, total number of fruits per plant, number of primary branches per plant, marketable fruit yield per plant, average fruit girth, average fruit length, total fruit yield per plant. The highest heritability estimate was observed for average plant height, average fruit weight, total number of fruits per plant followed by days to 50% flowering, days to first picking, average fruit length, average fruit girth, number of fruits per plant per picking, total soluble solids, number of primary branches per plant, marketable fruit yield per plant and total fruit yield per plant indicating predominance of additive gene action in the expression of these traits. High genetic advance as percent of mean was observed for total number of fruits per plant, followed by number of fruits per plant per picking, average fruit weight, average fruit length, average fruit girth, marketable fruit yield per plant, average plant height, number of primary branches per plant and total fruit yield per plant. Higher heritability estimate coupled with higher genetic advance as percent of mean were observed for total number of fruit per plant, number of fruits per plant per picking, average fruit weight, average fruit length, average fruit girth, total fruit yield per plant, marketable fruit yield per plant, average plant height and number of primary branches per plant and these traits can be improved through simple selection.

Keywords: *Eggplant, GCV, PCV, Heritability*

INTRODUCTION

Brinjal is one of the most popular and traditional fruit vegetable crop of India and Chhattisgarh as well. Varied forms, colors and shapes of brinjal are grown throughout Chhattisgarh state which also shows that ample amount of under exploitable genetic variability is available. It offers much scope for improvement through selection in variable population of brinjal. The knowledge of the extent to which the desirable characters with economic values are heritable is a prerequisite for any crop improvement programme (Roychowdhury and Tah, 2011). Breeders have continually retained their interest in the grouping of the germplasm and the pedigree of selected cultivars since the information might be particularly helpful in effective breeding strategy determination (Ali *et al*., 2011). Various traits with agro-economic value like seed weight, number of branches, leaves, flowers, leaf area, etc. are very much complex in nature because they confirm polygenic inheritance and greatly influenced by minute fluctuation of environmental factors. This may raise breeder's concern, since the genetic organization provides the base for crop enhancement of environmental adaptation, yield and other associated attributes. The presence of adequate genetic variability between treatments of a cultivar is critically important (Fasoula and Fasoula, 2002). Moreover, the genetic progress in a breeding program is actually dependent on the variation in the present gene pool (Dreisigacker *et al.*, 2004) associated with the magnitude of several genetic parameters like analysis of variance of each mean value, phenotypic and genotypic variances, phenotypic and genotypic coefficients of variation (PCV and GCV), broad sence heritability and genetic gain.The extent of variability is measured by genotypic coefficient of variance (GCV) and its phenotypic counterpart (PCV) that provides information about relative amount of variation in different characters. Variability alongwith high to medium genetic advance provides enough scope for selection; however an opposite situation of this suggests hybridization as a potential method for crop improvement (Johnson *et al.*, 1955).

MATERIAL AND METHODS

The experiment material comprised of eleven hybrids, seven parents and a commercial check (Pusa Hybrid-6) were evaluated in a Randomized Block Design with three replications in All India Coordinated Research Project on Vegetable Crops (AICRP on Vegetable Crops), Instructional cum Research Farm at Department of Genetics and Plant Breeding, IGKV, Raipur (C.G.) during 2011-12 *Kharif* season and the details of the parents and F_1's used in the present study are given in (Table 1). Observation on five randomly selected plants were recorded for twelve yield characters *viz.*, days to 50% flowering, days to first picking, plant height (cm), number of primary branches per plant, average fruit weight (gm), number fruit length (cm), fruit girth (cm), number of fruits per picking per plant, total number of fruits per plant, total fruit yield per plant (kg), marketable fruit yield per plant (kg) and total soluble solids (%).

Table 1: Details of the parents, F_1's and check along with notations and its source used in the study

S. No.	Parents	Notations	Source
1.	IBWL-2007-1	IBWL	IGKV, Raipur (C.G.)
2.	Green Long	GL	IGKV, Raipur (C.G.)
3.	Muktakeshi	MK	Local (C.G.)
4.	Pant Rituraj	PR	GBPUA&T, Pantnagar
5.	Pusa Purple Long	PPL	IARI, Pusa, New Delhi
6.	Pusa Purple Cluster	PPC	IARI, Pusa, New Delhi
7.	Punjab Sadabahar	PS	PAU, Punjab
S. No.	**F_1's**	**Notations**	
1	IBWL-2007-1 X Muktakeshi	IBWL X MK	
2	IBWL-2007-1 X Pusa Purple Long	IBWL X PPL	
3	IBWL-2007-1 X Punjab Sadabahar	IBWL X PS	
4	IBWL-2007-1 X Pant Rituraj	IBWL X PR	
5	Muktakeshi X Punjab Sadabahar	MK X PS	
6	Pusa Purple Long X IBWL-2007-1	PPL X IBWL	
7	Pusa Purple Long X Pusa Purple Cluster	PPL X PPC	
8	Pant Rituraj X Pusa Purple Long	PR X PPL	
9	Punjab Sadabahar X IBWL-2007-1	PS X IBWL	
10	Punjab Sadabahar X Muktakeshi	PS X MK	
11	Punjab Sadabahar X Pant Rituraj	PS X PR	
	National Check Hybrid		
1.	Pusa Hybrid-6	PH-6	IARI, Pusa, New Delhi

The all data were analyzed statistically. Mean values were subjected to analysis of variance (ANOVA) to test the significance for each character as per methodology advocated by Gomez and Gomez (1976). Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were calculated according to Singh and Chaudhary (1985) and its classification Sivasubrmanaian and Madhavamenon (1973). Heritability in broad sense was estimated as per Singh and Chaudhary (1985). Genetic advance of the genotypes and its per cent of mean at 5% intensity of selection pressure were worked out as per Johnson *et al.* (1955).

REULT AND DISCUSSION

The estimation of genetic variability based on the nature of extent of genetic variation for desirable traits in selection for improvement of the crop. The knowledge of genotypic and phenotypic coefficient of variation is being useful in designing selection criteria for variable population. The highest GCV was recorded for number of fruits per plant per picking (63.11 %) followed by average fruit weight (62%), total number of fruits per plant (58.46 %), number of primary branches per plant (33.85 %), marketable fruit yield per plant (32.29%), average fruit girth (31.88%), average fruit length (30.09%), total fruit yield per plant (27.61%), average plant height (25.03%), days to 50% flowering (17.2%), days to first picking (11.19%) and total soluble solids (10.08 %).The highest PCV was recorded for number of fruits per plant per picking (63.61%), average fruit weight (62.42%) followed by total number of fruits per plant (58.66%), number of primary branches per plant (34.85%), marketable fruit yield per plant (34.77%), average fruit girth (32.12%), average fruit length (30.33 %), total fruit yield per plant (30.02 %), average plant height (25.11%), days to 50% flowering (17.3%), days to first picking (11.26%) and total soluble solids (10.24 %).

The magnitude of PCV was higher than the corresponding GCV for all the traits. This might be due to the interaction of the genotypes with the environment to some degree or environmental factor influencing the expression of these traits. Close correspondence between phenotypic and genotypic coefficient of variation were observed i.e. sufficient variability among the traits is present among the genotype. Hence, the ample scope of improvement of these traits. These results are in general accordance with the findings of Mohanty and Prusti (2002), Sao (2006), Naliyadhara *et al*. (2007), Mishra *et al.* (2008), Ambade (2008), Ansari (2010), Biswas (2010).

The nature and extent of inherent capacity of a genotype for a character is an important parameter that determines the extent of any crop species. Genetic improvement of any character is difficult without having sufficient heritability, genetic advance and genetic variability; Hence heritability and genetic advance are the important parameters for selecting a genotype that permits greater effectiveness of selection by separating out the environmental influence from total variability. Heritability estimates along with genetic advance are normally more useful in predicating the gain under selection than that heritability alone. However it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*. 1955).

Estimates of heritability give some idea about the gene action involved in the expression of various polygenic traits .The selection should be effective if variance due to additive genes, estimated in terms of heritability. Heritability estimates remain extremely useful in the inheritance studies of quantitative traits. To facilitate the comparison of progress in various characters of different genotypes, Genetic advance was calculated as % of mean. Genetic advance and heritability are the major factor in the improvement of mean genotypic value of selected plants over the parental population. The success of genetic advance depends on; genetic variability, heritability, selection intensity. The heritability and genetic advance of the experiment is being presented in Table 2 and discussed as under.

The highest heritability estimate was observed for average plant height (99 %), average fruit weight (99 %), total number of fruits per plant (99 %) followed by days to 50% flowering (98 %), days to first picking (98 %), average fruit length (98 %), average fruit girth (98 %), number of fruits per plant per picking (98 %), total soluble solids (96 %), number of primary branches per plant (94 %) marketable fruit yield per plant (86 %) and total fruit yield per plant (84 %) indicating predominance of additive gene action in the expression of these traits. This being fixable in nature considerable progress is expected through appropriate selection scheme to be adopted. The findings are in agreement with the findings of Singh *et al.* (2003), Prasad *et al.* (2004), Sao (2006), Naik (2006), Ambade (2008), Mishra *et al.* (2008), Ansari (2010), Biswas (2010) and Chattopadhyay *et al.* (2011).

The heritability values alone however, provide no information of the amount of genetic improvement that would results from selection of superior genotypes. The heritability estimates would be more reliable if its limitation in a broad sense, additive and non additive genes where accompanied with high genetic advance (Ramanujam and Tirumalachar 1967).

High genetic advance as percent of mean was observed for total number of fruits per plant (145.45 %), followed by number of fruits per plant per picking (138.38 %), average fruit weight (129.78 %), average fruit length (76.31 %), average fruit girth (75.32 %), marketable fruit yield per plant (60.72 %), average plant height (58.67 %), number of primary branches per plant (53.04 % and total fruit yield per plant (50.91 %).

Table 2: Genetic variability for fruit yield and its components in Brinjal during *Kharif* 2011.

Characters	**Mean**	**Range**		**Heritability h^2_{bs} (%)**	**Genetic advance as % of mean**	**GCV %**	**PCV %**
		Max.	**Min.**				
Days to 50% flowering	45.63	59.00	39	98	34.40	17.2	17.30
Days to first picking	62.79	71.00	46	98	22.47	11.19	11.26
Plant height (cm)	72.25	102.00	54	99	58.67	25.03	25.11
Number of primary branches per plant	7.73	10.00	06	94	53.04	33.85	34.85
Average Fruit length (cm)	11.02	17.50	06	98	76.31	30.09	30.33
Average Fruit girth (cm)	9.32	15.90	3.6	98	75.32	31.88	32.12
Average fruit weight (gm)	69.34	194.00	33	99	129.78	62.00	62.42
Total number of fruits per plant	19.05	40.00	06	99	145.45	58.46	58.66
Number of fruits per plant per picking	7.45	15.80	04	98	138.38	63.11	63.61
Marketable fruit yield per plant (Kg)	1.11	1.71	0.63	86	60.72	32.29	34.77
Total fruit yield per plant (Kg)	1.24	1.89	0.69	84	50.91	27.61	30.02
Total soluble solids (%)	4.37	5.10	3.6	96	19.9	10.08	10.24

Moderate genetic advance as percent of mean was observed for days to 50% flowering (34.40 %) and days to first picking (22.47 %).

Low genetic advance as percent of mean was observed for total soluble solids (19.9 %).

Higher heritability estimate coupled with higher genetic advance as percent of mean were observed for total number of fruit per plant, number of fruits per plant per picking, average fruit weight, average fruit length, average fruit girth, total fruit yield per plant, marketable fruit yield per plant, average plant height and number of primary branches per plant. This indicated the role of additive genetic variance towards expression of these traits.

High heritability coupled with moderate genetic advance as percentage of mean observed for days to 50% flowering and days to first picking which is mainly due to the role of non additive gene action in their expression. On the other hand high heritability coupled with low genetic advance as percentage of mean observed for total soluble solids (%).These findings are in agreement with the findings of Singh *et al.* (2003), Prasad *et al.* (2004), Sao (2006), Mishra *et al.* (2008), Ambade (2008), Ansari (2010), Biswas (2010) and Chattopadhyay *et al.* (2011).

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ANALYSIS OF GENETIC PARAMETERS IN M_2 GENERATION OF FIELDPEA (*PISUM SATIVUM* L.)

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Abstract: The Present investigation was undertaken with an objective to assess the induced genetic variability in M_2 generation. The research programme was conducted during *rabi* 2008-09 at field Experimentation center, Department of Genetics and Plant Breeding, SHIATS, Allahabad. The parent material, seeds of PUSA212 variety were irradiated with 10kR, 15kR, 20kR, 25kR and 30kR doses of gamma rays at NBRI, Lucknow. Next day after treatment, the seeds along with control were space planted for raising M_1 generation. Each M_1 plant was harvested separately. Desirable ten M_1 individual plant progenies from each treatment were bulked and laid in RCBD for raising M_2 generation. Induced mutations delivered fairly good amount of genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance with respect to plant height, number of pods per plant, indicating scope for improving fieldpea yield by selection. The mutants with small pods, tall and increased number of pods per plant were isolated in M_2 generation.

Keywords: *Pisum sativum* L., Gamma rays, Induced variability, Genetic parameters, M_2 generation

INTRODUCTION

Fieldpea is an important pulse crop among pulses due to its multiple uses, which is utilized in preparing several food products mostly dhal and snacks. Besides this some promising qualities of field pea are easy cook ability, high biological value and free from flatulence inducing substances. As a component of pulses, field pea supply major share for protein requirement of our country and per capita availability of pulses. However our nation's pulse becomes weak due to stagnated pulse production. A variety of factors like lack of genotypes with higher yield potential, use of landraces and native cultivars by farmers, agro climatic condition acting as a constraints in hampering the field pea area and production of our country. Ultimately it is too difficult meet the needs of human consumption. So, it is a challenge for breeder to increase the quantitative and qualitative traits of field pea, which are agronomically and economically desirable through genetic improvement.

Conventional breeding methods exploit huge time to improve genetic variability which is already present in the population. In fact, the natural genetic variability in field pea has been exhausted due to natural and artificial selection. So, further broadening of genetic base of field pea can be made through mutagenesis. Mutation breeding is a supplementary breeding method which is rapid, potential and valuable tool to create genetic variability for various quantitative and qualitative characters in crop plants. Induced mutations are produced by the use of mutagenic agents like physical mutagens (x-rays, Gamma rays etc.) and chemical mutagens (alkalating agents, base analogues etc.) However gamma rays act on genetic material by ionization leading to more of chromosomal rather than point mutations and gamma rays are successfully used in plant breeding programmes because of its simple application, good penetration, reproducibility, high mutation frequency and less disposal problems

Genetic variability of desirable attributes is essential for any crop improvement programme and its creation and management are central to plant breeding. The investigation was carried to assess the induced variability in yield attributes along with seed protein content in M_2 generation.

MATERIAL AND METHODS

The parent material used in the present mutation breeding experiment was PUSA-212 variety of fieldpea. Uniform, healthy and dry seeds of field pea variety PUSA - 212 were irradiated with different doses viz. 10, 15,20 25,30 kilo Roentgen of gamma rays (source: cobalt 60) at NBRI, Lucknow. Next day, treated seeds of each dose and control were sown in two rows with 50x40cm. spacing during *rabi* 2007-08 for raising M_1 generation. For M_2 generation, ten M_1 plant progenies were selected which showed significant deviation in mean values of the control, particularly for yield. Seeds from each selected M_1 plant progenies were bulked and raised during r*abi* 2008-2009 in three replications for each treatment (Wani and Khan, 2006). The data were recorded on different traits **(**plant height ,number of pods per plant, days to flowering, days to pod setting, days to maturity, grain yield per plant, test weight, harvest index and seed protein content) in M_2 generation. Seed protein content (%) is estimated by Lowry's (1951) method. The data was subjected to analysis of variance and used for estimation of extent of induced variability and genetic parameters. Heritability (H) estimate was worked out by the formula and Burton and Devane (1953).The genetic advance i.e. expected genetic gain was worked out

by using the formula suggested by Lush (1949) and Johnson *et al.,* (1955).

RESULT AND DISCUSSION

The success of breeding programme depends upon the thorough knowledge of genetic variability, heritability and genetic advance for improvement of desirable characters. Mutations affecting quantitative characters can be best inferred by estimates of range, mean, and other genetic parameters in the mutagen treated population. The experimental results revealed significant induced variability in different yield attributes. Selection on the significant characters like number of pods per plant, days to flowering, days to pod setting, harvest index may directly result in getting high yield since they are having high heritability, genetic advance. This indicates the scope for creating induced genetic variability and for selecting mutants having desirable traits.

The estimates of mean and range in the experiment was more for plant height (211.73-109.53), number of pods per plant (48.23-31.56), days to flowering (52.33-49.33), days to pod setting(73.66-69.33), days to maturity (129.66-125.33), grain yield per plant (34.73-28.16), test weight (25.20-22.00) harvest index(63.20-56.73) and seed protein content(11.93-11.49) was observed Table-1. Lal.M.Gaibrial (2006) was observed similar wide range for different yield attributes in M_2 generation. The analysis of variance Table-2 for different characters under consideration shown a quantum of genetic variability or mutability in five treatments of M_2 generation. The mean sum of squares due to treatments exhibited a significant difference for the traits under the study. Similar results in pea were also reported by Ghareeb (2006), and Khan and Irfan (1983) in Mungbean.

Table-1 Mean performances of six treatments of Gamma rays for different characters in Fieldpea cv-PUSA 212 (M_2 generation)

Treatment	Number of pods per plant	Days to flowering	Days to pod setting	Days to maturity	Grain yield per plant (g)	Test weight (g)	Harvest index (%)	Seed protein content (%)
Control	39.43	50.00	69.33	126.33	32.46	22.60	61.03	11.56
10kR	42.66	52.33	73.66	125.33	33.63	22.00	63.20	11.87
15kR	47.46	50.33	72.66	126.00	32.10	20.76	62.03	11.93
20kR	48.23	51.66	71.66	127.00	34.73	25.20	59.70	11.89
25kR	40.26	49.33	71.00	126.66	30.26	22.40	60.20	11.65
30kR	31.56	50.33	69.33	129.66	28.16	22.86	56.73	11.49
Grand mean	41.60	50.66	71.27	126.83	31.89	22.63	60.48	11.73
Maximum	48.23	52.33	73.66	129.66	34.73	25.20	63.20	11.93
Minimum	31.56	49.33	69.33	125.33	28.16	22.00	56.73	11.49
S.Em	0.843	0.379	0.696	0.459	0.338	1.895	0.588	0.159
S.Ed	1.193	0.537	0.984	0.649	0.478	2.680	0.832	0.225
CD (5%)	2.658	1.197	2.194	1.447	1.065	5.971	1.854	0.502
CD (1%)	3.780	1.701	3.118	2.056	1.514	8.492	2.636	0.713

Table-2 Analysis of variance for different characters in six gamma rays treatments rays for different characters in Fieldpea cv-PUSA 212 (M_2 generation)

Characters	Replication	Treatments	Error
d.f.	**(2)**	**(5)**	**(10)**
Plant height	40.350	4440.133*	12.590
Number of pods per plant	3.84	112.0178*	2.136
Days to flowering	1.50	3.732*	0.433
Days to pod setting	3.388	9.255*	1.455
Days to maturity	0.166	6.766*	0.633
Grain yield per plant	1.1705	16.7992*	0.3432
Test weight	1.1505	6.349*	1.197
harvest Index	0.3072	14.8942*	1.0392
Seed protein content (%)	0.0363	0.1069	0.0762

* Indicates significant at 5% level of significance

Table-3 Estimation of components of variance and genetic parameters for different characters in six gamma ray treatments of field pea Cv PUSA-212 (M_2 generation)

Characters	GCV (%)	PCV (%)	Heritability (bs) (%)	GA (%)
Plant height	28.29	28.41	99.2	78.80
Number of pods per plant	14.54	14.96	94.48	12.11
Days to flowering	2.069	2.443	71.73	1.82
Days to pod setting	2.26	2.82	64.11	2.65
Days to Maturity	1.12	1.290	76.35	2.57
Grain yield/ plant	7.34	7.57	94.11	4.68
Test weight	7.58	12.87	58.92	2.07
Harvest Index	3.55	3.93	81.63	3.99

Genetic parameters of different traits under study was represented in table- 3.Highest phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) for the plant height (28.41, 28.21) was observed. Thus it suggests substantial amount of variation was present in the experimental material. Phenotypic coefficient of variation was higher than genotype coefficient of variation for all the characters where as other characters exhibited moderate to low estimates of PCV Coefficient of variation was observed for character number of Pods per plant (14.54, 14.96) followed by Test weight (12.87,5.8) , Grain Yield per plant (7.34, 7.57) . These finding are in agreement with the Mazik Tokei and Furedi (1991), Mehandjiev *et.al.,* (2006) in Fieldpea,

Heritability was highest for the character number of Pods per plant (94.48), followed by grain yield per plant (94.11), and remaining characters exhibited less than 80 percent. Genetic advance for different traits revealed that it varied from. days to flowering(1.82) to Plant height(78.80) and for number of pods/plant is (12.11). The higher values of heritability and genetic advance were earlier reported by Ghareeb (2006), Amitava and Singh (2005) in fieldpea

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SOWING DATES AND VARIETAL EFFECTS ON LEAF AREA INDEX, MEAN TILT ANGLE AND HEAT SUSCEPTIBILITY INDEX OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract: A field experiment was conducted at the Crop Research Center of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) during rabi season of 2008-09 to study the photosynthesis, growth and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) varieties at different sowing dates. The experiment was conducted in split plot design with 4 replications with treatments comprising six wheat varieties on Nov.14, Dec.4 and Dec.24. Delay in sowing adversely affected leaf area index. Reduction in leaf area index at 45, 60 and 75 day after sowing and at anthesis and two week after anthesis stage was observed due to late sowing. High leaf area index was noticed in variety UP 2526 at 75 day after sowing and at anthesis and variety DBW 17 followed by UP 2526 recorded highest leaf area index at two week after sowing. Heat susceptibility index computed for yield and yield attributes indicated that variety Raj 3765 was most heat tolerant variety. High grain yield of a genotype under late sown condition indicated the presence of gene for heat tolerance.

Keywords: Sowing date, Leaf area index, Mean Tilt angle, Heat susceptibility index, Yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the oldest cereals widely consumed by human being. Wheat is the most important rabi season crop in the country occupying about 50 % of the total area under food crops and accounting for more than 70 % of the total grain production in the rabi season. Moreover, the success of food grain production in India over the years is attributed mainly to the performance of wheat crop. The short day length and low temperature prolong vegetative plant growth phase. However, reproductive phase (anthesis) is highly sensitive to elevated temperature coupled with less humidity, dry air and sharp sun light (Singh *et al*., 2006). It has been envisaged that at least 110 million tonnes of wheat will be needed by 2020A.D. for food security of Indian population. Since little scope exists for horizontal growth, the alternative seems to be vertical growth by increasing present productivity from 2.83 tonnes per ha to 4.0 tonnes per ha. Temperature is the main environmental factor which determines the rate of development possibly because all plants and processes of development are sensitive to it. Hence, temperature plays a key role in determining sowing time. High temperature (more than 30^0C) during grain filling is one of the major constraints in increasing productivity of wheat in tropical countries like India (Rane and Nagarajan, 2004). Grain development in wheat under the north India conditions take place under rising temperature regimes during the month of February to April and as a growth factor, temperature is a major factor determining the grain yield of wheat. The crop environment varies with date of sowing and determines the yield of wheat.

MATERIAL AND METHOD

Selection of field

The field experiment was conducted at the Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during the winter season (*rabi*) of 2008-09. Pantnagar is situated at 29°N latitude and 79.3°E longitude and at an altitude of 243.83 m above mean sea level. Geographically Pantnagar comes under humid sub-tropical zone and is situated at the foothills of 'Shivalik range' of Himalayas. It falls under the '*Tarai* area' which is narrow belt in the foothills of Himalayas. The soil was silty loam, rich in organic matter, high in available phosphorus and medium in available potassium and neutral in reaction. The experiment was laid out in split plot design with 4 replications with treatments comprising three dates of sowing viz, Nov. 14, Dec.0 4 and Dec. 24 in main plots and 6 different wheat varieties viz. 'PBW 17', 'RAJ 3765', 'UP 2526', 'UP 2565', 'UP 2572' and 'UP 2584' in sub-plots. Sowing was done in rows spaced 23 cm apart at a depth of 5 cm. Recommended cultural practices for raising of wheat crop were followed.

Leaf area index and Mean tilt angle

Plant Canopy Analyzer (LAI-2000, LI-COR, USA) was used to record leaf area index at different stages in this study. This instrument is helpful in indirectly recording leaf area index (LAI), mean tilt angle (an indicator of leaf angle) and gap fraction (proportion of area not covered in a crop canopy) by measuring attenuation of light passing through canopy at five zenith angles. The instrument was set to record one observation above the canopy and 4 observations below the canopy in four replication from each plot.

Therefore, observations from each plot were based on 60 pairs of observations (4 below canopy observation × 4 replications × 5 angles). Sixteen below canopy observations were recorded in four separate inter row spacings in net plot area by placing sensor close to left and right rows and in the middle of inter row space. These observations were recorded in diffused light in evening.

Heat susceptibility index

Heat susceptibility index was given by Fisher and Maurer (1978). Heat susceptibility index (HIS) for all the varieties was calculated for grain yield and other attributes on the basis of high temperature stress (December 24 sowing) and non-stress environments (November 14 sowing) by using the formula as presented by Fisher and Maurer:

$$HSI = (1-Y_D/Y_P)/D$$

Where,

HSI = Heat susceptibility index

Y_D = mean of genotype in high temperature stress environment

Y_P = mean of genotype under non-stress environment

D = 1-(mean Y_D of all genotypes/mean Y_P of all genotypes)

RESULT AND DISCUSSION

Leaf area indices recorded at different stages were significantly affected due to main effect of sowing dates and varieties at all the stages. In general, leaf area index increased upto anthesis and declined thereafter. Successive delay in sowing also caused gradual reduction in LAI. November 14 sown crop produced significantly higher LAI than other two sowings at all the stages except 45 and 60 days after sowing where differences in leaf area indices between November 14 and December 4 sown crops were non-significant. December 4 sown crop showed higher LAI than December 24 sown crop at all the stages but the difference was non-significant at 45 and 75 days after sowing (Table 1). At 45 days after sowing, the highest LAI was recorded in Raj 3765 (2.19) followed by UP 2526, UP 2565 and UP 2572. These varieties significantly differed from each other in their LAI. The lowest LAI was recorded in UP 2584 (1.44) which was *at par* with DBW 17 at this stage.

At 60 days after sowing, the highest leaf area index was noticed in variety UP 2572 which was statistically superior to all other varieties. It was followed by UP 2526, Raj 3765 and UP 2565 which were *at par* with each other. The lowest leaf area index was produced by variety UP 2584 which was *at par* with DBW 17. At 75 days after sowing, the highest LAI was observed in variety UP 2526 followed by UP 2572, Raj 3765, UP 2565 and UP 2584. The differences in leaf area indices between any two consecutive varieties were non-significant. Variety DBW 17 had significantly lower LAI than all other varieties.

At anthesis, variety UP 2526 (4.30) produced significantly higher leaf area index than all other varieties. It was followed by UP 2572 and Raj 3765 which were *at par* with one another. The lowest leaf area index exhibiting variety DBW 17 (3.74) was *at par* with UP 2584 and UP 2565. Variety DBW 17 followed by UP 2565 and UP 2572 produced the highest leaf area index two weeks after anthesis. These varieties being *at par* with each other produced significantly higher leaf area indices than rest of the varieties. Variety UP 2584 being *at par* with UP 2565 produced the lowest leaf area index. The similar results were found by Mishra (2002), Tripathi (2003) and Pande (2009) also reported that timely sown crop had higher LAI than late sown crop.

Mean tilt angle (MTA)

It can be inferred from Table 2 that mean tilt angle of the crop declined with successive delay in sowings. But differences in mean tilt angle due to sowing dates were non significant at 45 days after sowing. November 14 sown crop being *at par* with December 4 sown crop showed significantly higher mean tilt angle than that of December 24 sown crop at all stages except 45 days after sowing. December 4 and December 24 sown crops statistically did not differ from each other at 75 days after sowing, at anthesis and two weeks after anthesis.

At 45 days after sowing, variety UP 2565 followed by DBW 17, UP 2572, UP 2584 recorded the highest mean tilt angle. Variety Raj 3765 and UP 2526 jointly showed the lowest mean tilt angle. However, varietal differences in mean tilt were non-significant at this stage. At 60 days after sowing, variety DBW 17 had significantly higher mean tilt angle than all other varieties except UP 2584 and UP 2565 which were *at par* with each other. The lowest mean tilt angle was observed in UP 2526 followed by UP 2572, Raj 3765 and UP 2565 which was *at par* with each other. At 75 days after sowing, DBW 17 had significantly higher mean tilt angle than all other varieties except UP 2565 and UP 2584. Variety UP 2565 and UP 2584 being *at par* with each other recorded significantly higher mean tilt angle than Raj 3765. UP 2572 which showed the least mean tilt angle value was *at par* with UP 2526 and Raj 3765.

At anthesis, the highest canopy angle was observed in UP 2565 (50.4°) which was statistically superior to all other varieties except Raj 3765. The lowest mean tilt angle of 47.5° was observed in variety UP 2526 which was *at par* with all other varieties except UP 2565.At two weeks after anthesis, variety UP 2565 showed significantly higher mean tilt angle than all other varieties except UP 2584 and Raj 3765. Varieties UP 2584, Raj 3765, UP 2526 and DBW 17 being *at par* with each other recorded significantly higher mean tilt angle than UP 2572 which had the

lowest mean tilt angle. The similar results were agreement with the result of Mishra (2002) and Pande (2009).

Heat susceptibility index

To estimate the heat susceptibility index, six most important yield characters namely grain yield, biological yield, number of ear bearing shoots, grain weight per spike, number of grains per spike and 1000-grain weight were selected. Heat susceptibility index computed for yield and yield attributes indicated that variety Raj 3765 was most heat tolerant variety as it had minimum heat susceptibility indices for all the parameters except biological yield where it was very close to UP 2565 which had the lowest heat susceptibility index of 0.61 (Table 3). Heat susceptibility index for biological yield indicated that variety UP 2584 followed DBW 17 and UP 2572 were most susceptible varieties. Heat susceptibility index for grain yield and 1000-grain weight showed that Raj 3765 followed by UP 2526, UP 2565 and UP 2572 were the least heat susceptible varieties whereas variety UP 2584 followed by DBW 17 were most heat susceptibility varieties.

For number of ear bearing shoots, Raj3765 followed by UP 2526 and UP 2565 were most heat stress tolerant and UP 2584 followed by UP 2572 and DBW 17 were most heat susceptible varieties. Heat susceptibility index for number of grains per spike was lowest for Raj 3765 followed by UP 2565, UP 2584, UP 2572, UP 2526 and DBW 17 which had the highest heat susceptibility index. Heat susceptibility index for grain weight per spike was lowest in Raj 3765 followed by UP 2565, UP 2526 and UP 2572. The highest value of heat susceptibility index for grain weight per spike was observed in DBW 17 which was followed by UP 2584. High grain yield of a genotype under late sown condition indicated the presence of gene for heat tolerance.

Table 1: Effect of sowing dates and varieties on leaf area index at 45, 60, 75 DAS*, at anthesis and two weeks after anthesis

Treatment	Leaf area index				
	45 DAS*	60 DAS*	75 DAS*	At anthesis	2 weeks after anthesis
Sowing dates					
November 14	1.82	3.07	4.18	4.26	3.64
December 4	1.67	3.05	3.77	3.98	3.19
December 24	1.62	2.90	3.65	3.65	2.74
S.Em.±	0.06	0.03	0.05	0.04	0.08
CD (5%)	0.21	0.10	0.17	0.12	0.28
Varieties					
DBW 17	1.47	2.76	3.47	3.74	3.46
Raj 3765	2.19	3.10	3.96	3.98	3.10
UP 2526	1.87	3.13	4.17	4.30	3.39
UP 2565	1.70	3.08	3.82	3.87	2.99
UP 2572	1.58	3.37	4.02	4.07	3.34
UP 2584	1.44	2.62	3.76	3.82	2.86
S.Em.±	0.04	0.06	0.07	0.06	0.07
CD (5%)	0.12	0.18	0.20	0.16	0.19

*DAS : Days after sowing

Table 2 : Effect of sowing dates and wheat varieties on mean tilt angle (°) at 45, 60, 75 DAS*, at anthesis and two weeks after anthesis

Treatment	Mean tilt angle (°)				
	45 DAS*	60 DAS*	75 DAS*	At anthesis	2 weeks after anthesis
Sowing dates					
November 14	47.0	50.4	52.5	49.5	47.8
December 4	46.0	49.0	50.0	48.7	46.5
December 24	42.9	44.6	47.4	47.4	45.7
S.Em.±	1.5	1.0	0.8	0.4	0.4
CD (5%)	NS	3.5	2.9	1.4	1.5
Varieties					
DBW 17	45.8	50.6	51.4	48.2	46.3
Raj 3765	44.6	47.3	49.0	49.0	47.1
UP 2526	44.6	45.8	48.9	47.5	46.4
UP 2565	47.1	48.1	51.3	50.4	48.2

UP 2572	45.0	46.3	48.2	47.7	44.7
UP 2584	44.8	49.7	50.9	48.5	47.3
S.Em.±	0.8	0.9	0.6	0.6	0.5
CD (5%)	NS	2.6	1.7	1.8	1.5

*DAS : Days after sowing

Table 3 : Heat susceptibility indices for different parameters in wheat varieties

Varieties	Characters					
	Grain yield (t ha^{-1})	**Biological yield (t ha^{-1})**	**Number of ear bearing shoots m^{-2}**	**Grain weight per spike (g)**	**Number of grain per spike**	**1000-grain weight (g)**
DBW 17	1.27	1.19	1.24	1.36	1.68	1.29
Raj 3765	0.63	0.64	0.52	0.54	0.37	0.46
UP 2526	0.85	0.85	0.63	0.95	1.62	0.74
UP 2565	0.68	0.61	0.78	0.74	0.50	0.85
UP 2572	1.07	1.29	1.35	1.02	1.31	0.86
UP 2584	1.45	1.38	1.42	1.32	1.03	1.63

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EFFICACY OF BOTANICALS ON HATCHING AND LARVAL MORTALITY OF *MELOIDOGYNE INCOGNITA*

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Abstract Botanical extracts of *Azadirachta indica, Ocimum canum, Mentha spicata, Aloe barbedenses, Vincia rosea, Tagetes erecta, Calotropis gigantean, Humulus lupulus, Datura innoxia, Rosa damascene* and *Ricinus comunis* were evaluated for their nematicidal effect against *Meloidogyne incognita* juveniles hatching from egg masses. Results were found that all botanical extracts significantly inhibit/ educe the emergence of juveniles (J_2) from egg masses as compared to control. Among the botanical treatments, extracts of *Azadirachta indica* showed maximum inhibition on the emergence of juveniles from egg masses, maximum effect on larval mortality and minimum gall formation as compared to other plant extracts used.

Keywords: Botanical extracts, *Meloidogyne incognita*, Juveniles

INTRODUCTION

Root knot nematode, *Meloidogyne incognita* is a major plant parasitic nematode species affecting the quality and quantity of the crop production in many annual and perennial crops. Several measures have been employed to manage nematode problems worldwide. Notable among these are chemical nematicides. They cause a lot of hazards to both man and livestock cause pollution to the environment. This has prompted research into alternatives that are effective, cheap and compatible with the environment. The use of alternatives to chemicals for the control of plant parasitic nematodes is a response to present and future environmental requirements. One possible alternative is the utilization of nematicides from origin, known as botanical nematicides. They are considered to be non-persistent under field conditions as they are readily transformed by light, oxygen and micro-organisms into less toxic products. Plant extracts containing volatile compounds, especially essential oils, have been found to possess nematicidal activity. Various medicinal and antagonistic plants have been found effective for the control of root knot nematodes (Ahmad *et al*., 2004; Abrahim *et al*., 2006; Abo-Elyousr *et al*., 2010; Hussain *et al*., 2011b). The present investigation was conducted to evaluate the nematicidal properties of some botanicals viz *Azadirachta indica, Ocimum canum, Mentha spicata, Aloe barbedenses, Vincia rosea, Tagetes erecta, Calotropis gigantean, Humulus lupulus, Datura innoxia, Rosa damascene* and *Ricinus comunis* leave extracts for the management of root knot nematode.

MATERIAL AND METHOD

Multiplication of *M. incognita*

Culture of *Meloidogyne incognita* was maintained on tomato variety "Pusa Ruby" raised in pots with sterilized mixture (2:1:1) sand, loamy soil and farmyard manure respectively.

Extraction of eggs and juveniles

Sixty days after inoculation, the pots were depotted and roots were washed properly under a slow stream of tap water until the roots were free of soil and debris and egg masses were collected from the roots by passing through 60 mesh sieve.

Collection of plant materials

Fresh healthy leaves of *Azadirachta indica, Ocimum canum, Mentha spicata, Aloe barbedenses, Vincia rosea, Tagetes erecta, Calotropis gigantean, Humulus lupulus, Datura innoxia, Rosa damascene* and *Ricinus comunis* were collected from the Horticulture research field of Allahabad Agriculture Institute, washed with tap water and surface sterilized with 2% sodium hypochlorite for 5 minutes and washed thoroughly 2-3 times with sterile distilled water and macerated separately in pestle and mortar. Extracts were squeezed through muslin cloth and thus collected extract were centrifuged at 2000 rpm for 15 min. A stock solution (100%) was maintained and further dilutions of 50% and 25% were prepared.

Assessment of effect of plant extracts on hatching and mortality of *M. incognita*

The dilutions were tested against egg masses of *Meloidogyne incognita* by exposing 10 egg masses of uniform sizes in cavity blocks containing dilutions with three replications and a control with sterile distilled water at 28±1°C . The observations on egg hatched and larval mortality were taken after every 12, 24, 48 and72 hours.

The percentage (%) of larval mortality was calculated with the following formula:

$$\text{Mortality} = \frac{\text{No. of dead larvae in treatment} - \text{No. of dead larvae in control}}{\text{Total}} \times 100$$

Assessment of effects of plant extracts on *M. incognita* and plants in pot conditions

Effects of standard concentrations of plant extracts were evaluated in the pots by transplanting the 4weeks old tomato seedlings into the pots with sterile soil. One week after transplanting of seedlings, each pot was inoculated with approximately 3000 nematode larva and each pot were irrigated with 300 ml of plant extract after 5days of inoculation. Each treatment was replicated three times and a control was maintained with sterile distilled water. After 30 days the seedlings were carefully brought out of the pots and their roots were washed with tap water. Information on plant height, fresh and dry weight of foliage and roots, the nematode population in the soil were recorded.

Table 1: Efficacy of plant extracts on hatching of *M. incognita* from egg masses.

Treatments/Plant extracts	Exposure time in hours	Concentrations of plant extracts			
		25%	50%	100%	Control
Azadirachta indica	12 hours	03.00	03.00	01.00	13.00
	24 hours	07.00	07.00	03.00	27.00
	48 hours	10.00	07.00	07.00	50.00
	72 hours	10.00	10.00	10.00	71.00
Ocimum canum	12 hours	03.00	03.00	03.00	10.00
	24 hours	10.00	07.00	07.00	17.00
	48 hours	17.00	17.00	13.00	30.00
	72 hours	24.00	20.00	17.00	53.00
Mentha spicata	12 hours	10.00	07.00	07.00	13.00
	24 hours	13.00	13.00	13.00	20.00
	48 hours	17.00	20.00	17.00	50.00
	72 hours	30.00	27.00	23.00	66.00
Aloe barbadenses	12 hours	03.00	03.00	07.00	10.00
	24 hours	10.00	07.00	07.00	20.00
	48 hours	13.00	10.00	10.00	30.00
	72 hours	24.00	20.00	17.00	50.00
Vincia rosea	12 hours	10.00	07.00	07.00	24.00
	24 hours	13.00	13.00	07.00	33.00
	48 hours	20.00	20.00	13.00	53.00
	72 hours	27.00	27.00	17.00	71.00
Tagetes erecta	12 hours	07.00	03.00	00.00	13.00
	24 hours	10.00	07.00	03.00	17.00
	48 hours	13.00	13.00	10.00	37.00
	72 hours	20.00	17.00	17.00	57.00
Calotropis gigantean	12 hours	10.00	10.00	10.00	17.00
	24 hours	24.00	20.00	24.00	27.00
	48 hours	40.00	27.00	40.00	47.00
	72 hours	50.00	47.00	43.00	53.00
Humulus lupulus	12 hours	10.00	10.00	07.00	13.00
	24 hours	24.00	17.00	10.00	24.00
	48 hours	33.00	30.00	17.00	47.00
	72 hours	47.00	40.00	27.00	70.00
Datura innoxia	12 hours	10.00	10.00	13.00	13.00
	24 hours	17.00	13.00	13.00	23.00
	48 hours	24.00	20.00	17.00	40.00
	72 hours	37.00	33.00	27.00	70.00
Rosa damascene	12 hours	10.00	10.00	07.00	20.00
	24 hours	17.00	13.00	10.00	30.00
	48 hours	27.00	24.00	17.00	40.00
	72 hours	30.00	30.00	27.00	67.00
Ricinus communis	12 hours	07.00	03.00	10.00	17.00
	24 hours	20.00	24.00	13.00	30.00
	48 hours	30.00	30.00	30.00	40.00
	72 hours	47.00	40.00	40.00	67.00

Values are mean of three replications.

Table 2: Efficacy of plant extracts on mortality of *M. incognita* juveniles after 48 hours of exposure.

Treatments/Plant extracts	Concentrations of plant extracts			
	25%	50%	100%	Control
Azadirachta indica	42.0	43.7	47.0	11.6
Ocimum canum	21.6	27.7	33.3	14.7
Mentha spicata	34.3	37.7	45.0	23.7
Aloe barbadenses	30.0	39.0	46.7	13.3
Vincia rosea	32.7	36.7	46.0	20.7
Tagetes erecta	35.0	38.3	40.0	17.6
Calotropis gigantean	31.7	33.3	38.7	20.0
Humulus lupulus	26.7	28.3	33.3	15.0
Datura innoxia	23.3	30.0	36.0	10.0
Rosa damascene	23.3	26.7	34.0	26.7
Ricinus communis	30.0	33.3	38.3	19.0

Values are mean of three replications.

Table 3: Efficacy of 300ml/pot of plant extracts on plant height, dry seed weight and galling index of tomato plants inoculated with 3000 juveniles of *M. incognita* /pot.

Treatments/Plant extracts	Plant height (cm)	Dry seed weight (g)	Galling index
Azadirachta indica	28.1	11.8	01.7
Ocimum canum	15.5	07.9	09.0
Mentha spicata	24.5	11.0	02.6
Aloe barbadenses	22.8	10.3	04.0
Vincia rosea	23.6	10.6	03.8
Tagetes erecta	26.4	11.0	01.9
Calotropis gigantean	22.0	09.6	05.3
Humulus lupulus	19.4	08.7	06.4
Datura innoxia	18.0	08.0	07.7
Rosa damascene	17.2	08.0	08.6
Ricinus communis	20.9	09.2	06.5
Control	30.3	12.5	24.1

Values are mean of three replications.

RESULT AND DISCUSSION

The different plant extract treatments and their potentized dose had favourable effect on the hatching of *Meloidogyne incognita* (J_2) from egg masses. All the medicinal plants *viz. Azadirachta indica, Ocimum canum, Mentha spicata, Aloe barbedenses, Vincia rosea, Tagetes erecta, Calotropis gigantean, Humulus lupulus, Datura innoxia, Rosa damascene* and *Ricinus comunis* significantly inhibit the emergence of second stage juveniles (J_2) from egg masses as compared to control. Maximum inhibition of the hatching was observed in treatment with *Azadirachta indica* and *Tagetes erecta* as compared with other treatments including control. Gowda and Setty (1978) reported the hatching of larvae from fresh eggs of *M. incognita* were placed 24 hours into extract of *Azadirachta indica* cake was significantly reduced in all the dilution as compared with control.

The efficacy of plant extracts on mortality of *M. incognita* juveniles after 48 hours of exposure to plants extract shows *Azadirachta indica* with 42 % @ 25 ppm , 43.7 % @ 50 ppm and 47% @ 100 ppm. Rajendran and Saritha (2005) used plant extracts of *Arnica montana , Calendula officinalis , Carica papaya* and *Azadirachta indica* for evaluating the nematicidal effect against *M. incognita* infesting tomato , variety PKMI. They reported that all plant extracts tested were found to reduce the root galls and nematode population in soil, further they reported that maximum mortality was recorded in plants treated with *Azadirachta indica* at 30 % dilution.

The result of the study shows maximum effect on plant height, dry seed weight and galling index with leaves extract of *Azadirachta indica* @ 28.1 , 11.8 and 1.7 % respectively. Saxena and Gangopadhyay (2005) reported fruits leaves extracts of *Citrus aurantifolia, Annona squamosa , Psidium guajava , Musa species* and *Aegle marmelos* had nematostatic properties and effective against *M. incognita* after exposed to various concentrations *viz.,* 250, 500, 1000 and 2000 ppm for 3,6,24, 48 and 72 hours .

CONCLUSION

The results show that used of botanical plant extracts is successful in reducing the number of juveniles

hatching from egg masses of *Meloidogyne incognita* .The extent of number of hatching reduces depending on qualitative and quantitative application of specific plant extracts and time duration . Therefore use of leaves extract of botanical plants (as in experiment) is more beneficial than the use of chemical treatments. The natural materials are generally non-toxic to plants as well as animals (non-bio hazardous as well as eco- friendly) as compared to chemicals.

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IMPACT OF FUTURES TRADING ON VOLATILITY IN SPOT AND FUTURES PRICES OF AGRICULTURAL COMMODITIES IN INDIA

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Abstract: The agricultural product's prices are highly volatile. There is considerable time lag between the time of initial spending and procuring of receipts from the final farm produce. A farmer is highly susceptible to price fluctuations of both farm produce as well as farm inputs. Traditionally, this risk is borne mainly by the producer (sometimes by the government) more than the consumer for a variety of reasons. It has made farmers look for alternatives to mitigate the risk. Futures market is one such option. The present study was carried out on NCDEX. The daily spot and futures price data of selected agricultural commodities were obtained from the website of National Commodity and Derivative Exchange (NCDEX), Mumbai. Three commodities *viz.* wheat, refined soy oil and chana were studied for a period of nine years from year 2004 to 2012 as per the availability of data. Auto Regressive Conditional Heteroskedasticity (ARCH) and Generalised Auto Regressive Conditional Heteroskedasticity (GARCH) model were used to achieve the objective of the study. Major findings of the study revealed that, the spot and futures price series of wheat and refined soy oil were significantly volatile. While, that of chana, spot price was found to be non-significant and hence stable, while futures price was found significant and volatile.

Keywords: ARCH, GARCH, NCDEX, Spot prices, Futures prices

INTRODUCTION

Post independence, agriculture became a vibrant sector of the economy. Green revolution technology was introduced in mid 1960s, which, by 1990s spread to almost all parts of the country depending upon the conditions suitable for adoption of such technology. The contribution of agriculture and allied sector was estimated to be 13.9 percent in the Gross Domestic product (GDP) during the fiscal year 2011-12 (Economic Survey, 2012-13). But in any agriculture-dominated economy, like India, farmers face not only yield risk but price risk as well. Over past two decades, farm produce prices have been more volatile than the prices of manufactured goods.

A central problem of agricultural markets in India has been price instability which has a negative impact on economic growth, income distribution, and on the poor (Srikanth T. and Rani A.R. 2007). The uncertainty of commodity prices leaves a farmer open to the risk of receiving a price lower than the expected price for his farm produce. Globally, futures contracts have occupied a very important place to cope this price risk. Many countries have been establishing and promoting commodity futures markets. At present, the futures and derivatives segment is growing at an exponential rate, which is a positive sign of development (Easwaran and Ramasundaram, 2008).

Futures trading perform two important functions of price discovery and risk management with reference to the given commodity. It is useful to all segments of the economy. It is useful to producer because he can get an idea of the price likely to prevail at a future point of time and therefore can decide between various competing commodities, the best suits him. Farmers can derive benefit from futures markets by participating directly/indirectly in the market to hedge their price risks and to take benefit of prices discovered on the platform of commodity exchanges by taking rational and well informed cropping/marketing decisions (Anonymous, 2008). The National Agricultural Policy 2000 (NAP), sought to "enlarge the coverage of futures markets to minimize the wide fluctuations in commodity prices as also for hedging their risk". It is also observed that commodities futures have been less volatile compared with equity and bonds, thereby providing an efficient portfolio diversification option (Sairam A. and Pasha M.F., 2008).

Rationale and Objective

The possibility of adverse price change in futures increase the risk involved in any business. It has been forcefully argued that futures markets are dominated by speculative interests and farmers are not direct participants, so price rise can partially attributed on such trading, which leads to high price volatility. It is being expected that the futures trading has made significant impact on the volatility of the spot and futures prices over period. Research in this area is still in a very nascent stage in the country. Keeping this in view, the present study were undertaken to know the volatility in spot and futures prices of selected agricultural commodities. This is important to see, whether futures trading is really volatile the spot and futures prices?

METHODOLOGY

The study was conducted on secondary data. The daily spot and futures prices of selected agricultural

commodities were obtained from the website of NCDEX, Mumbai, from 2004 to 2012.

Keeping in view the importance of commodities from both uses as well as futures trading point of view, commodities were selected for the study.

Wheat is one of the most important food crop of India as well as world and it also have maximum value of futures trading in NCDEX among the all cereals food crops. It has 20.35 lakh tonnes by volume which has 2401.69 Rs. Crore value of trade up to January 2012 in financial year 2011-12. Main Delivery centre of wheat is Delhi, it is also delivered at some centre namely Ahmedabad, Bareilly, Indore, Itarsi, Kanpur, Karnal, Khanna, Kota, Moga, Rajkot, Shahjahanpur and Sirsa etc.

Refined soy oil was chosen for the purpose of study because, again it is very important from domestic consumption as well as futures trading point of view. Refined soy oil has maximum value of trade among all the edible oils in NCDEX. It has 613.02 lakh tonnes by volume which has value of 402028.75 Rs. Crore up to January 2012 in current financial year 2011-12. Delivery centre of soy oil is Indore (M.P.).

Chana was chosen for the purpose of study because it is a very important pulse crop of India. Chana shows maximum futures trade among all the pulse crops and in the financial year 2011-12, up to January, 2012 the volume of trade is 769.28 lakh tonnes and value is 241085.75 Rs. Crore. Main delivery centre is Delhi and it is also deliverable at Indore and Bikaner.

So, all the selected commodities have maximum trade in their respective group i.e. cereal, edible oils and pulses not only current financial year but previous years also.

Analytical Framework

Volatility was measured using the univariate ARCH-type models. Autoregressive Conditional Heteroskedasticity (ARCH) models are specifically designed to model and forecast conditional variances. The variance of the dependent variable is modelled as a function of past values of the dependent variable and independent or exogenous variables.

ARCH models were introduced by Engle (1982) and generalised as GARCH (Generalised ARCH) by Bollerslev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis.

The ARCH specification

In developing an ARCH model, one has to provide two distinct specifications one for the conditional mean and one for the conditional variance.

In this study, the GARCH (1, 1) model was used, which is as follows:

In the standard GARCH (1, 1) specification:

$Z_t = \gamma_0 + \varepsilon_t$ ….. (1)

$\sigma_t^2 = \omega + \alpha e^2_{t-1} + \beta \sigma^2_{t-1}$ ..... (2)

The mean equation given in equation (1) is written as a function of exogenous variables with an error term. Here dependent variable is spot or futures price i.e. Z_t.

Since σ_t^2 is the one-period ahead forecast variance based on past information, it is called conditional variance. The conditional variance equation specified in equation (2) is a function of three terms:

1) The mean: **ω**
2) News about volatility from the previous period, measured as the lag of the squared residual from the mean equation: e^2_{t-1} (the ARCH term)
3) Last period's forecast variance: σ^2_{t-1} (the GARCH term)

The (1, 1) in GARCH refers to the presence of a first-order GARCH term (the first term in parentheses) and a first-order ARCH term (the second term in parentheses). An ordinary ARCH model is a special case of a GARCH specification in which there are no lagged forecast variances in the conditional variance equation.

RESULT AND DISCUSSION

Generally, volatility refers to the fluctuation in prices of commodities/goods. In agricultural commodities, volatility originates mainly from supply disturbances. These disturbances coupled with short-run demand and supply elasticities give rise to acute price fluctuations. In this study, it was measured using the univariate ARCH-type models. The results of volatility analysis using the univariate ARCH-type model for the selected agricultural commodities are:

Table 1: Auto Regressive Conditional Heteroskedasticity (ARCH) with spot price as dependent for wheat

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	0.000731	0.000333	2.191322	0.0284
Variance Equation				
C	3.93E-06	9.93E-07	3.959964	0.0001
RESID(-1)^2	**0.885162**	0.326836	2.708280	0.0068
GARCH(-1)	**0.494815**	0.086843	5.697814	0.0000
R-squared	-0.001296	Mean dependent var		0.000364
Adjusted R-squared	-0.001296	S.D. dependent var		0.010196
S.E. of regression	0.010203	Akaike info criterion		-6.804190
Sum squared resid	0.129282	Schwarz criterion		-6.787696

Log likelihood	4232.804	Hannan-Quinn criter.	-6.797988
Durbin-Watson stat	1.632321		

Table 2: Auto Regressive Conditional Heteroskedasticity (ARCH) with futures price as dependent for wheat

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	0.001525	0.000282	5.414027	0.0000
Variance Equation				
C	9.26E-06	2.83E-06	3.272661	0.0011
RESID(-1)^2	**1.991418**	0.569918	3.494221	0.0005
GARCH(-1)	**0.202725**	0.063827	3.176161	0.0015
R-squared	-0.008723	Mean dependent var		0.000285
Adjusted R-squared	-0.008723	S.D. dependent var		0.013277
S.E. of regression	0.013335	Akaike info criterion		-6.573408
Sum squared resid	0.220859	Schwarz criterion		-6.556915
Log likelihood	4089.373	Hannan-Quinn criter.		-6.567206
Durbin-Watson stat	2.081684			

Table 1 and Table 2 are showed the univariate GARCH (1, 1) parameters for the mean and variance equations of spot and futures price of wheat. The tables were divided into two panels, upper panel represent the mean equation and lower panel represents the variance equation of model. In above tables, sum of the coefficient of ARCH (α) and GARCH (β) terms for spot and futures series were 1.38 and 2.19 respectively which were greater than one and hence, significant. So, we can conclude that both spot and futures series were highly volatile during the period under study.

Table 3: Auto Regressive Conditional Heteroskedasticity (ARCH) with spot price as dependent for refined soy oil

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	-0.000622	0.000334	-1.860141	0.0629
Variance Equation				
C	4.41E-06	2.87E-06	1.537217	0.1242
RESID(-1)^2	**0.730046**	0.405885	1.798651	0.0721
GARCH(-1)	**0.571676**	0.072042	7.935262	0.0000
R-squared	-0.005223	Mean dependent var		0.000194
AdjustedR-squared	-0.005223	S.D. dependent var		0.011292
S.E. of regression	0.011321	Akaike info criterion		-6.699172
Sum squared resid	0.256476	Schwarz criterion		-6.687980
Log likelihood	6709.872	Hannan-Quinn criter.		-6.695063
Durbin-Watson stat	1.784376			

Table 4: Auto Regressive Conditional Heteroskedasticity (ARCH) with futures price as dependent for refined soy oil

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	9.41E-06	2.31E-05	0.407914	0.6833
Variance Equation				
C	6.28E-07	2.97E-08	21.14934	0.0000
RESID(-1)^2	**0.883781**	0.064894	13.61889	0.0000
GARCH(-1)	**0.105816**	0.043295	2.444084	0.0145
R-squared	-0.003451	Mean dependent var		0.000193
AdjustedR-Squared	-0.003451	S.D. dependent var		0.003123
S.E. of regression	0.003128	Akaike info criterion		-9.626985
Sum squared resid	0.019581	Schwarz criterion		-9.615793
Log likelihood	9640.612	Hannan-Quinn criter.		-9.622876
Durbin-Watson stat	0.205816			

Table 3 and Table 4 are showed the univariate GARCH (1, 1) parameters for the mean and variance equations of spot and futures price of soy oil. In the above tables sum of the coefficient of ARCH (α) and GARCH (β) terms for spot and futures series were 1.30 and 0.99 respectively, which were greater than one and nearer to one and hence, significant. So, we can conclude that both spot and futures series are volatile during the period under study, but spot price series was more volatile than futures price series.

Table 5: Auto regressive conditional heteroskedasticity (ARCH) with spot price as dependent for chana

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	0.000630	0.000319	1.975480	0.0482
Variance Equation				
C	3.51E-05	3.95E-05	0.887848	0.3746
RESID(-1)^2	-0.002113	0.041395	-0.051041	0.9593
GARCH(-1)	0.850065	0.233773	3.636290	0.0003
R-squared	-0.000318	Mean dependent var		0.000377
Adjusted R-squared	-0.000318	S.D. dependent var		0.014205
S.E. of regression	0.014207	Akaike info criterion		-5.661438
Sum squared resid	0.377456	Schwarz criterion		-5.649607
Log likelihood	5300.276	Hannan-Quinn criter.		-5.657079
Durbin-Watson stat	1.898771			

Table 6: Auto regressive conditional heteroskedasticity (ARCH) with futures price as dependent for chana

GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	0.000239	4.99E-05	4.793075	0.0000
Variance Equation				
C	1.93E-06	1.13E-07	17.06303	0.0000
RESID(-1)^2	0.993015	0.093032	10.67389	0.0000
GARCH(-1)	0.011978	0.048205	0.248472	0.8038
R-squared	-0.000667	Mean dependent var		0.000350
Adjusted R-squared	-0.000667	S.D. dependent var		0.004303
S.E. of regression	0.004304	Akaike info criterion		-8.692153
Sum squared resid	0.034640	Schwarz criterion		-8.680321
Log likelihood	8135.509	Hannan-Quinn criter.		-8.687794
Durbin-Watson stat	0.190824			

Table 5 and Table 6 are showed the univariate GARCH (1, 1) parameters for the mean and variance equations of spot and futures price of chana. In above tables, sum of the coefficient of ARCH (α) and GARCH (β) terms for spot and futures series were 0.85 and 1.00 respectively. Out of which value of futures price series are greater than one and hence, significant, while value of coefficient for spot price series was less than one and hence, non significant. This implies that spot series was not volatile and futures series was volatile during the period under study. Volatility increases the price risk faced by the farmers and other market participants. It can be reduced by adopting the hedging option provided by the futures trading mechanism on one hand and reducing supply side constraints on the other.

Bharadwaj and Vasisht (2009) also obtained similar results while studying price volatility in the spot and futures market of gram. The univariate GARCH (1, 1) parameters for the mean and variance equations of spot price of gram crop showed a value of 0.57, which was relatively smaller than the value obtained in the futures price series. It meant that spot price was less volatile as compared to futures price.

CONCLUSIONS AND POLICY IMPLICATIONS

Finding of the study showed that, the both spot and futures prices are volatile, it may be due to another reason, because period of the study was very short, in which, to measure the real effect of futures trading was very difficult. Volatility in the prices may be due to some other general factors like supply side, international trade and growth of economy.

Hence, the hypothesis that there is no volatility in the spot and futures prices of selected agricultural commodities was not rejected in chana for spot price

series. But, it was rejected in the other two commodities *viz.* wheat and refined soy oil, and also for futures price series of chana. This implies that, there was volatility in the prices even after futures trading, but risk arise due to the price volatility can be minimize through hedging option provided by futures trading. The allegation that introduction of futures trading has led to inflation in agricultural commodity prices has been proved to be false in the above analysis in keeping with the findings of Sen Committee constituted in 2008 for studying the impact of futures trading on agricultural commodity prices. Hence, the prohibition on futures trading in cereals and pulses should be lifted. Price risk can be minimized, if farmers will be used hedging option provided by the futures trading.

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ISOLATION AND AUTHENTICATION OF ENTOMOPATHOGENIC NEMATODES FROM ALLAHABAD REGION

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Abstract: Random surveys were carried out for the detection of entomopathogenic nematodes from cultivated areas in different villages of Allahabad district, Uttar Pradesh, India. A total of 60 soil samples were processed for baiting using larvae of cabbage semi-looper, *Thysanopulsia orichalcea* (Lepidoptera: Noctuidae). Of these, only ten soil samples (16.67%) yielded EPNs. *Heterorhabditis sp.* was yielded from six soil samples (10%) collected from different villages, while *Steinernema sp*. was yielded from four samples (6.7%).However, no EPNs were recovered from soil samples of twelve villages. The nematodes were recovered from sandy, sandy loam and alluvial soils with soil pH ranging from 6.50 to 8.00. The isolated entomopathogenic nematodes were found to be *Steinernema sp*. and *Heterorhabditis sp*. The bioassay of the isolated EPNs was studied under laboratory condition on *Corcyra cephalonica* larvae in different inoculums level of 50, 100, 150, 200 and 250 IJs/ml. After 120 hours of inoculation the % mortality of the test insect with *Steinernema sp*. was found to be 97.5% with 250 IJs/ml while that of *Heterorhabditis sp*. was found to be 100%. And also the % net mortality after 120 hours of inoculation with 250 IJs/ml of *Steinernema sp.* was found to be 79.6% whereas that of *Heterorhabditis sp.* was found to be 81.6%. Hence it was found out that the dose mortality response on the test insect with isolated *Heterorhabditis sp*. was observed to be more effective than that of *Steinernema sp.*

Keywords: EPN, *Heterorhabditis sp*., *Steinernema sp*., *Corcyra cephalonica*

INTRODUCTION

The insect pests are one of the major limiting factors in agricultural production. To overcome the situation of development of resistance, secondary outbreak of minor or unknown pests, pesticide persistence and residue problems, contamination of food water resources other effective and environmental friendly method i.e. the used of bio pesticides have been developed and are becoming increasingly important as pest management tools in various cropping systems globally essentially to remedy problems associated with the indiscriminate use of hard inorganic pesticides and consumer-driven needs towards organic agriculture. During the recent past greater attention has been given to entomopathogenic nematodes to explore their bio control potential for the management of insect pests. Nematodes belonging to more than 30 families are known to parasitize insects but potential entomopathogenic nematodes belong to only two families, Steinernematidae and Heterorhabditidae. Entomopathogenic nematodes from these families possess wide host range and have been widely exploited for their bio control potential (Lacey *et al.*, 2001; Kaya and Gaugler, 1990). The impressive attributes of EPN have stimulated strong commercial interest in nematodes as biological insecticides. This includes their wide spectrum of insecticidal activity, ability to kill most hosts within short periods and efficient mass culturing techniques. (Kaya and Gaugler, 1993).EPNs have a great potential as biological control agents against insect pests of crops due to their wide host range, easy of handling, short life cycle, economically large scale production and environment safety (Cabanillas *et al.*, 1994; Poinar, 1990; Ali *et al.*, 2005) .They have the potential for long term establishment in soil through recycling on infected insects. All Steinernematids and Heterorhabditid infective juveniles carry symbiotic bacterial species belong to genus, *Xenorhabdus* and *Photorhabdus*, but are specific for each nematode species (Akhurst and Boemare, 1988; Poinar and Brooks, 1977; Thomas and Poinar, 1979). All the species of *Steinernema* are associated with bacteria of genus *Xenorhabdus* and all *Heterorhabditis* nematodes species are associated with genus *Photorhabdus*. These bacteria are released into the insect haemoceal causing septicaemia and death of the insect (Kaya and Gaugler, 1993). However, the insect mortality is determined by the nematode-insect complex and not simply by the virulence of the bacterium. They are unique because they are the only nematodes which are capable of carrying and introducing symbiotic bacteria into the body cavity of insects and thus killing them within 48 hours. The parasitic cycle of the nematodes is initiated by the 3rd stage infective juveniles (IJs). These non-feeding juveniles locate and invade suitable host insects through natural body openings (i.e. anus, mouth and spiracles) once they enter inside the host, the nematode invade the haemoceal and release the symbiotic bacteria that are held in the nematode intestine which cause septicaemia, killing the host within 24-48 hours. The bio control potential of these nematodes is well established in laboratory and also in field under favourable conditions. Performance of EPNs, however, varies greatly with the isolate, in addition to insect host and climate conditions. So, there is need to explore the native strains of EPNs which could perform well under given set of

environmental conditions and could provide a better and long lasting control. The present study deals with a preliminary work to isolate local population (Allahabad district, India) of a potential EPN and to examine its pathogenicity against laboratory host.

MATERIAL AND METHOD

Collection of soil samples

A survey was conducted from twenty different villages of Allahabad district, during October 2009 to February 2010 in which a total of sixty composite soil samples were collected. The information regarding the locality, soil type, habitat and raised/standing crop in the field was recorded. The soil samples were collected from the upper soil profile at a depth of 5-20 cm into polythene bags (500g).Each sample was than mixed thoroughly in each plastic container with some quantity of distilled water to maintain soil moisture of 15±1%.

Soil baiting

Soil baiting was done by using the living instars larvae of cabbage semi-looper, *Thysanopulsia orichalcea* in the collected soil samples. To each soil samples, five insect larvae were released and the plastic containers were filled completely with moist and sterilized soil and were covered with muslin cloth. The moisture level in pots was maintained by adding sterilized water. Larval mortality was checked first after 24 hours. After five days of baiting all the larvae was found death. Dead insects were identified by lack of movement, lack of response to gentle prodding, colour change, growth of fungus on the dead insects etc. We have also observed that the dead insect does not pupate (Rishi *et al*., 2008; Hussaini *et al*., 2002).

Nematode collection

The dead insect larvae were kept in harvesting container consisting of a small Petri dish (~6 cm) as a lid with a slightly larger diameter than the base and so it enable commercial filter disks to fit inside the larger Petri dish without raising or touching the lid of the larger petri dish. A filter paper was placed in the smaller petri dish. The dead insects were transferred to the paper and it's moistened just enough so that it was evenly wet, but not so much that there were no excess water for the nematodes to emerge .Into the base of the larger petri dish enough water was added so that the water touches all the sides of the dish .The lid of the smaller dish with the insect and paper was placed in the larger plate with the lid. After 24 hours, entomopathogenic nematodes were seen emerging out from the dead insects. They look like clumps of off white matter when seen through the naked eye. They are attracted towards the water and move to edge of small dish and finally to the larger dish (White, 1927).

Preparation of Nematode suspension

Harvested infective juveniles were collected in a beaker and sterilized distilled water was added to make the nematode suspension. Ten ml of each of the samples were prepared by measuring in a measuring cylinder and 1ml from each samples were collected in the counting dish and the entomopathogenic nematodes were observed under a binocular and counting of nematode population was done .

Rearing of rice grain moth (*Corcyra cephalonica*)

The conventional method of rearing was followed in the present investigation. In this method, rearing from egg to adult stage was undertaken using broken grain of sorghum in wooden rearing cage of 45x30x15 cm size; covered with wooden lid. Broken sorghum grains were first sterilized at 110°C for 2 hours in a hot air oven and used for mass rearing. The sterilized grains were mixed with dried yeast powder @2g/kg .0.001% streptomycin, pinch of sulphur dust and kept 2.5 kg of sorghum in each tray. At the beginning of rearing 1cc of *Corcyra cephalonica* eggs were sprinkled and kept for the development. The larvae feed on grains and pupated inside the tray itself. The moth started emerging from the 30^{th} day onwards, the emerged moth were collected and kept for egg lying in ovipositional cage provided with honey solution .The moth laid most of the eggs within 3days after emergence. The moth were collected daily and then transferred to the especially designed ovipositional cages. Moth emergence reduced after 100 days of initial infestation and boxes were reused after cleaning.

Bioassay of EPNs against laboratory host

Dose mortality response

The bioassay of isolated EPN was studied under laboratory condition on larvae of rice grain moth, *Corcyra cephalonica*. Different inoculums levels *viz* 50, 100, 150, 200 and 250 I Js/ml was prepared following serial dilution technique and were used in bioassay study. The prepared inoculum of EPNs was applied on filter paper kept in the petri dish and sufficient amount of water was applied to maintain the moisture of filter paper. Ten full grown larvae of *Corcyra cephalonica* were released into each petri plates. A control was taken for each inoculum where in the filter paper was treated only with distilled water and whole experiment was replicated four times. The mortality count of the larvae was recorded from 24 hours to 120 hours at 24 hours interval.

RESULT AND DISCUSSION

Survey for native isolates of EPNs

After the survey conducted we found out that out of sixty soil samples examined, entomopathogenic nematodes

were recovered from ten soil samples (16.67%) of total (Table 4).Four samples (6.7%)were found positive for the occurrence of Steinernematids at Baswar sample no. (BA 2) and (BA 3), Hadgan (HAD 1) and Ubhari (UB 2). Six samples (10%) were found positive with *Heterorhabditidis* at Balapur (BAL 1), Dandupur (DA 3), Jasra (JA 2), Maraoka (MA 2), Perpersa (PE 1) and (PE 2). No nematodes was recovered from twelve sampling sites *viz.*,Bhandra, Gahonia , Hadgani, Jhansi, Kheri , Karchana , Murlikot , Muhodipur , Mohabatganj , Shyamlalkapura , Umari and Udaidaskapura .

The nematodes were found at varying pH ranging from normal (6.50 to 7.60 pH) to slightly alkaline (8.00 pH) e.g., the *Heterorhabditis sp.* isolated from Dandupur. The *Heterorhabditis sp.* isolates were found in sandy loam and alluvial soils whereas, *Steinernema sp.* was found in sandy soil and alluvial soil, respectively. This may be due to various factors such as soil texture, moisture, temperature and host availability which is thought to be important in determining their distribution. Although these nematodes seem ubiquitous, Allahabad and its adjoining areas are virtually unexplored; therefore the objective of the present study was to survey the cultivated areas in Allahabad district and to isolate entomopathogenic nematodes from soil. From the experiment was found out that nematodes were found at varying pH ranging from normal (6.50 to 7.60). The *Heterorhabditis sp*. was found in sandy loam and alluvial soil whereas *Steinernema sp*. was found in sandy soil and alluvial soil.

Table I: Survey of entomopathogenic nematodes from different locations of Allahabad district

Location	Sample code	No of positive samples	Vegetation	Soil pH	Soil type
Baswar	BA1	Sample 1(-ve)	Orchard	7.00	Alluvial soil
	BA2	Sample 2(+ve)	Orchard	7.30	Alluvial soil
	BA3	Sample 3(+ve)	Orchard	7.40	Alluvial soil
Bhandra	BH1	Sample 1(-ve)	Cultivated land	6.90	Alluvial soil
	BH2	Sample 2(-ve)	Cultivated land	7.60	Alluvial soil
	BH3	Sample 3(-ve)	Cultivated land	7.00	Alluvial soil
Balapur	BAL1	Sample 1(+ve)	Cultivated land	7.20	Sandy loam
	BAL2	Sample 2(-ve)	Cultivated land	6.50	Sandy loam
	BAL3	Sample 3(-ve)	Cultivated land	7.42	Sandy loam
Dandupur	DA1	Sample 1(-ve)	Orchard	7.30	Alluvial soil
	DA2	Sample 2(-ve)	Orchard	7.50	Alluvial soil
	DA3	Sample 3(+ve)	Orchard	8.00	Alluvial soil
Gahonia	GA1	Sample 1(-ve)	Cultivated land	6.88	Alluvial soil
	GA2	Sample 2(-ve)	Cultivated land	6.50	Alluvial soil
	GA3	Sample 3(-ve)	Cultivated land	7.00	Alluvial soil
Hadgani	HA1	Sample 1(-ve)	Cultivated land	7.50	Sandy loam
	HA2	Sample 2(-ve)	Cultivated land	6.87	Sandy loam
	HA3	Sample 3(-ve)	Cultivated land	6.55	Sandy loam
Hadgan	HAD1	Sample 1(+ve)	Orchard	7.00	Sandy soil
	HAD2	Sample 2(-ve)	Orchard	7.54	Sandy soil
	HAD3	Sample 3(-ve)	Orchard	7.21	Sandy soil
Jasra	JA1	Sample 1(-ve)	Orchard	6.75	Alluvial soil
	JA2	Sample 2(+ve)	Orchard	6.50	Alluvial soil
	JA3	Sample 3(-ve)	Orchard	6.00	Alluvial soil
Jhansi	JH1	Sample 1(-ve)	Orchard	7.86	Alluvial soil
	JH2	Sample 2(-ve)	Orchard	7.90	Alluvial soil
	JH3	Sample 3(-ve)	Orchard	7.43	Alluvial soil
Kheri	K1	Sample 1(-ve)	Cultivated land	6.30	Alluvial soil
	K2	Sample 2(-ve)	Cultivated land	6.66	Alluvial soil
	K3	Sample 3(-ve)	Cultivated land	6.80	Alluvial soil
Karchana	KA1	Sample 1(-ve)	Orchard	7.83	Alluvial soil
	KA2	Sample 2(-ve)	Orchard	7.00	Alluvial soil
	KA3	Sample 3(-ve)	Orchard	7.00	Alluvial soil
Murlikot	M1	Sample 1(-ve)	Cultivated land	6.56	Alluvial soil
	M2	Sample 2(-ve)	Cultivated land	6.84	Alluvial soil
	M3	Sample 3(-ve)	Cultivated land	6.70	Alluvial soil
Muhodipur	MU1	Sample 1(-ve)	Cultivated land	7.00	Alluvial soil
	MU2	Sample 2(-ve)	Cultivated land	6.50	Alluvial soil

	MU3	Sample 3(-ve)	Cultivated land	6.00	Alluvial soil
Maraoka	MA1	Sample 1(-ve)	Cultivated land	6.65	Sandy loam
	MA2	Sample 2(+ve)	Cultivated land	6.50	Sandy loam
	MA3	Sample 3(-ve)	Cultivated land	6.89	Sandy loam
Mohabatganj	MO1	Sample 1(-ve)	Cultivated land	6.10	Alluvial soil
	MO2	Sample 2(-ve)	Cultivated land	6.00	Alluvial soil
	MO3	Sample 3(-ve)	Cultivated land	6.43	Alluvial soil
Perpersa	PE1	Sample 1(+ve)	Orchard	7.00	Sandy loam
	PE2	Sample 2(+ve)	Orchard	7.60	Sandy loam
	PE3	Sample 3(-ve)	Orchard	7.40	Sandy loam
Shyamlalkapura	SH1	Sample 1(-ve)	Orchard	8.10	Alluvial soil
	SH2	Sample 2(-ve)	Orchard	8.00	Alluvial soil
	SH3	Sample 3(-ve)	Orchard	7.71	Alluvial soil
Ubhari	UB1	Sample 1(-ve)	Orchard	7.98	Sandy soil
	UB2	Sample 2(+ve)	Orchard	7.50	Sandy soil
	UB3	Sample 3(-ve)	Orchard	6.90	Sandy soil
Umari	UM1	Sample 1(-ve)	Cultivated land	7.00	Alluvial soil
	UM2	Sample 2(-ve)	Cultivated land	7.54	Alluvial soil
	UM3	Sample 3(-ve)	Cultivated land	6.20	Alluvial soil
Udaidaskapura	UD1	Sample 1(-ve)	Cultivated land	7.60	Sandy loam
	UD2	Sample 2(-ve)	Cultivated land	7.00	Sandy loam
	UD3	Sample 3(-ve)	Cultivated land	7.03	Sandy loam

Identification of isolated EPNs

The isolated entomopathogenic nematodes were studied for their morphological characters and camera Lucida diagrams were prepared however, species level confirmation is awaited. The measurements were taken by an ocular micrometer. The entomopathogenic nematodes isolated was found to be of the family Steinernematidae and Heterorhabditidis. The adult of *Steinernema sp*. were found with six lips partially fused, stroma short and wide, nerve ring encircling the isthmus, excretory pore anterior to nerve ring, oesophagus muscular with cylindrical procorpus, narrow isthmus, tail tip with a mucron. Females have amphidelphic, didelphic reflexed ovaries. Males have single testis reflexed at tip. Whereas the adults of *Heterorhabditis sp.* have six lips which are fused at the base, excretory pore posterior to nerve ring, nerve ring distinct and surrounding the isthmus in females and basal bulb in males, excretory pore always located anterior to nerve ring, long and acutely pointed tail. Females have didelphic, amphidelphic reflexed ovaries. Male have single testis and reflexed. The isolated nematode was identified as *Steinernema sp*. and *Heterorhabditis sp* .These morphological features were compared with the taxonomic reviews of entomopathogenic nematodes (Hominick *et al.*, 1997; Adams *et al.* 2002; Ganguly, 2006).

Table II. Comparative measurements of adult males and females of the Allahabad isolates and the original population of *Steinernema sp.* and *Heterorhabditis sp.*

Characters	***Steinernema sp***		***Heterorhabditis sp.***	
Body length (L)	446 (398-495)	558 (438-650)	528(479- 573)	588(512- 670)
Body width(W)	11.3 (10.3-14.8)	10.6 (9.1-11.2)	20(19-22)	23(18-34)
Oesophagus (ES)	94.5 (80-107)	120 (103-190)	117(109-123)	125(100-139)
Excretory pore (EP)	35 (29-38)	38(30-60)	101(93-109)	98(83-112)
Tail (T)	35.5 (31-41)	53(46-61)	98(88-107)	103(87-110)

(All the measurements are taken in mm)

Bioassay of EPNs against laboratory host

The filter paper method was used in the present investigation to record the mortality of EPNs on *Corcyra cephalonica* , the choice of the substrate has always been consider to relevant to the bioassay because of its effect on nematode seeking behaviour. A filter paper environment favour nematodes, which use an ambush strategy to find the host, whereas the species that are more active, should be more infective on sand and soil environment (Grewal *et al.*, 1994).

Dose mortality response of Steinernema *sp*. against *Corcyra cephalonica*

It is clear from the data presented in Table no. III that the % mortality of *Corcyra cephalonica* with different inoculum levels of 50-250 IJs/ml of *Steinernema sp.* was found to be ranging from 2.5 to 97.5 % after 120 hours of inoculation. The data in Table no. III shows that net mortality of *Corcyra cephalonica* was found to be ranging from 1.0 to 79.6%. The lowest % net mortality of 1.0% was observed with 50 IJs/ml after 24 hours of inoculation whereas the highest net mortality of 79.6 % was observed with 250 IJs/ml after 120 hours of inoculation.

Dose mortality response of *Heterorhabditis sp* against *Corcyra cephalonica*

It is clear from the data presented in Table no.IV shows that the % mortality of *Corcyra cephalonica* with different inoculum levels of 50-250 IJs/ml of *Heterorhabditis sp.* was found to be ranging from 2.5 to 100 % after 120 hours of inoculation. The data in Table no.IV shows that net mortality of *Corcyra cephalonica* was found to be ranging from 1.0 to 81.6%. The lowest % net mortality of 1.0 % was observed with 50 IJs/ml after 24 hours of inoculation whereas the highest net mortality of 81.6 % was observed with 250 IJs/ml after 120 hours of inoculation. Comparing the mortality response of both *Heterorhabditis sp*. and *Steinernema sp*. we found out that 100% mortality was observed with *Heterorhabditis sp.* In this study *Heterorhabditis sp.* was found to be more virulent against *Corcyra cephalonica*. Virulence of entomopathogenic nematode differs greatly among species and isolates. Ricci *et al.*, 1996 detected differences in virulence towards *C. cephalonica* when comparing *Steinernema sp*. and *Heterorhabditis sp*. in petri dish bioassays. The present study shows that there is increase in the nematodes inoculums level the insect mortality level also increases.

Table III: Efficacy of *Steinernema sp.* against *Corcyra cephalonica* with different inoculum levels after 24, 48, 72, 96 and 120 hours of inoculation.

Exposure time		Treatments (No. of IJs / ml)					
		T_0 Control	T_1	T_2	T_3	T_4	T_5
24 hours	% mortality	02.5	10.0	12.5	22.5	32.5	42.5
	% net mortality	01.0	04.1	05.1	09.1	13.1	17.2
48 hours	% mortality	02.5	27.5	37.5	47.5	57.5	67.5
	% net mortality	01.0	11.1	15.2	19.2	23.3	27.3
72 hours	% mortality	02.5	40.0	50.0	60.0	70.0	80.0
	% net mortality	01.0	16.2	20.2	24.3	28.3	32.3
96 hours	% mortality	02.5	50.0	60.0	70.0	80.0	90.0
	% net mortality	01.0	40.8	49.0	57.2	65.3	73.5
120 hours	% mortality	15.0	60.0	70.0	80.0	90.0	97.5
	% net mortality	04.1	49.0	57.2	65.3	73.5	79.6

Treatments

T_0 – Control
T_1 – 50 IJs/ml of *Steinernema sp.*
T_2 – 100 IJs/ml of *Steinernema sp.*
T_3 – 150 IJs/ml of *Steinernema sp.*
T_4 – 200 IJs/ml of *Steinernema sp.*
T_5 – 250 IJs/ml of *Steinernema sp.*

Table IV: Efficacy of *Heterorhabditis sp.* against *Corcyra cephalonica* with different inoculum levels after 24, 48, 72, 96 and 120 hours of inoculation.

Exposure time		Treatments (No. of IJs / ml)					
		T_0 Control	T_1	T_2	T_3	T_4	T_5
24 hours	% mortality	02.5	12.5	22.5	32.5	42.5	52.5
	% net mortality	01.0	05.1	09.1	13.1	17.2	21.2
48 hours	% mortality	02.5	32.5	45.0	57.5	67.5	77.5
	% net mortality	01.0	13.1	18.2	23.2	27.3	31.3
72 hours	% mortality	02.5	42.5	55.0	67.5	77.5	85.0
	% net mortality	01.0	17.2	22.2	27.3	31.3	34.4
96 hours	% mortality	05.0	52.5	65.0	77.5	85.5	95.5
	% net mortality	04.1	42.9	53.1	63.3	69.4	77.6
120 hours	% mortality	05.0	62.5	75.0	85.0	95.5	100.0
	% net mortality	04.1	46.9	61.2	69.4	77.6	81.6

Treatments
T_0 – Control
T_1 – 50 IJs/ml of *Heterorhabditis sp.*
T_2 – 100 IJs/ml of *Heterorhabditis sp.*
T_3 – 150 IJs/ml of *Heterorhabditis sp.*
T_4 – 200 IJs/ml of *Heterorhabditis sp.*
T_5 – 250 IJs/ml of *Heterorhabditis sp.*

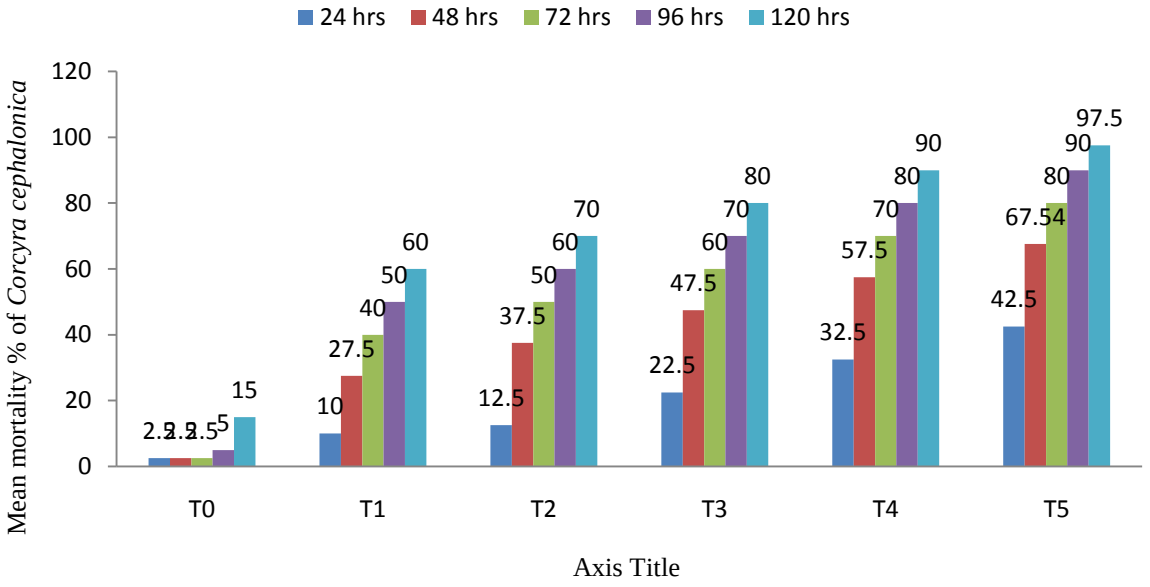

Fig. I: Mean mortality % of *Corcyra cephalonica* at different hours after inoculating with different inoculum levels of *Steinernema sp.*

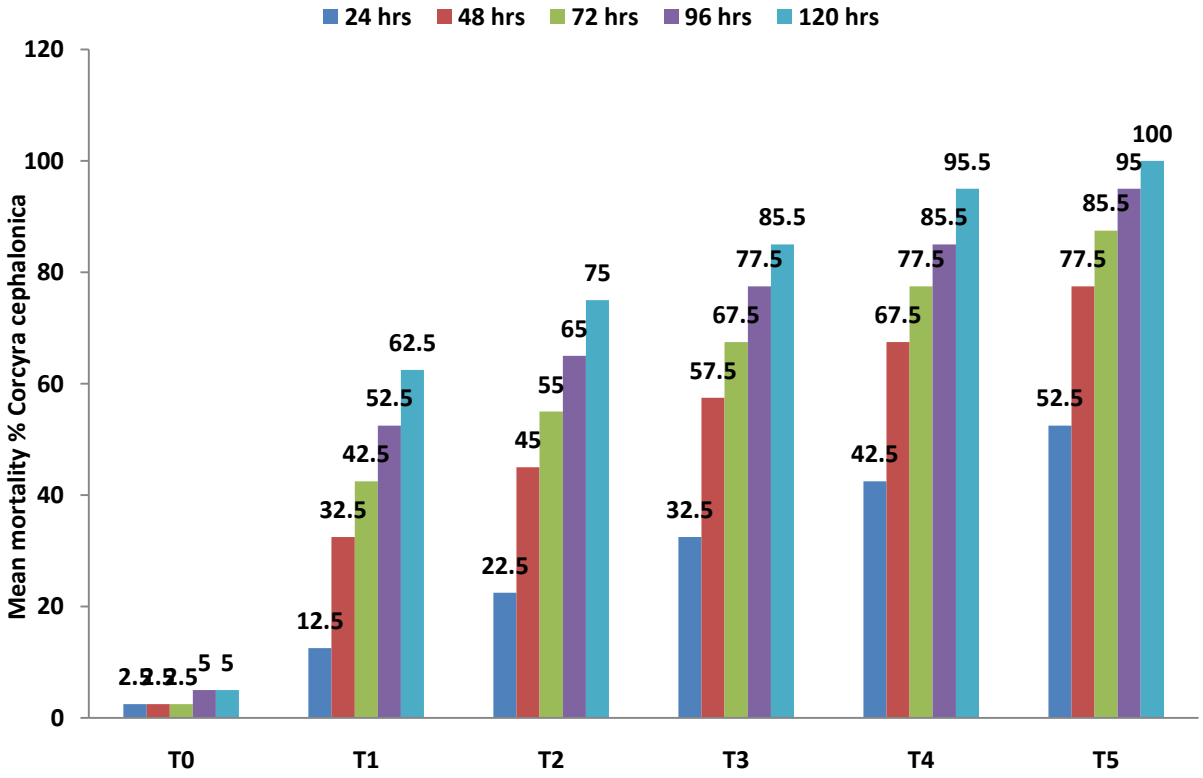

Fig. II: Mean mortality % of *Corcyra cephalonica* at different hours after inoculating with different inoculum levels of *Heterorhabditis sp.*

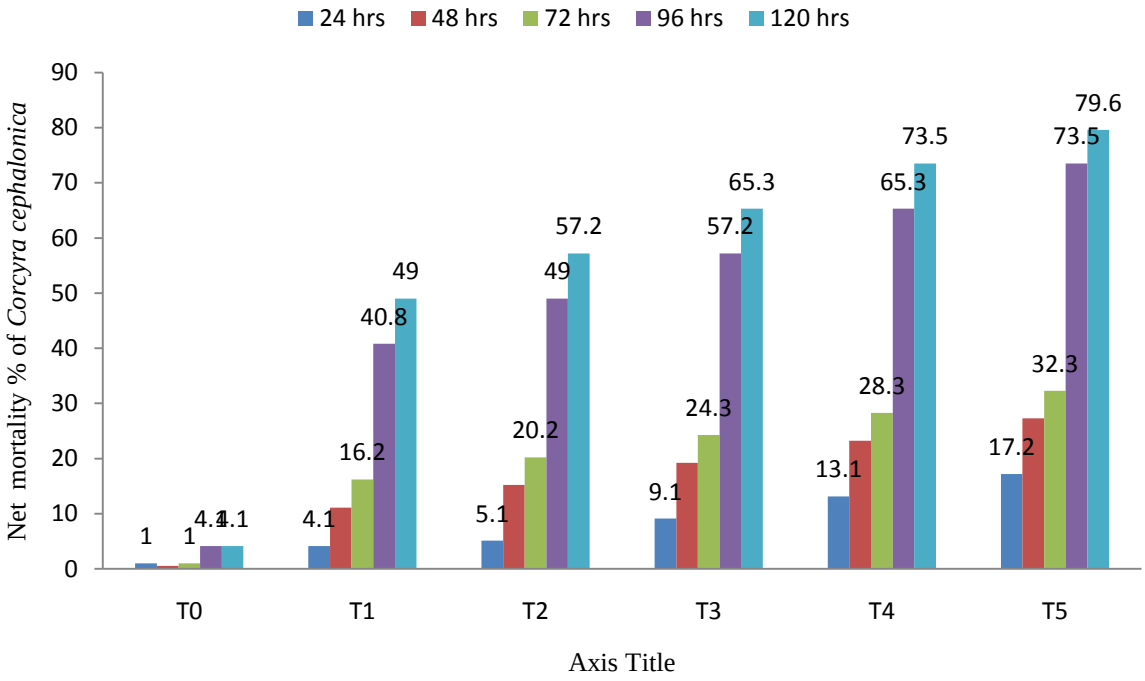

Fig. III: Net mortality % of *Corcyra cephalonica* at different hours after inoculating with different inoculum levels of *Steinernema sp.*

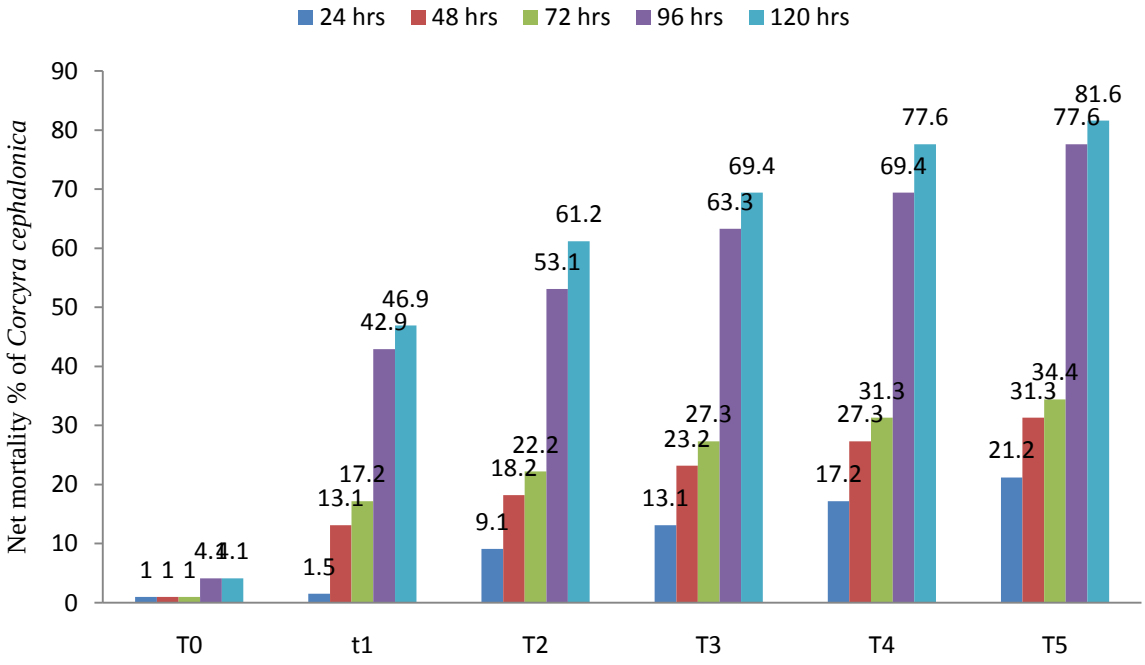

Fig. IV: Net mortality % of *Corcyra cephalonica* at different hours after inoculating with different inoculum levels of *Heterorhabditis sp.*

CONCLUSION

The present study entitled "Isolation and Authentication of Entomopathogenic Nematodes from Allahabad region" was conducted in the laboratory of Department of Plant Protection, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, India.

It may be concluded that the use of naturally occurring nematodes as biological agents may also reduce the risk to non- target organisms.

Entomopathogenic nematodes characteristically have a wide host range in insect members of the order Lepidoptera and Coleoptera .In tropical country like India; Lepidopteran insect larvae are usually easily available for most of the year due to multiple and varied cropping sequences. The number of insect species susceptible to entomopathogenic nematodes seems unlimited. Hence, there is need to conduct extensive survey for isolation and identification of potential strains of entomopathogenic nematodes, which can be used for the management of crop pests.

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EFFECT OF POST EMERGENCE HERBICIDE FOR WEED MANAGEMENT IN FINGER MILLET

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Abstract: There were thirteen treatments which comprised single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on Clayey *Vertisols* soil of College of Agriculture, Raipur during *kharif* season of 2012. *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron alone was found most suitable for weed control without any harm to the crop. There was complete control of broad leaf weeds *viz. Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* and sedges *i.e. Cyperus iria* by the application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron, where as grassy weed *i.e. Echinochloa colona* was completely killed by the application of fenoxaprop-p-ethyl. Hand weeding twice recorded the highest grain yield and net return. Application of ethoxysulfuron registered the highest B:C ratio which was at par with metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

Keywords: Weed management, Finger millet

INTRODUCTION

Finger millet (*Eleusine indica*) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. It is used both as medicinal and traditional purposes. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield (Kushwaha *et al*. 2002). The production and productivity of the country is lower because of weeds pose one of the major constraints in the production of finger millet. Owing to initial slow growth of the finger millet favours weed growth, which cause more competition for sunlight, nutrient and water in early stages of growth lead in lowering productivity (Kumara *et al*. 2007). The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav, 1982). Weeds compete with crop plants for water, nutrients, space and solar radiations by reduction of yield upto 20 to 50 per cent. (Kushwaha *et al*. 2002) reported that weeds caused an appreciable reduction in density, dry weight and depletion of nutrients. Manual weed management, which is the most prevalent method for weed management in finger millet, requires a lot of labour. Now a day, due to the scarcity of labours, chemical weed management is considered as better option than the hand weeding. Chemical weed management practices might be an answer to achieve greater weed control efficiency, which in turn, may increase over all benefit of finger millet cultivation. The work on effect of post emergence herbicides in weed management of finger millet is very limited; therefore, keeping these points in view the present investigation was carried out to evaluation of post-emergence herbicides for weed management in direct sown finger millet.

MATERIAL AND METHOD

The present investigation entitled "Evaluation of post-emergence herbicides for weed management in direct sown Finger millet." was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season (July-November) 2012. The soil of experimental field was Clayey *(Vertisols)*, which was low in nitrogen, medium in phosphorus and high in potassium contents with neutral in pH. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, using seed rate of 10 kg ha^{-1} at 25 cm distance and gaps were maintained by thinning to obtain proper plant population. Sowing was performed by manually and crop was fertilized with 60:40:40 N: P_2O_5:K_2O kg ha^{-1}. Half dose of nitrogen (30 kg/ha) and full dose of P and K (40 and 20 Kg/ha respectively) were applied as basal and remaining half of nitrogen (30 kg/ha) was top dressed one month later. Plant protection measures were followed as per recommendation. The treatments were *viz.* T_1- Fenoxaprop-p-ethyl (37.5 g ha^{-1}), T_2- Fenoxaprop-p-ethyl (45.0 g ha^{-1}), T_3- Metsulfuron methyl + Chlorimuron ethyl, T_4- Ethoxysulfuron, T_5 – Cyhalofop-butyl, T_6- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_7- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_8- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron, T_9- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron, T_{10}- Cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl, T_{11}- Cyhalofop-butyl + ethoxysulfuron, T_{12}- Hand weeding twice and T_{13}- Weedy check. Weed counts (number m^{-2}) and dry weight (g m^{-2}) were recorded by putting a quadrate (0.25 m^{-2}) at random spots in

each plot at 15 days after sowing (DAS) and every 15 days interval till harvesting stage of crop. Weed control efficiency (WCE) was also calculated on the basis of dry matter production of weeds. The experimental data recorded for growth, yield and economics were statistically analyzed. Data on weed density and dry weight of weeds were transformed using square root transformation *i.e.* X+0.5 before statistical analysis (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Weeds

The major weed flora of experimental field consisted of *Echinochloa colona, Phyllanthus urinaria, Eclipta alba, Alternanthera triandra and Cyperus iria* and other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Cyperus rotundus, Euphorbia hirta, Euphorbia geniculata, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum. Irrespective of weed management practices density and dry weight of weeds decreased due to application of different post emergence herbicides. *Echinochloa colona* was effectively controlled with application of fenoxaprop-p-ethyl at higher dose (45.0 g ha^{-1}) and the combination of other herbicide with it reduced its toxicity. Moreover, combined application of fenoxaprop-p-ethyl with ethoxysulfuron was detrimental to *Echinochloa colona* but the effect was seen very late *i.e.* 40 days after spraying. Reddy *et al.* (2000) also reported the similar findings. Metsulfuron methyl + chlorimuron ethyl exhibited detrimental effect on *Cyperus iria* 10 days after spraying and no any plant was alive till maturity of the crop. Similar finding was also reported by Singh *et al.* (2004). Ethoxysulfuron was also detrimental on it but its effect was visible late *i.e.* 25 days after application and continued up to harvesting of the crop. Control of sedges by ethoxysulfuron was also observed by Sharifi (2003) and Ashraf *et al.* (2006). The weed was completely controlled by the application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron after 10 days of spraying and further no any plant was observed in this treatment. Better control of *Alternanthera triandra* by application of ethoxysulfuron followed by metsulfuron methyl + chlorimuron ethyl was also reported by Saini and Angiras (2002). Complete control of *Eclipta alba* by the application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl was observed and no any plant was noticed live up to harvesting. Control of broad leaf weed by ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl was recorded by many workers (Singh *et al.*, 2004, Narwal *et al.*, 2002, Sharifi, 2003 and Ashraf *et al.*, 2006). Metsulfuron methyl + chlorimuron ethyl completely killed the *Phyllanthus urinaria*. Ethoxysulfuron also showed slight effect on weed but plants were not killed completely. Chlorimuron-ethyl + metsulfuron-methyl controlled broad leaf weeds as reported by Singh *et al*. (2004), Singh and Tiwari (2005) and Prasad *et al*. (2010). Minimum weed density of other weed species was observed in hand weeding twice. This was equivalent to combined application of fenoxaprop-p-ethyl at higher level combined with metsulfuron methyl + chlorimuron ethyl which may be due to control of all categories of weeds by these two herbicides. The crop experienced severe weed competition in cyhalofop-butyl followed by fenoxaprop-p-ethyl at both levels which might be due to unfavourable conditions leading to vigorous growth of weeds. The highest weed density was recorded in weedy check. All the weed management practices caused significant reduction in density, dry weight of weeds in comparison to weedy check plot (Table 1 and 2). Weedy check recorded the highest density and dry weight by weeds owing to their greater competitive ability than crop plant put under highest biomass of weedy check.

Table 1. : Density (m^{-2}) of different weed species at 30 DAS as influenced by different herbicidal treatments in finger millet

Treatment	Dose (g ha^{-1})	*Echinochloa colona*	*Cyperus iria*	*Alternanthera triandra*	*Eclipta alba*	*Phyllanthus urinaria*	*Phyllanthus urinaria*
T_1 : Fenox	37.5	3.38 (11.33)	4.26 (17.67)	3.02 (8.67)	3.89 (14.67)	4.60 (20.67)	4.80 (22.67)
T_2 : Fenox	45.0	0.71 (0.00)	3.89 (14.67)	2.91 (8.00)	4.26 (17.67)	4.91 (23.67)	4.49 (19.67)
T_3 : MSM+CME	2.0+2.0	5.98 (35.33)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	3.81 (14.33)
T_4 : Ethox	15.0	5.69 (32.00)	1.74 (2.67)	0.71 (0.00)	0.71 (0.00)	4.26 (17.67)	4.21 (17.33)
T_5 : Cyhalo	62.5	3.54 (12.33)	2.47 (5.67)	2.97 (8.33)	3.98 (15.33)	4.45 (19.33)	4.36 (18.67)
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	3.55 (12.33)	1.05 (0.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	3.15 (9.67)
T_7 : Fenox+MSM+	45.0+2.0+2.0	1.46 (1.67)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	2.45 (5.67)

CME							
T_8 : Fenox+Ethox	37.5+15.0	3.12 (9.33)	1.74 (2.67)	0.71 (0.00)	0.71 (0.00)	5.17 (26.33)	3.95 (15.33)
T_9 : Fenox+Ethox	45.0+15.0	1.81 (3.00)	1.56 (2.00)	0.71 (0.00)	0.71 (0.00)	4.70 (21.67)	3.71 (13.33)
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	1.17 (1.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	1.72 (2.67)
T_{11} : Cyhalo+Ethox	62.5+15.0	1.39 (1.67)	1.93 (3.33)	0.71 (0.00)	0.71 (0.00)	4.63 (21.00)	3.33 (10.67)
T_{12} : Weed free (HW at 20 and 40 DAS)		1.46 (1.67)	1.46 (1.67)	1.22 (1.00)	1.46 (1.67)	1.34 (1.33)	1.46 (1.67)
T_{13}: Weedy check		9.24 (85.00)	4.30 (18.00)	3.13 (9.33)	4.33 (18.33)	5.52 (30.33)	5.01 (24.67)
SEm ±		**0.26**	**0.15**	**0.05**	**0.10**	**0.18**	**0.26**
CD at 5 %		**0.78**	**0.46**	**0.16**	**0.29**	**0.53**	**0.78**

The observations are square root transformed. Figures in parentheses indicate the original value. Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl,
CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

Table2. : Dry weight (g m^{-2}) of different weed species at 30 DAS as influenced by different herbicidal treatments in finger millet

Treatment	**Dose (g ha^{-1})**	***Echinochloa colona***	***Cyperus iria***	***Alternanthera triandra***	***Eclipta alba***	***Phyllanthus urinaria***	**other weed**
T_1 : Fenox	37.5	1.77 (2.72)	2.97 (8.33)	1.51 (1.87)	1.38 (1.39)	1.13 (0.78)	2.72 (6.97)
T_2 : Fenox	45.0	0.71 (0.00)	2.75 (7.04)	1.70 (2.40)	1.46 (1.63)	0.98 (0.47)	2.62 (6.37)
T_3 : MSM+CME	2.0+2.0	2.15 (4.15)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	2.19 (4.32)
T_4 : Ethox	15.0	1.76 (2.60)	1.32 (1.25)	0.71 (0.00)	0.71 (0.00)	0.85 (0.23)	2.23 (4.52)
T_5 : Cyhalo	62.5	1.73 (2.52)	1.07 (0.65)	1.44 (1.58)	1.27 (1.13)	0.96 (0.42)	2.65 (6.52)
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	1.81 (2.85)	0.86 (0.25)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	1.88 (3.09)
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	2.06 (3.73)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	2.23 (4.49)
T_8 : Fenox+Ethox	37.5+15.0	1.28 (1.16)	0.82 (0.17)	0.71 (0.00)	0.71 (0.00)	0.92 (0.35)	1.60 (2.12)
T_9 : Fenox+Ethox	45.0+15.0	2.05 (3.71)	1.07 (0.65)	0.71 (0.00)	0.71 (0.00)	0.91 (0.33)	2.37 (5.14)
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	2.10 (3.94)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	2.12 (4.03)
T_{11} : Cyhalo+Ethox	62.5+15.0	1.96 (3.35)	1.33 (1.26)	0.71 (0.00)	0.71 (0.00)	0.92 (0.35)	2.51 (5.84)
T_{12} : Weed free (HW at 20 and 40 DAS)		1.32 (1.23)	1.14 (0.80)	1.48 (1.68)	1.23 (1.02)	0.84 (0.20)	1.40 (1.49)
T_{13}: Weedy check		2.96 (8.33)	3.48 (11.67)	1.72 (2.45)	1.98 (3.46)	1.34 (1.33)	2.91 (8.33)
SEm ±		**0.10**	**0.05**	**0.05**	**0.05**	**0.04**	**0.14**
CD at 5 %		**0.29**	**0.14**	**0.05**	**0.15**	**0.14**	**0.41**

The observations are square root transformed. Figures in parentheses indicate the original value. Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl,
CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

Table 4 .29: Economics of different post emergence herbicides for weed management in finger millet

Treatments	Grain yield (Kg ha^{-1})	Total Cost of Cultivation (Rs ha^{-1})	Gross Return (Rs ha^{-1})	Net Return (Rs ha^{-1})	B:C Ratio
T_1 : Fenox	140		2863	-9165	0.24
T_2 : Fenox	77	12162	1551	-10611	0.13
T_3 : MSM+CME	771	11662	15417	3755	1.32
T_4 : Ethox	794	11795	15662	3867	1.33
T_5 : Cyhalo	188	12706	3682	-9023	0.29
T_6 : Fenox+MSM+ CME	191	12328	3801	-8527	0.31
T_7 : Fenox+MSM+ CME	188	12462	3689	-8773	0.30
T_8 : Fenox+Ethox	180	12548	3488	-9060	0.28
T_9 : Fenox+Ethox	165	12682	3199	-9483	0.25
T_{10} : Cyhalo+MSM+ CME	163	13006	3260	-9746	0.25
T_{11} : Cyhalo+Ethox	119	13226	2467	-10759	0.19
T_{12} : Weed free (HW at 20 and 40 DAS)	1210	18370	23377	5007	1.27
T_{13}: Weedy check	540	11070	10648	-422	0.96
SEm ± **CD at 5 %**	**21.58** **63.00**		**451.39** **1317.5**	**451.39** **1317.5**	**0.03** **0.10**

Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

Economics

Hand weeding twice recorded the highest gross return. Among herbicides ethoxysulfuron gave maximum gross return which was at par with that of metsulfuron methyl + chlorimuron ethyl. Fenoxaprop-p-ethyl (45.0 g ha^{-1}) gave minimum gross return. The maximum net return was observed in hand weeding twice which was at par with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl and B:C ratio was observed with ethoxysulfuron which was at par with that of metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

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AN ECONOMIC ANALYSIS OF IMPROVED PADDY CULTIVATION IN BILASPUR DISTRICT OF CHHATTISGARH

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Abstrect: An attempt has been made in this paper to examine the economic analysis of improved paddy cultivation in Bilaspur district of Chhattisgarh. The study was conducted in Bilaspur district of Chhattisgarh with thirty farmers who were selected by simple random sampling techniques from four villages. After selection of villages, a list of total paddy growers by traditional method was prepared separately and categorized in to three size group on the basis of their land holding size viz, small (up to 02 ha.) medium (02-04 ha.) and large (above 04 ha.). Ten farmers were selected from each of the size group to collect the required information. The primary data were collected from the paddy producers through well prepared interview schedule for the production year 2011-12. Study revealed that the, on an average material cost was estimated as Rs.8165.40 per ha in which 45.00 per cent share of total material cost constituted by the fertiliser material. The average cost of cultivation of improved paddy was estimated to be Rs.31808.40 per ha and ranged from Rs. 27785.60 to Rs.35912.2 in different size groups. The average gross income of paddy was estimated to be Rs. 75961.60 per ha. The average net income and farm business income was calculated as Rs. 44153.20 and Rs. 60517.10 per ha respectively at sampled farms of improved paddy growers in the study area.

Key word: Break of cost, Cost of Cultivation, Cost concepts

INTRODUCTION

Rice is one of the important food crop in the world and ranks, second in terms of area and production. It is the staple food for about 50 per cent of the population in Asia, where 90 per cent of the world's rice is grown and consumed. In Asia, India has the largest area under rice occupying 29.4 per cent of the global area, and it is one of the staple food for 65 per cent of the population in India. It is the largest consumed calories source among the food grain, India is the second largest producer of rice in the world next to China. In India rice is cultivated in 43.81 million hectares with production 96.43 million tonns. This crop plays a vital role in our national food security and is a mean of livelihood for million of rural household. In India, there is growing demand for rice due to ever burgeoning population. It is estimated that rice demand by the year 2010 will be of 100 million tonnes. To assure food security in the rice-consuming countries of the world, rice production would have to be increased by 50 per cent in these countries by 2025 and, this additional yield will have to be produced on less land with less usage of water, labour and chemicals (Zeng et al, 2004). Also, the main threats to the future food-security are: shrinking land, depleting water resources, declining trends in soil fertility and productivity, and depletion of ground water table. Chhattisgarh is the state where paddy is the important crop during kharif season which occupies about 90 per cent area during kharif season. The total area under paddy cultivation in the state is 3.48 million hectare having 6.15 million tonnes of production. The productivity of paddy in the state is 1517 kg per hectare during 2010-11. The area, production and productivity reduced in the subsequent year. The research and development activities in paddy have consistently been concentrated on new paddy varietal.

Therefore, an attempts made in this way in order to analyse the yield, input use and there economics of improved paddy cultivation in the study area to know the efficientness of the resources in to yield to make future intervention of improved paddy cultivation and to suggest to the improved paddy producers accordingly.

MATERIAL AND METHODS

Bilaspur district of Chhattisgarh was selected purposively. The district comprises of block *viz* Bilaspur, Kota, Lormi, Mungeli, Masturi, Pendra road, Bilha and Takhatpur blocks out of which Mungeli block was selected for the study as due to more number of paddy growers After selection of block, a list of total paddy growers by traditional method was prepared separately and categorized in to three size group on the basis of their land holding size viz, small (up to 02 ha.) medium (02-04 ha.) and large (above 04 ha.). From each size group 10 farmers were selected for the study purpose with simple random sampling method. Total 30 farmers were considered to collect the required information on different aspects, which are related to specific objectives of the study. The study pertains to agricultural year 2011-12. Simple mean and average method was applied for analysis.

RESULT AND DISCUSSION

Material used in improved paddy cultivation

Material used in improved paddy cultivation at different farms is presented in Table 1. The table revealed that on an average total cost of cultivation

of paddy was estimated as Rs. 31808.40 per hectare out of which the material cost was estimated as Rs. 8165.40 per ha. It is clear from the table that fertilizer was the major item across the categories in the material cost. The expenditure on this material was estimated as Rs. 3717 per hectare (45.50 per cent) which varied from Rs. 3281.10 at small farms to Rs. 4999.00 at large farms. It is clear from the figures that farmers of small, medium and large categories are very much cautions for production hence they use the more quantity of fertilizer which increases the cost of fertiliser materials. The next major cost incurred on seed material which showed a decreasing trend with the increase in farm size. On an average cost estimated for this material was Rs. 3628.70 (44.40 per cent) which varied from Rs.3590.00 at small farms to Rs.3670.00 per ha. at large farms. Plant protection material was the input another used in the paddy cultivation constituted 10 per cent of the total material cost.

Table 1. Materials used in improved paddy cultivation Unit: (Rs./ha.)

Particulars	Small	Medium	Large	Overall
Seed	3590.0 (47.5)	3625.9 (46.5)	3670.0 (40.0)	3628.7 (44.4)
Fertilizer	3281.1 (43.4)	3380.0 (43.9)	4499.0 (49.0)	3717.0 (45.5)
Plant Protection Measures	680.1 (9.0)	779.0 (10.0)	1000.0 (10.9)	819.7 (10.0)
Total	7551.4 (100)	7784.9 (100)	9160.0 (100)	8165.4 (100)

Note: Figures in parentheses indicate per cent to sub-total.

Break-up cost of cultivation of improved paddy cultivation at sampled farms

Cost incurred on different operations of paddy cultivation at different farms is presented in Table 02. Table revealed that on an average total cost of cultivation of paddy was estimated as Rs. 31808.40 per hectare. It is clear from the table that fertiliser was the major item across the categories in the variable cost. Out of the total cost of cultivation, cost incurred on fertiliser was estimated on an average Rs. 3717.00 per ha constituted 24.00 per cent of total cost of cultivation which varied from Rs. 3281.10 at small farms to Rs. 4490.00 at large farms. The next major cost incurred on seed material. On an average cost estimated for this input was Rs. 3628.70 (23.40 per cent) which varied from Rs.3590.29 at small farms to Rs.3670.00 at large farms. Human labour is an important component in paddy cultivation. The expenditure made on human labour was found to be Rs. 3446.40 per ha (20.60 per cent) on an average, which varied from Rs.3341.20 at small farms to Rs.3599.10 at large farms. The expenditure on machines used for different operations of paddy cultivation was estimated as Rs. 2240.00 (14.50 per cent). Other operations such as value of insecticide and bullock labour charges are estimated on an average Rs. 1252.90 per ha constituted about 08 per cent of the total cost of cultivation. Among the fixed cost, the land revenue was estimated equal at all the categories with an average of 0.01 per cent respectively. Similarly, the interest on working capital calculated at the rate of 10 per cent constituted 4.70 per cent. Table showed that the above said operation constituted 48 per cent of the total cost while remaining of 52 per cent cost constituted under interest on fixed capital, rental value of owned land and imputed value of family labour etc. in the total cost of cultivation of improved paddy cultivation.

Table 2. Break-up cost of cultivation of improved paddy cultivation at sampled farms Unit: Rs/ha

Particulars	Small	Medium	Large	Overall
1) Hired Human Labour	3341.2 (25.2)	3399.1 (21.6)	3599.1 (20.6)	3446.4 (20.6)
2) Bullock Labour Charges	1300.0 (9.8)	-	-	433.3 (2.8)
3) Machine Charges	-	3320.0 (21.1)	3400.0 (19.5)	2240.0 (14.5)
4) Value of seed	3590.2 (27.1)	3625.9 (23.1)	3670.0 (21.0)	3628.7 (23.4)
5) Value of Fertilizers	3281.1 (24.7)	13380.0 (21.5)	4490.0 (25.7)	3717.0 (24.0)
6) Value of Insecticides	680.1 (5.1)	779.0 (4.9)	1000.0 (5.7)	819.7 (5.3)

7) Depreciation on implements & Machinery	345.2 (2.6)	349.4 (2.2)	349.4 (2.0)	348.0 (2.2)
8) Irrigation Charges	58.2 (0.4)	60.0 (0.3)	60.0 (0.3)	59.4 (0.3)
9) Land revenue & other taxes	17.3 (0.1)	17.3 (0.1)	17.3 (0.1)	17.3 (0.1)
10) Interest on working capital @ 10 per cent	629.8 (4.7)	457.6 (4.7)	828.4 (4.7)	734.6 (4.7)
Cost A_1 / A_2	13243.1 [47.6]	15676.3 [49.4]	17414.2 [48.4]	15444.5 [48.5]
11) Interest on fixed capital @ 10%	315.4	320.3	340.0	367.9
Cost B_1	13558.5	15996.7	17754.2	15769.8
12) Rental value of owned land (1/6th of gross income)	10700.8	12606.6	14673.3	12660.2
Cost B_2	24259.3	28603.3	32427.5	28430.0
13) Imputed value of family labour	1000.4	240.0	220.0	486.8
Cost C_1	14558.9	16236.7	17974.2	16256.6
Cost C_2	25259.7	28843.3	32647.5	28916.8
14) 10% of Cost C_2	2525.9	2884.3	3264.7	2891.6
Cost C_3 (Total Cost)	27785.6 (100)	31727.6 (100)	35912.2 (100)	31808.4 (100)

Note: A figure in parentheses shows per cent to Cost C_3 (Total Cost).

Gross Income analysis of improved paddy cultivation at sampled farms

The gross income analysis of improved paddy at sampled farms is presented in Table 03. Table clearly revealed that the average yield was observed as 49.00 quintal per ha. which varied from 41.40 quintal per ha at small farms to 56.80 quintal per ha. at large farms. The average gross income was observed as Rs.75961.60 per hectare which ranges from Rs.64205.00 per hectare at small farms to Rs.88040.00 at large farms. These figures clearly indicate that farmers of larger categories have received more gross income as compared to the farmers of medium and small categories mainly due to relatively higher yield and price realized of the produce only.

Table 3. Gross Income analysis of improved paddy cultivation at sampled farms Unit: Rs. /ha

Particulars	**Small**	**Medium**	**Large**	**Overall**
Main produce (qtl.)	41.4	48.8	56.8	49.0
Value of main product (Rs.)	49680.0 (77.3)	58560.0 (77.4)	68160.0 (77.4)	58800.0 (77.4)
By Product (qtl.)	41.5	48.8	56.8	49.0
Value of by product (Rs.)	14525.0 (22.6)	17080.0 (22.5)	19880.0 (22.5)	17161.6 (22.5)
Gross Income (Rs.)	64205.0 (100)	75640.0 (100)	88040.0 (100)	75961.6 (100)

Note: Figures in parentheses shows per cent to Gross Income.

Profitability aspects of improved paddy cultivation at sampled farms

The profitability aspects of improved paddy cultivation are presented in Table 04. The net farm income was estimated as Rs.44153.20 per ha. ranges from Rs.36419.40 per ha. at small farms to Rs. 52127.80 per ha at large farms. Farm business income was estimated on an average as Rs. 60517.10 per hectare followed by income from family labour was estimated as Rs. 47531.60 per ha at different farms of sampled respondent. The average benefit cost ratio was estimated as 2.3 which varied from 2.3 at small farms to 2.4 at large farms.

Table 4. Profitability aspects of improved paddy cultivation at sampled farms Unit: Rs/ha

Particulars	Small	Medium	Large	Overall
Net farm Income	36419.4	43912.4	52127.8	44153.2
Farm Business Income	50961.9	59963.7	70625.8	60517.1
Family Labour Income	39945.7	47036.7	55612.4	47531.6
Benefit Cost Ratio	2.3	2.3	2.4	2.3
Cost of production / quintal	320.3	300.1	282.2	300.8

CONCLUSION

The forgoing analysis of paddy cultivation indicates that the Paddy is the important major kharif crop in the study area. On an average material cost was estimated as Rs.8165.40 per ha in which 45.00 per cent share of total material cost constituted by the fertiliser material. The average cost of cultivation of improved paddy was estimated to be Rs.31808.40 per ha and ranged from Rs. 27785.60 to Rs. 35912.2 in different size groups. The average gross income of paddy was estimated to be Rs. 75961.60 per ha. The average net income and farm business income was calculated as Rs. 44153.20 and Rs. 60517.10 per ha respectively at sampled farms of improved paddy growers in the study area.

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RESOURCE ECONOMICS OF WHEAT CULTIVATION IN CHHINDWARA DISTRICT OF MADHYA PRADESH

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Abstrect: An attempt has been made in this study to examine the resource economics of wheat cultivation in Chhindwara district of Madhya Pradesh state. The present study was based on the data collected from a random sample of forty farmers who were selected randomly from four villages. Ten wheat growers from each of the selected village considered to collect the required information on the cost of cultivation aspects of this crop for the present study. The simple mean and average method was used to work out the cost of cultivation of wheat crop. The per hectare cost of cultivation was worked out as Rs.19452.28, Rs.20125.54, Rs. 21722.86 and Rs. 22731.61 per hectare at marginal, small, medium and large farms respectively in the district. The average cost of cultivation was estimated as Rs. 20997.56 per ha. Among the different item of resources used in the cultivation of wheat crop, the share of input and labour cost was accounted 78.51 per cent (Rs. 16485.63) and 21.49 per cent (Rs. 4511.93) of total cost respectively in the study area. Per hectare application of NPK was observed as 143.86 kg; 73.61kg. and 28.53 kg. in the district respectively. The average net return was estimated as Rs. 24863.21 per ha. in the district. The input-output ratio was observed as 1:2.03, 1:2.23, 1:2.26 and 1:2.18 at the different farms respectively with an average of 1:2.18.

Keyword: Input cost, Labour cost, Cultivation, Wheat, Madhya Pradesh

INTRODUCTION

Wheat is one of the foundation crops of India and has got prestigious place in India sub-continent from time immemorial plays the crucial role in food economy and food security system of India. It is the most important stable food crop for one third of the world of the population and contributes more calories and proteins to the world diet than any other cereal crop. It can be processed in to various types of foods. Wheat is cultivated in about 120 countries of the world. China is the largest producer of wheat with annual production of 115.10 million tons during 2009 followed by India with a production of 80.80 million tons. Out of total (685.80 million tons) world's wheat production, 16.79 per cent is contributed by China followed by India (11.78 per cent) (Anonymous 2009-10). The major wheat growing states of India are Uttar Pradesh, Madhya Pradesh, Punjab, Haryana and Rajasthan. These five states contribute about 90 per cent of total wheat production of country. India is the world's biggest consumer of wheat after China with annual domestic demand of about 70 million tons. Export of wheat in India is in terms of quantity showed a sharp fluctuation. Sometimes India used to have large surplus for wheat export depending on the domestic production and stock management. Country exported 26.49 lakh tones of wheat during 2001-02 which remained highest till 2003-04 (40.93 lakh tons of wheat of a value of Rs. 2391.25 Crore). Thereafter, the export of wheat showed a sharp decline up to the year of 2006-07. Wheat trade was inversely affected in India due to violent fluctuations in area under and productivity of crop during the year of 2004-05 to 2006-07 (Anonymous 2006-07). One of the main objectives of a production unit is to co-ordinate and utilize resources or factors of production in such a manner that together the yield the possible highest net return. Increasing cost of agricultural inputs is contributed in to higher cost of production. In view of this, it is necessary that available scared inputs should be used as economically and efficiently as possible. Therefore, the present study aims to examine the economics of resources used in the cultivation of wheat at different size group of farms.

MATERIAL AND METHODS

The area under wheat in Chhindwara district is 0.11 million ha. which is about 2.50 per cent of the total area under wheat cultivation in the state. Out of nine tehsils of Chhindwara district, Chourai and Amarwara tehsils are combinedly constitute 0.042 million ha. of area (37.78 per cent) and 0.099 million tone (42.68 per cent) production of the total district. Therefore, one of them i.e. Chourai tehsil was selected randomly for present study. The Chourai tehsil has 195 numbers of villages, out of these, a sample of two per cent village is considered randomly for this study purpose. Therefore, four villages namely Bamhinilala, Bariwara, Chand, and Rajalwadi are selected randomly for the study purpose, in order to collect the primary information related to this study. There are large numbers of wheat growers in these selected villages. From each of these selected villages, a proportionate sample of respondents is considered in order to make a number of respondents equal to forty. These farmers are classified into different categories based on their land holding i.e. marginal (up to 1.00 ha.), small (1.01 to 2.00 ha.), medium (2.01 to 4.00 ha.) and large (above 4.00 ha.).

RESULT AND DISCUSSION

(I) Cost of cultivation of wheat at sampled farms

The cost comparison within the important operations of the crop in the study areas is presented in Table 01. It is clear from this table that total cost of cultivation of wheat was estimated as Rs.20997.56. It is interesting to note that total cost is increasing along with size of holdings in the study area. Looking to different operations, the average expenditure on harvesting, threshing, winnowing and transportation is also considerably higher (Rs.4731.92 per hectare) at the different farms of which shows that the cost involved in these operations mainly due to more production of crop at farms of study area. The seed and sowing is also playing an important role in obtaining the better yield. The expenditure incurred on this operation was observed as Rs.4153.09 per hectare on an average at sampled farms. Cost of seed material and sowing method are mainly responsible for this cost of seed and sowing operation. Farmers generally purchase the seed each year for sowing of wheat crop. Manures and fertilizers is an operation which has large difference in the cost of cultivation. The average cost incurred on this operation was computed as Rs.4149.43 per ha. This wide variation is mainly due to higher price and more quantity of fertilizer applied by the farmers in the study area only. Another difference in expenditure was observed in irrigation. Farmers spent Rs. 3156.44 per hectare on irrigation. More number of irrigation (5 No) provided by the farmers in the wheat is the main reason of this large cost of irrigation in study area.

(II) Cost of labour at sampled farms:

Cost of labour at different operations like field preparation, intercultural & plant protection and harvesting & threshing are some operations in which considerable cost of labour was observed at different farms of study area. The share of labour cost in total cost of cultivation of wheat of different operation at sampled farms is presented in Table 02. On an average the cost of labour was estimated as Rs. 4511.93 per hectare at sampled farms which is about 22 per cent of the total cost of cultivation. Looking to different operations, it is clear from this table that the labour cost incurred on harvesting & threshing was considerably more at the sampled farms. Across the categories, this difference varies from about 55 per cent to 40 per cent these operations. On an average the total labour cost was estimated on this operation Rs. 2188.53 per ha (48.51 per cent). Labour cost on irrigation was considerably more at the sampled farms. Across the categories, this difference varies from about 33 per cent to 68 per cent on irrigation operation. Probably, more number of irrigation at the farms of MP may be the appropriate reason of this high labour cost incurred at different farms of the study area.

Table: 1 Cost of cultivation of wheat at sampled farms (Rs. / ha.)

S. No.	Category	Field preparation	Manure and fertilizer	Seed and sowing	Pre-sowing irrigation+ irrigation	Intercultural+ plant protection	Harvesting + Threshing+ Transportation	Fixed cost	Total cost (Rs. /ha.)
1.	Marginal	2241.11 (11.52)	3280.72 (16.87)	3222.56 (16.57)	3004.62 (15.44)	1754.24 (9.01)	5510.99 (28.33)	438.04 (2.26)	19452.28 (100.0)
2.	Small	2443.78 (12.14)	3912.40 (19.43)	4036.67 (20.05)	2951.46 (14.67)	1418.93 (7.05)	4909.44 (24.40)	452.86 (2.26)	20125.54 (100.0)
3.	Medium	2727.56 (12.56)	4759.82 (21.91)	4318.89 (19.89)	3240.14 (14.91)	1850.21 (8.51)	4338.24 (19.98)	488.00 (2.24)	21722.86 (100.0)
4.	Large	2710.49 (11.92)	4510.11 (19.85)	5177.84 (22.78)	3440.77 (15.13)	2184.13 (9.61)	4198.07 (18.47)	510.20 (2.24)	22731.61 (100.0)
	Average	2538.68 (12.09)	4149.43 (19.77)	4153.09 (19.78)	3156.44 (15.03)	1795.96 (8.56)	4731.92 (22.53)	472.04 (2.24)	20997.56 (100.0)

Table:2. Cost of labour at sampled farms (Labour cost/ha.)

S. No.	Category	Field preparation	Manure and fertilizer	Sowing	Pre-sowing irrigation + irrigation	Intercultural + plant protection	Harvesting + transport. from field to threshing place+ field to home	Total cost (Rs. /ha.)
1.	**Marginal**	185.47 (3.29)	334.83 (5.93)	200.93 (3.57)	1010.81 (17.91)	803.70 (14.25)	3105.29 (55.05)	5641.03 (100.0)
2.	**Small**	82.84 (1.69)	253.25 (5.20)	78.10 (1.60)	1010.64 (20.73)	691.12 (14.18)	2758.57 (56.60)	4874.52 (100.0)
3.	**Medium**	32.28 (0.83)	256.29 (6.67)	160.09 (4.17)	1151.70 (29.96)	759.19 (19.75)	1484.81 (38.62)	3844.36 (100.0)

4.	**Large**	36.01 (0.95)	244.03 (6.46)	27.01 (0.71)	1257.07 (33.29)	669.05 (17.71)	1544.34 (40.88)	3777.51 (100.0)
	Average	82.69 (1.83)	272.79 (6.04)	125.23 (2.78)	1105.81 (24.51)	736.98 (16.33)	2188.43 (48.51)	4511.93 (100.0)

Table: 3. Cost of inputs at sampled farms (Input cost / ha.)

S. No.	Category	Field preparation (Machineries)	Manure and fertilizer	Seed	Pre-sowing irrigation+ irrigation	Intercultural+ plant protection	Harvesting + Threshing + Transport.	Fixed cost	Total cost (Rs./ha.)
1.	**Marginal**	2055.63 (14.89)	2945.89 (21.32)	3021.63 (21.88)	1993.81 (14.43.)	950.54 (6.89)	2405.71 (17.41)	438.04 (3.18)	13811.25 (100.0)
2.	**Small**	2360.94 (15.48)	3659.15 (23.99)	3958.57 (25.96)	1940.82 (12.72)	727.81 (4.78)	2150.87 (14.10)	452.86 (2.97)	15251.02 (100.0)
3.	**Medium**	2695.28 (15.08)	4503.53 (25.19)	4158.80 (23.27)	2088.44 (11.68)	1091.02 (6.10)	2853.43 (15.96)	488.00 (2.72)	17878.50 (100.0)
4.	**Large**	2674.48 (14.11)	4266.08 (22.50)	5150.83 (27.18)	2183.70 (11.52)	1515.08 (7.99)	2653.73 (14.00)	510.20 (2.70)	18954.10 (100.0)
	Average	2455.98 (14.90)	3876.64 (23.51)	4027.86 (24.43)	2050.62 (12.44)	1058.98 (6.42)	2543.51 (15.42)	472.04 (2.87)	16485.63 (100.0)

Table 4: Fertilizer consumption pattern in wheat cultivation at sampled farms

S. No.	Name of fertilizer	Fertilizer (in Kg.)		Nutrients (in Kg.)		
		Per farm	Per ha.	N_2	P_2O_5	K_2O
1.	DAP	723.44	130.82	23.54	60.17	-
2.	UREA	1446.75	261.61	120.34	-	-
3.	SSP	464.68	84.02	-	13.44	-
4.	MOP	262.96	47.55	-	-	28.53
Total				**143.88**	**73.61**	**28.53**

Table: 5: Economics of wheat production at sampled farms

S. No.	Particulars	Marginal	Small	Medium	Large	Average
1.	Cost of cultivation (Rs. /ha.)	19,452.28	20,125.54	21,722.86	22,731.61	20,997.56
2.	Production (Qu. /ha.)					
a.	Main product	32.45	34.91	37.11	36.60	35.34
b.	By-product	57.18	60.94	65.70	66.60	62.67
3.	Cost of production (Rs. /qtl.)					
a.	Main product	599.45	576.49	585.36	621.08	594.03
4.	Price (Rs. /qtl.)					
a.	Main product	1044.00	1115.55	1150.00	1160.00	1117.93
b.	By-product	100.00	100.00	100.00	100.00	100.0
5.	Return (Rs. /ha.)					
a.	Main product	33877.80	38943.85	42676.50	42456.00	39592.87
b.	By-product	5718.00	6094.00	6570.00	6660.00	6267.90
6.	Gross return (Rs. /ha.)	39,595.80	45,037.85	49,246.50	49,116.00	45,860.77
7.	Net return (Rs. /ha.)	20,143.52	24,912.31	27,523.64	26,384.39	24,863.21
8.	Net return (Rs. /qtl.	620.75	713.61	741.67	720.88	698.46
9.	Input-output ratio	1:2.03	1:2.23	1:2.26	1:2.16	1:2.18

The expenditure incurred on intercultural and plant protection is too much high at marginal, small and medium farms of the study area. The expenditure estimated on an average Rs.736.98 per ha. (16.33 per cent). Other operations like field preparation, seed and sowing and manure & fertiliser application are

some other operations in which considerable difference of labour cost at different farms of study area was not observed.

(III) Cost of inputs at sampled farms

The cost of input used in wheat crop in the study area is presented in Table 03. It is clear from this table that total input cost of wheat in MP is estimated as Rs.16485.63 per ha. Per hectare expenditure incurred on seed was observed as Rs.4027.86 per ha. Constituted 24.43 per cent of the total cost of inputs which shows that farmers of are spending more amount on this input. New seed purchased by farmers each year may be an appropriate reason of this phenomenon. It is observed from the table that on an average per hectare manures and fertilizers cost was estimated as Rs.3876.64 per ha. at farms constituted 23.51 per cent of total input cost. Thus, it is clear that the relatively higher doses of the fertilizer used by the farmers are the main reason behind this high cost. Another difference in expenditure was observed in field preparation in the study area. Farmers of study area spent Rs.2455.98 per hectare on this operation. More number of ploughing done by the farmers of MP before sowing the seed may be a reason of this difference at the farms.

(IV) Estimation of fertilizer use at sampled farms

The fertilizer consumption pattern at sampled farms is presented in Table 04. The table reveals that the DAP, urea, SSP and MOP are four major fertilizers which are used by the farmers for wheat cultivation. The application of these fertilizers was observed as 130.82 Kg., 261.61 Kg., 84.02 Kg. and 47.55 Kg. per hectare respectively which provide 143.88 Kg. Nitrogen, 73.61 Kg. Phosphorus and 28.53 Kg. Potash to the wheat crop at the farms of study area respectively.

(V) Economics of wheat production at sampled farms

The economics of wheat production at sampled farms is presented in Table 05. The per hectare cost of cultivation was estimated as Rs.19425.28, Rs. 20125.54, Rs. 21722.86 and Rs. 22731.61 at marginal, small, medium and large farms of Chhindwara district respectively along with Rs. 20997.56 as an average. It shows that the cost of cultivation is increasing as the size of holding increased. The higher cost of cultivation in the study area attributes to high productivity of the crop. Consequently, the average yield was observed as 35.34 quintal at farms of Chhindwara district. It is interesting to note that the yield has, generally, positive relation with the size of holding in the study area with few exceptions. The per quintal cost of production was ranges from Rs. 576.49 at small farms to Rs.621.08 at large farms having an average of Rs.594.03 per quintal at sampled farms. The higher yield at the different farms was the main reason of less cost of production at these farms. The average price of the produce was observed as Rs.1117.93 per quintal in the study area. Varity and quality of wheat is playing important role to decide the per quintal price. The average gross return was observed as Rs. 45860.77 per hectare which ranges from Rs. 39595.80 at marginal farms to Rs. 49246.50 at medium farms of the area. Per hectare net return depends on per hectare yield and price of this produce. The net returns of this crop was observed highest at medium farms i.e. Rs. 27523.64 followed by Rs. 26384.69 at large farms, Rs. 24912.31 at small farms and Rs. 20143.52 at marginal farms. The average input-output ratio was estimated as 1:2.18 which varied from 1:2.03 at marginal farms to 1:2.26 at medium farms. It clearly shows that the input-output ratio at sampled farms is more favorable to the producers due to higher yield and price received by the farmers of the study area.

CONCLUSION

The forgoing study indicates that the per hectare cost of cultivation was worked out as Rs.19452.28, Rs. 20125.54, Rs. 21722.86 and Rs. 22731.61 per hectare at marginal, small, medium and large farms respectively in the district. The average cost of cultivation was estimated as Rs. 20997.56 per ha. Among the different item of resources used in the cultivation of wheat crop, the share of input and labour cost was accounted 78.51 per cent (Rs. 16485.63) and 21.49 per cent (Rs. 4511.93) of total cost respectively in the study area. Per hectare application of NPK was observed as 143.86 kg; 73.61kg. and 28.53 kg. in the district respectively. The average net return was estimated as Rs. 24863.21 in the district. The input-output ratio was observed as 1:2.3, 1:2.23, 1:2.26 and 1:2.18 at the different farms of respectively.

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REPRODUCTIVE PHENOLOGY OF DOMINANT TREE SPECIES IN TROPICAL DECIDUOUS FOREST OF HASTINAPUR REGION IN WESTERN U.P.

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Abstract: Flowering and fruiting phenology of 20 selected dominant tree species in tropical deciduous forest of Hastinapur region in western U.P. was observed through fortnightly visit during November 2009 to December 2011 revealed that there exists a strong seasonality for flowering and fruiting phenophases. Reproductive interphenophases duration between phenological events varied for different selected dominant tree species. The fruiting phenology follows closely the flowering phenology. Correlation analysis shows that, there was a positive correlation between the interphenophase duration of production of young fruits (YFr) - maturation of fruits (MFr) and production of young flowers (YF1) - maturation of flowers (MF1) but no correlation was found between the interphenophase duration of maturation of fruits (MFr)- ripening of fruits (RFr) and maturation of flowers (MF1) - abscission of flowers (AF1). Phenological behaviour displayed by the trees are the result of interaction of surrounding biotic and abiotic environment.

Keywords: Correlation, Flowering, Fruiting, Hastinapur, Phenology

INTRODUCTION

Seasonal duration of leafing, flowering and fruiting mainly determine phenological behaviour in tropical trees. These phenological events are not mutually independent in woody species, and flowering may be partly or wholly dependent on leafing activity (van Schaik et al., 1993). Nevertheless, tree species with similar leaf phenology often differ in the timing of their flowering and fruiting (Seghieri et al., 1995). Many deciduous tree species show flowering and fruiting during the leafless period, exhibiting wide separation between leafing and flowering phenophases. In many evergreen and in some deciduous species leaf flush and flowering occur close in time on the same new shoot. An analysis of the proximate controls of flowering in tropical deciduous forest species indicates that the timing of vegetative phenology strongly determines the flowering periods, and thus flowering at least depends indirectly on environmental periodicity (Rivera et al., 2002). Variation in flowering time relative to vegetative phenology, induced by a variety of factors (significant rain in winter/summer, decreasing or increasing photoperiod, or drought-induced leaf fall), results in a number of flowering patterns in tropical trees (Borchert et al., 2004). Plant phenology are the result of interaction of biotic and abiotic factors over evolutionary time and through natural selection, the biotic and abiotic factors have entrained rhythemicity in plant life that results in appropriate of flowering, fruiting and leaf flushing and efficient growth and reproduction (Van Schaik et al.,1993).

The forests of Hastinapur, Meerut district of Uttar Pradesh west are facing various biotic, abiotic and anthropogenic pressures. Considering all the associated problems, it was found necessary to study the forest resources of Hastinapur, which not only protect the environment but also provide the basic needs of community residing in nearby areas, but the recent growing demand of growing population and tourism activities in this area has created various disturbances in the existing forest resulting in loss of phytodiversity and other natural resources thereby affecting the phenology of plants.

Objectives: The study describes the phenological patterns of the dominant tree species in tropical deciduous forest of Hastinapur region. Parameters considered for analysis of phenology are production of young flowers, maturation of flowers (Anthesis), abscission of flowers, production of young fruits, maturation of fruits, ripening of fruits.

MATERIAL AND METHODS

Study Area

The study site is located at 36.4 km north east to Meerut (Western Uttar Pradesh). It lies at 29.17 °N, 78.02 °E longitudes. Hastinapur forest region is of dry thorn type. The species forming the scrub vegetation are *Zizyphus xylopyra*, *Zizyphus mauritiana*, *Butea monosperma*, *Prosopis juliflora* etc. as far as the structure and function of these forest are concerned. The elevation of Hastinapur is roughly 205 meters above the sea level. The temperature ranges from 35° C to 43° C in summers while remain between 20° C and 30° during winters. There are three different major seasons in Hastinapur, Meerut: summer season (April to mid June), winter season (November to February) and monsoon season (June to September). October-March constitute the transition month, between the monsoon and winter season and between the winters and summer seasons. Annual average rainfall is 145mm. About 85% of the total rainfall is observed during the rainy seasons (south- west monsoon). The soil of the forest contains sand, silt and clay in different proportions. The soils of the forest were alkaline in nature.

The vegetation is at its zenith during the monsoon season because of high humidity and moderate

temperature. The forest of study site is suffering from various disturbances such as grazing, burning and cutting etc.

Three sites were selected for phenological study. Tree vegetation analysis was conducted during June-November, 2009 for selected sites of the forest. The quantitative information was carried out in the study forest site mainly for density, frequency, basal area and IVI (Importance value index) of tree layer vegetation. Importance Value Index (IVI) is a measure of dominance and ecological success of a species. Only the species with IVI over 10 were selected as dominant tree species for phenological study. The tree species were identified with flora guides. The tree vegetation analysis was conducted by using quadrat method. The size and number of the quadrats were determined by species area curve method (Mishra, 1968). Total 10 quadrats of 10×10 m^2 size were placed randomly in each forest site. The phytosociology characters such as density, frequency, basal area and IVI of individual species were quantified for different selected study sites using standard quantitative technique (Curtis and McIntosh, 1950; Mishra, 1968; Muller- Dombois and Ellenberg, 1974).

All the individual of tree species with a girth of 31cm and above were marked with a metal tag. Each site was visited once a fortnight from November, 2009 to December, 2011 to record the change for the 6 phenological events namely production of young flowers (YF1), maturation (anthesis) of flowers (MF1), abscission of flowers (AF1), production of young fruits (YFr), maturation of fruits (MFr) and ripening of fruits (RFr).

During the fortnightly visits, marked individual were qualitatively characterized for these six phenological events (Prasad and Hegde, 1986) and phenostage of each species was determined by considering the status of majority of individuals. In the case of species represented by only a few individuals, those present in nearby areas were observed to confirm the phenological status of that species. For each selected dominant tree species, majority of individuals observed phenophages event on a sampling date was recorded. The duration of phenological events in a species was computed by obtaining the number of days required for the completion of an event from the date of the fortnightly visit when the event was first observed. For each species, interphenophase duration, i.e. period between successive phenological events, were then obtained.

Study of soil properties

From each site the composite soil samples were collected from 0–10cm, 10-20cm and 20-30cm depth, packed in polythene bags and brought to the laboratory for analysis of physical and chemical properties. Moisture content was determined on dry wet basis, soil texture was determined using the sieve of different sizes. Soil Ph was measured using 1.5 proportions of soil and water by glass electrodes (Jackson, 1968).

Table-2.1: Composition of Tree Species in different study sites.

Site-1

S.No.	Species	D	F	TBA	R.D.	R.F.	R.Dom.	I.V.I.
1	*Acacia nilotica*	2.3	100	1075.20	21.10	15.87	19.76	56.73
2	*Acacia farnesiana*	1.8	90	828.21	16.51	14.28	15.22	46.01
3	*Prosopis juliflora*	1.9	90	676.05	17.43	14.28	12.42	44.13
4	*Acacia catechu*	1.8	80	670.25	16.51	12.69	12.32	41.52
5	*Dalbergia sissoo*	0.9	90	591.21	8.25	14.28	10.86	33.39
6	*Tectona grandis*	0.7	80	498.01	6.42	12.69	9.15	28.26
7	*Zizyphus xylopyra*	0.9	70	436.34	8.25	11.11	8.02	27.38
8	*Azadirachta indica*	0.2	10	238.26	1.83	1.58	4.37	7.78
9	*Albizia procera*	0.2	10	218.24	1.83	1.58	4.01	7.42
10	*Aegle marmelos*	0.2	10	208.37	1.83	1.58	3.83	7.24
	Total	10.9	630	5440.14	99.96	99.94	99.96	299.86

Site-2

S.No.	Species	D	F	TBA	R.D.	R.F.	R.Dom.	I.V.I.
1	*Acacia nilotica*	2.1	100	546.21	17.21	11.90	8.72	37.84
2	*Eucalyptus globulus*	1.7	100	532.56	13.93	11.90	8.50	34.34
3	*Butea monosperma*	0.9	80	960.55	7.37	9.52	15.34	32.24
4	*Bauhinia purpurea*	1.0	90	538.32	8.19	10.71	8.60	27.51
5	*H. adenophyllum*	0.9	80	477.43	7.37	9.52	7.62	24.52
6	*Pongamia pinnata*	1.0	70	401.78	8.19	8.33	6.41	22.94
7	*Tectona grandis*	0.9	60	331.34	7.37	7.14	5.29	19.81
8	*Albizia lebbeck*	0.7	50	481.75	5.73	5.95	7.69	19.38
9	*Cassia fistula*	0.8	60	371.64	6.55	7.14	5.93	19.63
10	*Bauhinia racemosa*	0.7	50	432.12	5.73	5.95	6.90	18.59
11	*A. odoratissima*	0.4	20	218.72	3.27	2.38	3.49	9.15

12	*Mangifera indica*	0.3	20	282.36	2.45	2.38	4.51	9.35
13	*Acacia leucophloea*	0.4	20	213.04	3.27	2.38	3.40	9.06
14	*D. melanoxylon*	0.2	20	241.12	1.63	2.38	3.85	7.87
15	*E. officinalis*	0.2	20	230.23	1.63	2.38	3.67	7.69
	Total	12.2	840	6259.17	99.89	99.96	99.92	299.92

Site- 3.

No.	**Species**	**D**	**F**	**TBA**	**R.D.**	**R.F.**	**R.Dom.**	**I.V.I.**
1	*Acacia catechu*	0.9	70	732.67	8.57	8.75	11.37	28.69
2	*Butea monosperma*	0.9	60	491.43	8.57	7.50	7.62	23.69
3	*Ailanthus excelsa*	0.9	60	461.46	8.57	7.50	7.16	23.23
4	*Cassia fistula*	0.8	60	521.32	7.61	7.50	8.09	23.20
5	*Phoenix sylvestris*	0.8	60	329.26	7.61	7.50	5.10	20.22
6	*Tectona grandis*	0.7	50	431.64	6.66	6.25	6.69	19.61
7	*Dalbergia sissoo*	0.8	50	356.29	7.61	6.25	5.52	19.39
8	*Bauhinia purpurea*	0.7	50	341.78	6.66	6.25	5.30	18.22
9	*Acacia nilotica*	0.5	50	421.91	4.76	6.25	6.54	17.55
10	*Bauhinia veriegata*	0.7	40	379.64	6.66	5.00	5.89	17.55
11	*Pongamia pinnata*	0.5	50	331.05	4.76	6.25	5.13	16.14
12	*Pithecelobium dulce*	0.5	40	374.34	4.76	5.00	5.80	15.57
13	*Bauhinia racemosa*	0.5	40	342.31	4.76	5.00	5.31	15.07
14	*Albizia lebbeck*	0.4	40	276.15	3.80	5.00	4.28	13.09
15	*Eucalyptus globulus*	0.4	40	231.67	3.80	5.00	3.59	12.40
16	*Diospyros cordifolia*	0.3	30	219.87	2.85	3.75	3.41	10.01
17	*Zizyphus jujuba*	0.2	10	201.08	1.90	1.25	3.12	6.27
	Total	10.5	800	6443.87	99.91	100	99.92	299.90

D-Density(individual/100m^2); F-Frequency(%); TBA-Total Basal Area(cm^2/100m^2): R.D.-Relative Density(%); R.F.-Relative Frequency(%); R.Dom.-Relative Dominance(%); I.V.I.-Importance Value Index.

Table-2.2. Physico-Chemical Properties of Soil.

Site/Horizon	**Texture**			**Moisture**	**Bulk density**	**Organic Carbon (Mean ±S.D)**	**pH**
Hillock	**Sand**	**Slit**	**Clay**				
Horizon A	87	9	8	95.00	1.49	0.51±0.014	7.67
B	79	8	11	96.58	1.44	0.48±0.014	8.05
C	78	8	15	91.79	1.47	0.47±0.014	8.13
Block- 1							
Horizon A	88	2	10	74.62	1.69	1.20±0.84	7.29
B	86	2	12	75.38	1.58	0.64±0.58	7.16
C	89	3	9	72.32	1.68	0.94±0.077	7.39
Block- 2							
Horizon A	84	8	9	71.16	1.71	0.42±0.021	8.34
B	91	2	10	73.54	1.67	0.46±0.027	8.41
	89	2	8	74.18	1.62	0.38±0.027	8.32

Table-2.3. Trees species, Vegetation Type (VT) and Interphenophase duration

S.N.	**Tree Species**	**VT**	**Interphenophase duration (days)**			
			YF1- MF1	**MF1- AF1**	**YFr- MFr**	**MFr- RFr**
1	*Acacia nilotica*	D	29	28	58	153
2	*Acacia farnesiana*	D	31	27	49	151
3	*Acacia catechu*	D	34	30	47	161
4	*Ailanthus excelsa*	D	35	30	30	43
5	*Albizia lebbeck*	D	27	22	179	61
6	*Bauhinia purpurea*	SE	20	22	59	89
7	*Butea monosperma*	D	23	25	30	80
8	*Bauhinia racemosa*	D	27	29	37	67
9	*Bauhinia variegata*	D	28	27	41	69

10	*Cassia fistula*	D	29	26	136	125
11	*Dalbergia sissoo*	D	19	21	38	48
12	*Diospyros cordifolia*	D	23	24	61	38
13	*Eucalyptus globulus*	E	29	28	36	41
14	*Prosopis juliflora*	D	29	26	36	79
15	*Pongamia pinnata*	E	20	26	72	68
16	*Phoenix sylvestris*	E	18	46	129	117
17	*Pithecelobium dulce*	D	22	29	75	51
18	*Tectona grandis*	D	29	34	62	65
19	*Heterophragma adenophyllum*	D	35	75	31	73
20	*Zizyphus xylopyra*	D	25	23	125	116

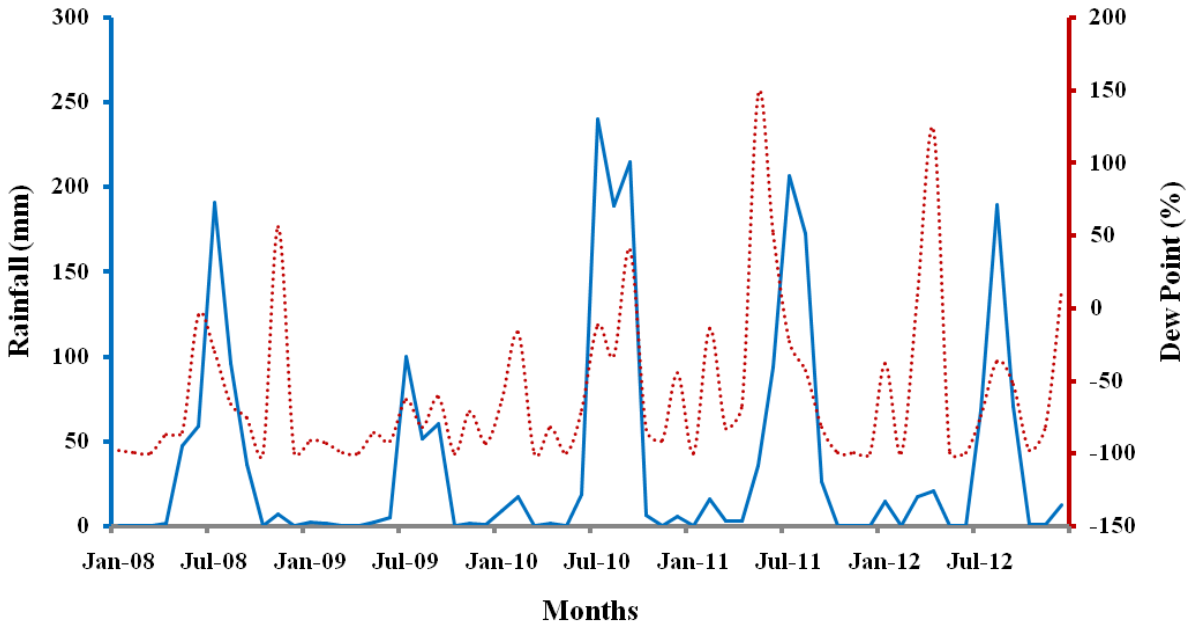

Figure-1: Monthly Average Rainfall and Dew Point Time Series of Meerut.

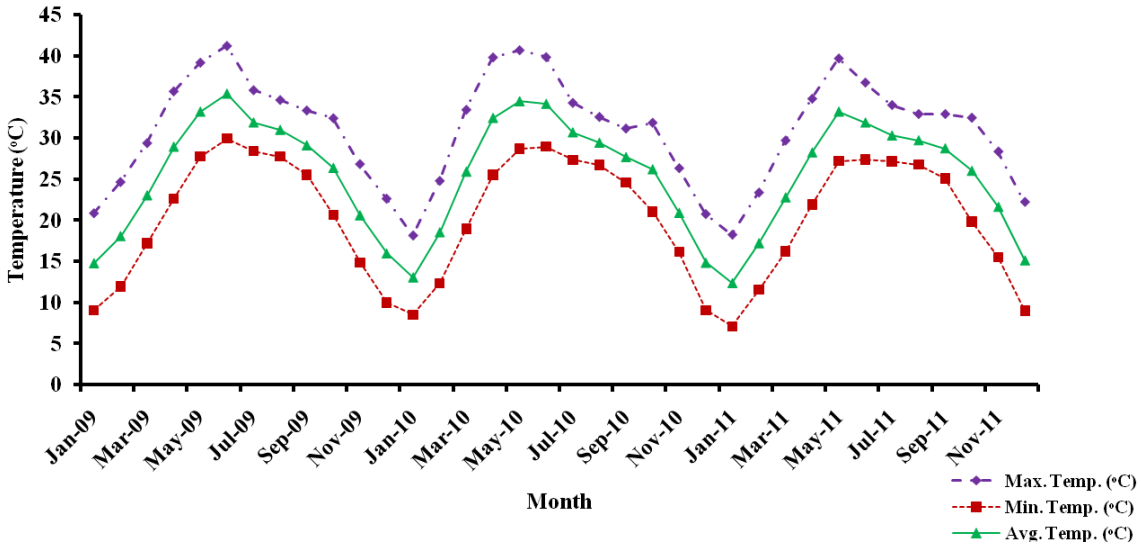

Figure-2: Monthly Average Time Series of Temperature.

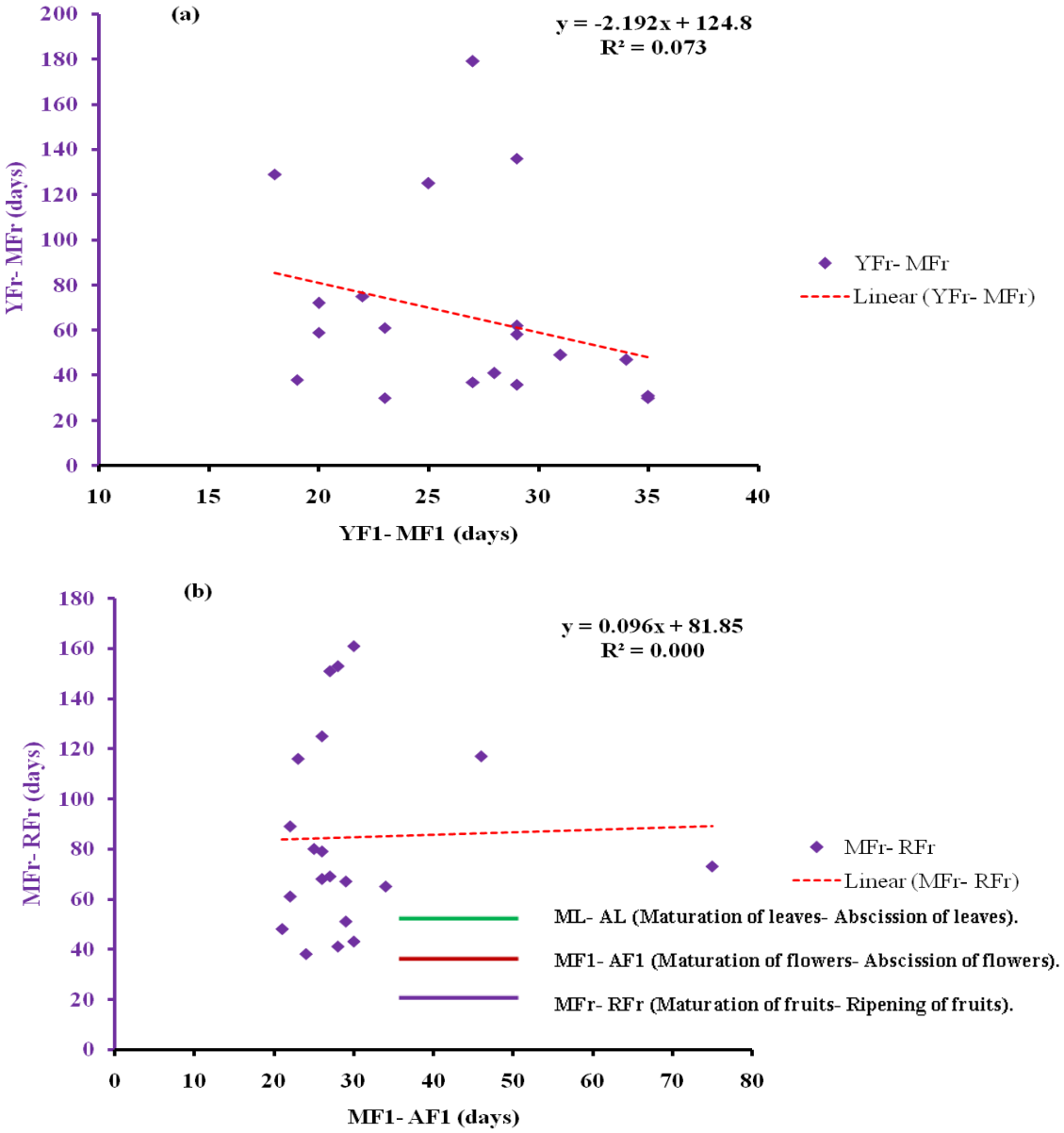

Figure-3:(a&b): Scatter plot of different interphenophases of dominant tree species.

RESULT AND DISCUSSION

Soil Characteristics: The nature of soil profile, soil pH, the nutrient cycling between the soil and trees are the important dimensions in determining the site quality. Soil analysis was done to observed that pH of the soil ranged from 7.16 on horizon B of site-2 to 8.41 on Horizon B of site-3, which indicated that soil was alkaline in nature. The soil is coarse in texture (i.e. sand predominating). The moisture percentage of soil has been found to be higher for site-1; it varies from 71.16% (horizon A of site-3) to 96.58% (horizon B of site-1). The availability of nutrient content was not enough due to low decomposition rate of organic matter and secondly the removal of litter by the villagers for their daily local needs. The range of organic carbon ranged from 0.38 (horizon C of site-3) to 1.20 (horizon A of site-2) (Table-2.2).

Quantitative Analysis of Tree Vegetation: The present study is based on the quantitative information of tree layer of forest in reference to density, frequency, basal area, Importance Value Index (IVI) and certain soil characteristics. Only the species with IVI over 10 were selected as dominant tree species in each site. A sum of twenty nine (29) tree species was reported in the study sites. On the basis of quantitative analysis, 20 dominant tree species were selected for phenological observations. Two species (*Acacia nilotica* and *Tectona grandis*) were present in each study sites. *Acacia nilotica* with highest value of IVI (56.73) showed its dominance in site-1 followed by *Acacia farnesiana* (46.01) and *Prosopis juliflora* (44.13). In site-2 *Acacia nilotica* was the

dominant species with highest value of density (2.10), total basal area (546.21) and IVI (37.84). Study site-3 was dominated by *Acacia catechu* (IVI= 28.69) followed by co- dominant species *Butea monosperma* (IVI= 23.69) and *Ailanthus excelsa* (IVI= 23.23) (Tables 2.1).

Although leaflessness or leaf shading nature (deciduousness) in trees is ill defined, the precise quantification of leaflessness has been least attempted and no convenient categorisation is available (Kushwaha and Singh, 2005). Currently the terminology used to describe phenological functional types lacks uniformity. In most phenological studies, terminology varies with the investigator and the climatic conditions of the habitat studied (Singh and Kushwaha, 2005.

In present study, on the basis of leaf shading nature we categorized 16 tree species namely *Acacia nilotica, Acacia farnesiana, Acacia catechu, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia variegata, Cassia fistula, Dalbergia sissoo, Diospyros cordifolia, Prosopis juliflora, Pithecelobium dulce, Tectona grandis, Heterophragma adenophyllum and Zizyphus xylopyra* as deciduous species, three tree species namely *Eucalyptus globulus, Pongamia pinnata, Phoenix sylvestris* as evergreen and one namely *Bauhinia purpurea* as semi- evergreen species(Table-2.3).

Reproductive Phenology: We have selected and observed 20 dominant tree species in 3 different sites of Hastinapur, Meerut during the study. All the tree individual of each selected species showed high variability in production of flowers and fruits in terms of quantity and frequency.. From the correlation analysis we found that there was a positive correlation between the interphenophase duration of production of young fruits (YFr) - maturation of fruits (MFr) and production of young flowers (YF1) - maturation of flowers (MF1) but no correlation was found between the interphenophase duration of maturation of fruits (MFr)- ripening of fruits (RFr) and maturation of flowers (MF1) - abscission of flowers (AF1)(Figure-2.3).

Flowering Activity: Flowering continued in different selected dominant tree species throughout the year. However , two peak period of flowering were distinguished; the first peak in the month of March and April when *Acacia nilotica, Acacia farnesiana, Acacia catechu, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia veriegata, Cassia fistula, Dalbergia sissoo, Diospyros cordifolia, Prosopis juliflora, Pithecelobium dulce* and *Zizyphus xylopyra* exhibited initiation in response to increasing length of photoperiod. The second peak of flowering was observed in November when *Acacia farnesiana, Albizia lebbeck, Bauhinia purpurea* and *Heterophragma adenophyllum* produced flower. *Acacia nilotica* and *Acacia farnesiana* and *Albizia lebbeck* showed two peaks in flowering. They showed first in April but *Acacia farnesiana* and *Albizia lebbeck* showed second peak in November while *Acacia nilotica* in September.

The duration of flower maturation and abscission varied in different selected species. The duration of flower maturation varied from 18 days (*Phoenix sylvestris*) to 35 days (*Ailanthus excelsa* and *Heterophragma adenophyllum*). The period between maturation and abscission of flower ranged from 21 days (*Dalbergia sissoo*) to 75 days (*Heterophragma adenophyllum*).

Fruiting Activity: In the present study of Hastinapur forest sites, most tree species (*Acacia nilotica, Acacia farnesiana, Acacia catechu, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia veriegata, Dalbergia sissoo, Diospyros cordifolia, Eucalyptus globulus, Prosopis juliflora, Pongamia pinnata, Pithecelobium dulce*) peak fruit ripening activity in monsoon period. But in some species (*Cassia fistula, Phoenix sylvestris, Tectona grandis, Heterophragma adenophyllum* and *Zizyphus xylopyra*) fruit ripening begins in post monsoon period and continues up to the end of cool and dry winter period, that may be due to the difference in fruit maturation activity of different species as reported for sub- tropical forests in North- Eastern India (Kikim and Yadav, 2001).

Fruit maturation and abscission period varied in different selected tree species. In the case of fruit, the duration of maturation varied from 30 days (*Ailanthus excelsa and Butea monosperma)* to 179 days *(Albizia lebbeck).* The period between maturation and abscission of fruits ranged from 41 days (*Eucalyptus globulus*) to 161 days (*Acacia catechu*). During the study it is observed that the fruiting phenology follows closely the flowering phenology most of the tree species. Interphenophase duration between different phenological events varied for different species. (Table-2.3).

Trees are highly variable among the individual in the quantity of flowers and fruits produced, and even the frequency of reproduction (Bullock, 1982; Sarukhan *et al*., 1984). Vegetative and reproductive developments are strongly interrelated in all plants, but in trees these relationships are considerably more complex than in herbaceous plants because of the structural complexity of the shoot system. In contrast to herbaceous plants, flower development in many trees is not continuous from flower induction to anthesis, but may become temporarily arrested at some intermediate stage. Final development of flower buds and anthesis will occur many months after flower initiation. This functionally important distinction has not been adequately considered in many discussions of flowering in tree (Borchert, 1983).At present, available evidence suggests that carbohydrate levels as well as the balance between plant growth regulators in vegetative buds are

involved in the control of flower induction (Zeevaart, 1976). The combination of all biotic and abiotic factors establishing conditions favorable for flower initiation and development varies with the species-specific position of the inflorescence within a tree's branch system and with the seasonal pattern of vegetative and reproductive growth. Like all other aspects of tree development, the phenology of flowering is determined partly by genetic, partly by environmental factor (Borchert, 1983)

Various physiologically active sites or sinks (e.g. leaf buds and leaves, flower buds and flowers, and fruit) may compete for water, nutrients and metabolites (Lieberman, 1982), and such internal competition may lead to the partitioning in time of plant functions like leafing and flowering. It is suggested that flowering time and time lag between the onset of leafing and flowering affect the degree of separation of resource use for vegetative and reproductive events within trees. Variation in flowering time in different species may be related to resource-use rate during vegetative growth (which depends on the duration of deciduousness) and the time required for fruit development (Singh and Kushwaha, 2006).In dry tropics water stress has frequently been cited as a primary trigger for leaf shading, but very little is known about its effect on reproductive phenology (Diaz and Granadillo, 2005). Tropical dry region trees exhibit considerable diversity in seasonal water relation (Borchert *et al*., 2005). Interaction between water availability, tree structure and ecophysiological characteristics leads to varying phenological patterns. Phenology patterns are most diverse and least understood. Studies from different parts of world have shown that climatic factors are mainly responsible for vegetative and reproductive phenology at both community and species level. Phenology of the tropical forest tree species is not well understood, although water stress is most frequently cited as a primary factor responsible for the timing of phenological events. However, various phenological events are triggered by rainfall, water availability, temperature, photoperiod, duration of dry spell and change in day length. It is often difficult to identify the direct trigger from simple observation, because many meteorological factors, such as temperature, rainfall, humidity, and solar radiation, are closely related, and never change independently. Flowering and fruiting also depends on the internal conditions of trees. Therefore, the same climatic conditions do not always bring about the same tree responses. An experimental approach is needed to evaluate the possible triggers of phenophases events. The present study revealed that the vegetative and reproductive phenologies of the selected dominant tree species are the results of interaction of biotic and abiotic environment and gives an idea about the time span of different phenophases in the dominant tree species of Hastinapur region.

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REPORT

CLEOME VISCOSA – BOON OR BANE

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Abstracts: Advent of modern agriculture system, growing energy demands, area development projects, increasing population and many more related activities has led to rapid decline in many plant resources and ultimately erosion of biodiversity from its unique ecosystem. Thus, the biodiversity conservation bodies and legal strategies framed by them are making every effort to conserve plants for the very survival and existence of life on the earth. Tremendous awareness in the field of biodiversity conservation has unravelled the untapped potential of certain unpopular plants like weeds. These undesired plants, if utilized carefully and judiciously, can prove fruitful in decelerating the pressure on the precious plant resources which we are losing due to increasing demands for their products.

Keywords: Agriculture, *Cleome viscosa*, Cleomaceae

INTRODUCTION

The aim of present paper is to provide insights and stimulate a discussion on one of the unrecognized weed species. Belonging to family Cleomaceae, *Cleome viscosa* L. is widely distributed throughout the tropical and sub-tropical regions of the world including India (Bremer *et al*., 2009). It is entitled with the status of a weed due to its luxuriant growth in different sites of diverse nature such as woodlands, fallow lands, roadsides, disturbed sites and agricultural land areas. This is on account of its quick blooming nature coupled with high fruit and seed sets (Anonymous, 1950). By virtue of this property, the species has become a major agricultural problem in crop fields of maize, brinjal, soyabeans, green and black grams (Singh *et al*., 1991; Reddy *et al*., 2000; Reddy *et al.*, 2007; Olorunmaiye and Olorunmaiye, 2008; Murugan and Kathiresan., 2010) and is also creating nuisance along residential areas.

Notwithstanding this, the advantages of this species overweigh the disadvantages. Some of these are enumerated below

1. The species has high reproductive potential in terms of fruits and seeds that are set during the short tenure of its annual life cycle. This feature ensures survival and boosts which helps in easy proliferation and invasion of the species to newer sites. This strategy can be exploited in greening and restoration of disturbed areas without putting much effort. The persistent seed bank further helps in replenishment of this plant for many years (Saroop, 2011; Saroop and Kaul, 2011). They also provide excellent material for control of soil erosion.

2. The blooming period appeals wide variety of pollinator fauna (bees belonging to family Apidae, Halictidae, Lepidoptera and Diptera) and insect (species of Lygaus, Eusarcocoris and Thysanuras) which actively feed on the flowers for pollen as their food or for completing their life cycle or part of it (per. Obs.). Plant pollinator interaction of this type can play important role in maintaining and conserving pollinator community. The sister species, *C. lutea* and *C. serrulata* are visited by a diverse array of pollinator fauna including bees, butterflies and wasps during the blooming period. Dense populations of both the species have been raised which proved fruitful in sustaining the native pollinator populations (Cane, 2008).

3. As an Ayurvedic medicine, the species is known to possess antihelminthic, analgesic, antipyretic, anti-diarrhoeal, anticonvulsant, hepatoprotective, insecticidal, allelopathic, nematicidal and antimicrobial properties (Chatterjee and Pakrashi, 1991; Devi *et al*., 2002, 2003 a,b; Mishra *et al*., 2010; Sengottuvelu *et al*., 2007; Gupta and Dixit, 2009; Williams *et al*., 2003; Jyothi and Rao, 2010; Jana and Biswas, 2011. These innumerable phytochemical benefits are conferred by the wide variety of chemical compounds which the species harbours in its different parts. Bioactive compounds like glucosinolates, glucocappin and glucocleomin (Gupta and Dixit, 2009), kaempferide 3-glucuronide are found in roots (Chauhan *et al*., 1979), while coumarinolignoids, cleomiscosins A, B and C (Bawankule *et al*., 2008), lactam nonanoic acid (Jana and Biswas, 2011), and amino acids in seeds (Lavate *et al*., 2010) of these plants. The extraction of these phytochemicals on a wider scale can boost the pharmaceutical sector. This will also reduce the pressure on the medicinal plants which are facing severe threats to their survival.

Commercial exploitation of bio-active compounds can also be utilized to regulate plant growth, insect and weed control.

4. Nanotechnology and bio-diesel production are the recent additions to the crown of this plant species.

The seed oil (26%) is rich in linoleic, unsaturated and free fatty acids and. The fatty acid profile of the oil is 10.6% palmitic, 4.9 %, stearic, 14.4% oleic and 68.6% linoleic (Anonymous, 1950). Along with physio-chemical characteristics similar to that of non-edible biodiesel crops like *Jatropha* and *Pongamia* makes this plant a potent source of biodiesel production (Kumari, 2012).

The leaf extract of this species is used for green synthesis of silver phytonanoparticles which is

ecofriendly and cost effective than chemically commercialized method.

5. Seeds are used as a substitute for cumin (*Cuminum cyminum*) and used in pickles. Oil extracted from the seeds is used for cooking vegetables, curries and pulses (Manandhar, 2002). Defatted seeds serve as sources of fodder and for production of biogas. Increasing consumption of its seeds has led to the commercialization of this species in Garhwal Himalaya providing economic benefits to the local farmers (Maikhuri *et al*., 2000). Fresh leaves of *Cleome viscosa* contain: water 80.4 g, protein 5.6g, calcium 880mg, P 73mg, Fe 24 mg, ascorbic acid 204 mg per 100 gm (Anonymous, 1950) and are used as vegetable.

In the light of above, should we still consider *C. viscosa* as a weed or an unrecognised super plant.

The positive entities of this plant species put together are likely to yield huge benefits in the biodiversity conservation, sustainable development, human welfare and economic growth.

Therefore, there is an immediate need to bring this plant species under mass cultivation in a controlled manner for harnessing its full potential in various agro and socio-economic sectors.

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SHORT COMMUNICATION

CONSTRAINS IN PRODUCTION AND MARKETING OF MAIZE IN KOREA DISTRICT OF CHHATTISGARH

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Abstracts: Agriculture forms the backbone of the Indian economy and despite concerted industrialization in the last five decades; agriculture occupies a pride of place. Maize is one of the most important cereal crops after rice. Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. In India, maize is grown in an area of 7.7 M ha with a production around 15.1 Mt and productivity 2.0 t/ha it ranks next to rice, wheat, sorghum and pearl millet. Though consumed all over the country, it is the staple food in hilly and sub mountain tracts of northern India. Though consumed all over the country, it is the staple food in hilly and sub mountain tracts of northern India. As a fodder and grain crop .it is extensively grown in Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar and Karnataka. Largest area under maize is in Rajasthan (1.0 M ha) followed by Karnataka (0.93 M ha) while the production is highest in Andhra Pradesh (3.05 Mt) followed by Karnataka (2.65 M t).

Keywords: Grain crop, Production, Maize, Korea district

INTRODUCTION

Maize in Chhattisgarh is one of major cereal crop as it contributes 171.2 areas in thousand hectares which have production 246.38 thousand tones and productivity 1439 kg per hectare in the year 2010-2011**.** In Chhattisgarh it is the second important crop after rice it's because of favorable climatic condition of maize in Chhattisgarh. In Chhattisgarh area, production and productivity was continuously increasing. People of this state uses maize in many purposes many people grow maize for commercial purpose some use to grow it for animal feedings and for personal consumption too. Maize in Chhattisgarh is generally grown in basis (area behind the house). It is generally grown in all season but kharif is highly suitable for its cultivation in this state. Maize is emerging crop in Chhattisgarh and the economic aspects of maize production and marketing are not adequately known to narrow down the gap. The present study was undertaken in the maize growing area of Chhattisgarh with following specific objective. To find out the constraints in the production and marketing of maize in study area and suggest suitable measures to overcome them.

MATERIAL AND METHOD

The present study was conducted in Korea district of Chhattisgarh. Sixty farmers were selected randomly from three villages namely Paradol, Banji, and Bundeli. The primary data were collected from randomly selected maize growers of three maize growing villages of Manendragarh block for the year 2010-11.

RESULT AND DISCUSSION

The constraints narrated by the respondents selected practices are presented in table I. Major constraints pertaining to cultivation of maize were lack of irrigation facilities (96.33 per cent) followed by lack of HYV seed (91.66 per cent) and Lack of technical knowledge (88.33 per cent). Other constraints are Lack of resources (83.33 per cent), lack of financing (80.00 per cent) and Lack of recommended package practices of crop (75.00 per cent).

Table I.: Farmer Perception on Constraints in Maize Cultivation.

S.NO.	Particulars	No. of : Farmers	percent
1.	Lack of technical knowledge	53	88.33
2.	Lack of irrigation facilities	58	96.66
3.	Lack of resources	50	83.33
4.	Lack of HYV seed	55	91.66
5.	Lack of financing	48	80.00
6.	Lack of recommended package practices of crop	45	75.00

Table II. Shows that the constraints in the marketing of Maize were lack of storage facilities (91.66 per cent) followed by lack of transportation (88.33 per cent) and small marketable surplus (83.33. per cent) and Lack of market intelligence (66.66 per cent).

Table II: Farmer Perception on Constraints In Marketing Of Maize Crops.

S. No.	Particulars	No. of : Farmers	Percent
1.	Small marketable surplus	50	83.33
2.	Lack of transportation	52	88.33
3.	Lack of regulated and cooperative market	49	81.66
4.	Lack of storage facilities	55	91.66
5.	Lack of market intelligence	40	66.66
6.	Lack of producers share in consumers rupees	48	80.00

CONCLUSION AND POLICY IMPLICATION

The major constraints pertaining to cultivation of maize crop were lack of irrigation (96.33 per cent) followed by lack of HYV seed (91.66 per cent) and Lack of technical knowledge (88.33 per cent). Other constraints are Lack of resources (83.33 per cent), lack of financing (80.00 per cent) and Lack of recommended package practices of crop (75.00 per cent).Constraints in the marketing of maize crop were lack of storage facilities (91.66 per cent) followed by lack of transportation (88.33 per cent) and small marketable surplus (83.33. per cent) and Lack of market intelligence (66.66 per cent).Establishment of farmers' cooperative societies and sale society will not only solve money problem of small and medium farmers but also reduce the role of commission agent which would result in high producer share in consumer rupees. To improve the production and marketing of maize crops immediate step should be taken to regulate the market in the study area and storage facilities also be provide at sub and main market yards. Suitable extension services regarding new technology of production disposal and extension workers should extend utilization of maize crops to the plant growers without any delay and other agencies involved in the extension, communication in the respective zones. Irrigation facilities are to be developed in the proper way so that farmers can adopt improved technology with assured irrigation facilities. It is essential to adopt the production system approach by linking the production technology, credit and marketing of maize crops.In tribal district, special marketing institution should be setup for those cereals, commodities which are produced in these areas.

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SHORT COMMUNICATION

PHYTOTOXIC EFFECT OF POST EMERGENCE HERBICIDE ON FINGER MILLET

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Abstract: Finger millet (*Eleusine coracana* L.) is an important small millet crop of tribal dominated areas and grown as rain-fed crops. Manual weed management, which is the most prevalent method for weed management in finger millet, requires a lot of labour. Now a day, due to the scarcity of labours, chemical weed management is considered as better option than the hand weeding. However, there is little work on role of post emergence herbicides in finger millet. It is evident that some of the herbicides cause phytotoxicity to the crops and make it until for use (Uludag *et al.* 1997). Thus, it is very important to know behavior and extent of phytotoxicity of different herbicides. Keeping these points in view the present investigation was carried out to evaluate the post-emergence herbicides for phytotoxicity in direct sown finger millet.

Keywords: Phytotoxicity, Fenoxaprop-p-ethyl, Metsulfuron methyl, Chlorimuron ethyl, Ethoxysulfuron, Cyhalofop-butyl

INTRODUCTION

The present investigation was carried out at Research cum Instructional Farm of College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season 2012. The soil of experimental field was Clayey *(Vertisols)*. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, at 25 cm row to row distance and gaps were maintained by thinning to obtain proper plant population. Sowing was performed manually and crop was fertilized with 60:40:40 N: P_2O_5:K_2O kg/ha. Application of herbicide was done at 20 DAS. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The treatments were T_1- Fenoxaprop-p-ethyl (37.5 g/ha), T_2- Fenoxaprop-p-ethyl (45.0 g/ha), T_3- Metsulfuron methyl + Chlorimuron ethyl, T_4- Ethoxysulfuron, T_5 – Cyhalofop-butyl, T_6- Fenoxaprop-p-ethyl (37.5 g/ha) + metsulfuron methyl + chlorimuron ethyl, T_7- Fenoxaprop-p-ethyl (45.0 g/ha) + metsulfuron methyl + chlorimuron ethyl, T_8- Fenoxaprop-p-ethyl (37.5 g/ha) + ethoxysulfuron, T_9- Fenoxaprop-p-ethyl (45.0 g/ha) + ethoxysulfuron, T_{10}- Cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl, T_{11}- Cyhalofop-butyl + ethoxysulfuron, T_{12}- Hand weeding twice and T_{13}- Weedy check. The crop was observed for phytotoxic effect of different herbicides at 7, 14 and 21 days after herbicide application. The number of live plants was counted from marked place in one m^2 net plot area. The
mortality of finger millet was calculated as per following formula:

$$\text{Mortality} \quad \% \quad = \frac{PP_i - PP_a}{PP_i} \times 100$$

PP_i = Plant population before herbicide application
PP_a = Plant population after herbicide application

Phytotoxicity observations were subjected to arc sine transformation before statistical analysis (Gomez and Gomez, 1984).

There was no mortality with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl alone at all the stages of observation. Thus, these two herbicides were completely safe for the crop. Bhowmick *et al*. (2002) also revealed that ethoxysulfuron did not show any phytotoxic effect. Fenoxaprop-p-ethyl at both doses were highly phytotoxic to the crop when applied alone or in combination with metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron and mortalility of crop ranged between 35.88% to 67.79% at 7 days after application. The mortality of the crop was observed up to 21 days after application. At 14 days after application, the extent of mortality ranged between 46.02% to 77.76%. whereas at 21 days after application. The mortality per cent was between 71.75% to 94.38%. Cyhalofop-butyl recorded lesser degree of phytotoxicity compared to fenoxaprop-p-ethyl. The mortality of finger millet ranged between 10.78% to 15.22% at 7 day after application with application of cyhalofop-butyl alone or in combination with metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron. The mortality of plants were increased up to 21 days after application the mortality ranged between 18.97% to 20.15% at 14 days after application and 36.96% to 46.14% at 21 days after application.

METHODOLOGY

The experiment comprised single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on *Vertisols* at Research cum Instructional farm of College of Agriculture, Raipur during *kharif* season of 2012. Application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron alone was found most suitable for weed control. Application of metsulfuron methyl + chlorimuron and ethoxysulfuron ethyl alone did not exhibit any

phytotoxicity however application of fenoxaprop-p-ethyl recorded highest degree of phytotoxicity. The mortality of crop with application of herbicides was recorded up to 21 days after application. The highest mortality of finger millet was recorded between 71.75% to 94.38% at 21 days after application of fenoxaprop-p-ethyl alone or in combination with metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron. Cyhalofop-butyl exhibited lesser degree of phytotoxicity and the mortality was ranged between 36.96% to 49.14% at 21 days after application.

Table : Phytotoxicity in finger millet by application of different herbicide

Treatment	**Dose (g/ha)**	**Plant population /m^2 before spraying**	**Mortality of plant %**		
			07 DAA	**14 DAA**	**21 DAA**
T_1 : Fenox	37.5	78	40.45 (42.33)	47.18 (53.57)	63.49 (79.42)
T_2 : Fenox	45.0	80	45.95 (51.60)	53.27 (64.11)	67.54 (84.79)
T_3 : MSM+CME	2.0+2.0	79	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_4 : Ethox	15.0	78	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_5 : Cyhalo	62.5	81	22.95 (15.22)	26.75 (20.15)	44.44 (49.14)
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	81	36.65 (35.88)	47.75 (55.18)	66.12 (83.81)
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	82	38.89 (39.20)	42.61 (46.02)	58.56 (71.75)
T_8 : Fenox+Ethox	37.5+15.0	80	48.70 (56.83)	60.05 (74.06)	73.56 (91.15)
T_9 : Fenox+Ethox	45.0+15.0	82	55.30 (67.79)	62.11 (77.76)	76.82 (94.38)
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	80	19.48 (11.15)	24.89 (18.97)	37.16 (36.96)
T_{11} : Cyhalo+Ethox	62.5+15.0	79	19.07 (10.78)	27.62 (21.58)	41.15 (42.86)
T_{12} : Weed free (HW at 20 and 40 DAS)		78	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_{13}: Weedy check		80	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SEm ±		**10.71**	**1.98**	**2.62**	**2.58**
CD at 5 %		**NS**	**5.79**	**7.65**	**7.55**

The observations are arc sine transformed. Figures in parentheses indicate the original value. Fenox = Fenoxaprop-p-ethyl, MSM = Metsulfuron methyl, CME = Chlorimuron ethyl, Ethox = Ethoxysulfuron, Cyhalo = Cyhalofop–butyl, HW = Hand weeding

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SHORT COMMUNICATION

COMPARATIVE ASSESSMENT OF BIOSORPTION OF MALACHITE GREEN DYE FROM ITS AQUEOUS SOLUTION BY LIVING AND DEAD HYPHOMYCETOUS FUNGI

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Abstract: The dead biomass of *Aspergillus nidulans* Eidan and *Humicola grisea* Traaen was found to be quite effective in adsorbing the dye malachite green from its aqueous solutions. In most of the case, the dead (autoclaved) biomass proved to be more effective then the living biomass. Changes in surface properties, modification of binding sites and increase in surface area due to autoclaving may be the possible reasons for increase efficiency of dead biomass.

Keyword: Dye pollution, Biosorption, Malachite green, Dead fungal biomass

INTRODUCTION

The industrial wastes including the effluents from dye, paper and pulp industries as also distilleries are the major contributors to water pollution. Approximately 700,000 tones and 10,000 different types of dyes and pigments are produced annually across the world, and are extensively used in many industries including textile, leather, pulp, pharmaceuticals, cosmetic, tannery, paper, food and plastics– the textile industries ranking first in the usage of dyes (Azhar *et al.,* 2005; Jain *et al.,* 2003; Sadettin and Donmez, 2006; Kiran *et al.,* 2009; Aksakal and Ucun, 2010). The production of dyes in India alone is estimated to be around 60,000 tons (Banate *et al.,* 1996). The coloured effluents containing dyes are toxic, mutagenic, carcinogenic as well as allergenic (Bakshi *et al.,* 1999; O'Mahony *et al.,* 2002; Aksu and Cagatay, 2006; Kumar *et al.,* 2006). The removal of colour from waste effluents becomes environmentally important because even a small quantity of dye in water can be toxic and is highly visible (Chou *et al*., 2001).

In view of the various shortcomings of convential dye removal technologies, environment–friendly alternatives for the removal of dyes by fungi through three principal mechanisms: biosorption, bioaccumulation and biodegradation have attracted the attention of scientists (Kaushik and Malik, 2009). The biological materials mainly yeast and fungi, are major candidates for the development of such devices which may be called biotraps (Crusberg, 2004).

Malachite Green (C_{52} H_{54} N_4 O_{12}), a basic cationic triarylmethane dye, has been widely used not only for the dyeing of cotton, silk, paper, leather wool and jute but also in the manufacture of paints and printing inks (Gupta *et al.,* 2004). Mouthri and Singra Charya (2009) reported that malachite green exhibited toxic effects on the growth of *Polyporous elegans, Trametes versicolor, Lenzites betulina* and *Mucor mucedo*. Khataee *et al.* (2010) investigated decolourisation of malachite green by *Chlorella, Cosmarium* and *Euglena* sps. and found that all of these species possess high decolourization efficiency.

The fungi may be classified into two categories according to their life state: (i) living cells that biodegrade and biosorb dyes; and (ii) dead cells (fungal biomass) which adsorb dye (Fu and Virraghavan, 2001). The use of dead biomass is preferred against the living by many workers since (a) dead organisms are not subject to toxicity limitations; (b) these do not require continous supply of nutrients; and (c) these can be regenerated simply and may be reused for many cycles (Akar and Tunali,2005; Padmes *et a*l.2005; Kumar, 2012 and Kumar and Charaya, 2013). The present study was carried out to assess the efficiency of living and dead biomass of *Aspergillus nidulans* and *Humicola grisea* to adsorb malachite green from its aqueous solution of different concentrations.

MATERIAL AND METHOD

One strain each of *Aspergillus nidulans* and *Humicola grisea*, isolated from soils from the dye-polluted sites (at Partapur Industrial Area, Meerut, were used in the present study. The fungal cultures were maintained on Potato Dextrose Agar (PDA) plates. The spore suspension of *Aspergillus nidulans* and *Humicola grisea* were separatly inoculated in MGYP (Malt Glucose Yeast Peptone) broth medium and were allowed to incubate for 15-20 days at 30^0C. After sufficient growth of the fungus had developed, the biomass was separated from the broth medium and the wet biomass washed thrice with tap water. One half of the washed biomass was used as living biomass while the other half of the biomass was autoclaved at 15 psi for 20 minutes to obtain dead biomass. Thirty six packets each containing 10 mg biomass of *Aspergillus nidulans* (9 of living; 9 of dead biomass) and *Humicola grisea* (9 of living; 9 of dead biomass) were prepared and used for biosorption experiments. Malachite green was used to assess the ability of the fungal biomass to adsorb dyes. Stock solution of malachite green was prepared in a manner so as to obtain different concentrations

(*i.e*. 100ppm, 200ppm and 300ppm) of malachite green in respective solution.

100 ml of 100 ppm malachite green solution were taken in each of a set of nine 250 ml flasks (Set A). Similarly, two sets of nine flasks each were prepared for (i) 200 ppm dye solution (Set B) and (ii) 300 ppm dye solution (Set C). To three flasks of set A were added 10 mg of living *A. nidulans* biomass (subset A1); to three flasks were added 10 mg of dead *A. nidulans* biomass (subset A2); while three flasks were kept as control (subset A3). The flasks of sets B and C were also treated similarly, thus yielding subsets B1, B2, B3 and C1, C2, C3. The flasks were shaken simultaneously on an orbital shaker at 150 rpm for about 10 minutes. After 10 minutes of continuous shaking, the solution of each flask was filtered through a plastic sieve to remove the fungal biomass and unadsorbed dye in supernatant was estimated using a *uv-vis* spectrophotometer (Model SL- 159) at 620 nm wave length. Similar procedure was repeated for *Humicola grisea*. The adsorption capacity and Q-values were calculated using the formula: Q = V (Ci- Cf)/ m where, Q = specific dye uptake (mg/g) of biomass, Ci and Cf are the initial and final dye concentrations (mg/ l), m = adsorbent dosage (g); and V is the volume of dye solution.

RESULT AND DISCUSSION

Both the fungal strains under test *i.e. Aspergillus nidulans* and *Humicola grisea* were found to be quite efficient at malachite green adsorption from the solutions of different concentrations of malachite green dye the percentage dye adsorption ranging from 83.07% to 94.83% (Tables 1.1, 1.2). Dead fungal biomass showed greater biosorption of malachite green dye, where the biosorption was 94.83%, 91.73% and 92.50% for 100, 200 and 300 ppm in case of *Aspergillus nidulans*; and 90.34%, 91.03% and 90.57% for 100, 200 and 300 ppm in case of *Humicola grisea*. Maximum biosorption upto 91.29% and 94.83% for *Aspergillus nidulans*; and 91.31% and 91.03% for *Humicola grisea* were recorded using living and dead biomass, respectively. The minimum dye removal by living biomass of *Aspergillus nidulans* (86.21% with 200 ppm dye conc.) and *Humicola grisea* (83.07% with 300 ppm conc.) were obtained.

In a present study, it is found that the performance of dead biomass was almost always more than dead by living biomass. A number of workers including Akar and Tunali (2005), Padmesh *et al.* (2005), Kumar and Charaya (2012) have suggested that living biomass may be subjected to toxic effects of dyes (and other pollutants) at elevated concentrations; therefore, nonviable or dead biomass may be preferred to overcome this disadvantage. A number of workers in the past have also found to dead biomass to be more dependable and efficient for biosorption (Abedin, 2008; Nanthakumar, 2009; Kumar, 2011).

Fu and Viraraghavan (2001) believed that the better performance of dead biomass in contrast to living biomass is due to greater adsorption strength, change in surface property and increase in surface area due to cell rupture after death. Baranaglu and Arica (2007) proposed that heat treatment can modify surface binding sites *via* denaturation of proteins on the cell wall structures.

From the result of the present study, it may be safely concluded that dead biomass of *A.nidulans* and *H. grisea* may serve as efficient components of biosorption-based effluent treatment system for the removal of malachite green.

Table 1.1 Biosorption of malachite green by living and dead biomass of *Aspergillus nidulans* from aqueous solution of the dye.

Initial concentration of malachite green in the solution	Type of biomass	Dye remaining in the solution	Dye adsorbed by *Aspergillus nidulans*	% Biosorption	Q- Value
100	**L**	8.71	91.29	91.29	912.9
	D	5.17	94.83	94.83	948.3
200	**L**	27.76	172.24	86.12	1722.4
	D	16.33	183.47	91.73	1834.7
300	**L**	33.08	266.92	88.97	2669.2
	D	22.5	277.5	92.5	2775

Table 1.2 Biosorption of malachite green by living and dead biomass of *Humicola grisea* from aqueous solution of the dye.

Initial concentration of malachite green in the solution	Type of biomass	Dye remaining in the solution	Dye adsorbed by *Humicola grisea*	% Biosorption	Q- Value
100	**L**	8.69	91.31	91.31	913.1
	D	9.66	90.34	90.34	903.4

200	**L**	28.69	171.31	85.65	1713.1
	D	17.94	182.06	91.03	1820.6
300	**L**	50.77	249.23	83.07	2492.3
	D	28.29	271.71	90.57	2717.1

L= Living fungal biomass; D= Dead fungal biomass

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SHORT COMMUNICATION

PADDY PRODUCTION ECONOMICS IN MAHASAMUND DISTRICT OF CHHATTISGARH

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Abstract: This study was on the Rice Production Economics in Mahasamund District of Chhattisgarh. Primary data were collected using pre structured survey schedule administrated to 123 paddy producers which consists of 47.97 percent marginal, 26.02 percent small , 13.01 per cent medium and 13.01 percent 13.01 large farmers using Three stages stratified random sampling technique. Tabular analysis was used to calculate cost and returns in paddy cultivation in district. Study come up with findings that cost of cultivation increases as farm size increases. Labour cost was the main component of operational cost covering 35.85 percent of total operational cost for all farm sizes. While Rental value of owned land and rent paid for leased in land was the dominating cost item in fixed cost items covering 40.62 percent of the total fixed cost. Net income, Family labour income, Farm business income, Farm investment income were maximum in case of small farm size *i.e.* Rs. 21703.20, Rs.31259.92, Rs. 44359.85 and Rs. 37775.57 respectively. Calculated net return per rupee of investment was also higher (1:1.66) in small size farm while it was 1:1.55 for all farm size.

Keywords: Paddy, Production, Cost of cultivation, Economic analysis, Farm Size, Input- Output ratio, Farm income

INTRODUCTION

Paddy is the major staple, which can provide a nation's population with the nationally required food security minimum of 2,400 calories per person per day (FAO, 2000). It is grown as principal crop under rainfed condition during Kharif in whole Chhattisgarh. Chhattisgarh popularly known as "rice bowl of India" occupies an area around 3.60 m ha with the production of 6.16 mt of paddy (Urkurkar et.al. 2007 and Krishi Karman Award 2010-11). Average productivity of paddy in state is still lower than the national productivity with wide variation in the productivity among different districts (Diwakar 2009 and Pandey et.al. 2010). Rice cultivation is major agricultural activity of the farming community of Mahasamund district sharing 5.61 and 7.82 per cent of total area and production of the rice grown in the state respectively. More than 80 percent of working population of the district is engaged in agriculture. The productivity of rice in the district is 1.97 tons per hectare. Keeping the economic importance of paddy in district's economy present study was conducted with primarily objectives of calculation of cost of cultivation and analysis of profitability in paddy production in Mahasamund district.

METHODOLOGY

Three stages stratified random sampling technique was adopted for conducting the present enquiry. y At first stage, out of the total 5 developmental blocks in this district, Mahasamund block was selected randomly. At second stage, 8 villages were selected randomly from selected block. At third stage, list of all the farmers were prepared from the selected villages with their net cultivated area. Thereafter farmers/paddy growers were classified into four farm size group, viz. Marginal (Less than 1 ha), Small (1 to 2 ha), Medium (2 to 4 ha) and large (Above 4 ha). Then a sample of 59 marginal, 32 small, 16 medium, 16 large size paddy growers (10 percent of total population size) were selected randomly from the universe of 08 selected villages making the sample size of 123 paddy growers.

The primary data pertaining to crop year 2010-11 were collected from the selected farmers/ paddy growers with the help of a pre structured schedule by personal interview method.

Analytical Frame work

Economics in paddy production was calculated by subtracting the Total Cost (TC) from Total Revenue (TR). The cost concepts approach to farm costing is widely used in India (Raju and Rao, 1990., Nirmala and Mathuraman, 2009). These cost concepts include Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2 and Cost C3. Various costs have been worked out by applying following methods :

Cost A1 = All actual expenses in cash and kind incurred in production

Cost A2 = Cost A1+ Rent paid for leased in land

Cost B1 = Cost A1+ Interest on value of owned capital assets

Cost B2 = Cost B1+ Rental value of owned land and rent paid for leased in land

Cost C1 = Cost B1+ Imputed value of family labour

Cost C2 = Cost B2+ Imputed value of family labour

Cost C3 = Cost C2+10% of Cost C2 on account of managerial functions performed by the farmer

Total Revenue was calculated by total quantities of Paddy were multiplied by its price. Similarly for estimation of profitability in paddy production various income measures *viz*. Gross income, Net income, Family labour income, Farm business income, Farm investment income, Input : Output ratio were worked out.

RESULTS AND DISCUSSION

Cost of Cultivation of Paddy

Table 1. shows the cost of cultivation per hectare for various farm sizes and table 2 exhibited various Cost concept in paddy production. These were increasing with increasing size of farms, witnessing a positive correlation of cost of cultivation with the size of farms. Cost of fertilizer was costliest item in each category of farm size. It was also observed that hierd labour cost was increasing with increasing farm size while family labour cost was increasing only upto medium farm size but it was decline in case of large farm size showing less interest to work at outside of home as their status doesn't allow them to work at farm. Share of family bullock/ machinery cost was increasing while share of hierd bullock/machinery cost was decreasing indicating farmers maintained their own farm implements as farm size increases.

Table 1: Cost of cultivation of paddy by various size of farms: (Rs./ha)

S. No.	Input factor	Marginal (< 1 ha)		Small (1-2 ha)		Medium (2-4 ha)		Large (>4 ha)		Overall	
A.	**Operational Cost**										
I	Material Cost										
A	Seed	785.00 (2.76)		880.00 (2.96)		1000.00 (3.11)		1087.50 (3.30)		938.13 (3.05)	
B	Manure	540.00 (1.90)		550.00 (1.85)		560.00 (1.74)		600.00 (1.82)		562.50 (1.83)	
C	Fertilizer										
	Urea	1070.85 (3.78)		1215.63 (4.09)		1455.56 (4.54)		1160.00 (3.52)		1225.51 (3.98)	
	Phasphorus	850.00 (3.0)		1005.00 (3.38)		1161.11 (3.62)		937.50 (2.85)		988.40 (3.21)	
	Potash	433.33 (1.52)		418.75 (1.41)		480.55 (1.50)		322.50 (0.98)		413.78 (1.34)	
	Total of fertilizer cost	2354.18 (8.30)		2639.38 (8.88)		3097.22 (9.65)		2420.00 (7.35)		2627.69 (8.54)	
D	Plant Protection Chemical	1091.65 (3.85)		1168.75 (3.93)		1238.89 (3.86)		1300.00 (3.95)		1199.82 (3.90)	
E	Interest on working capital	639.67 (2.25)		728.27 (2.45)		901.07 (2.81)		1055.52 (3.20)		831.13 (2.70)	
	Sub Total	5410.50 (19.08)		5966.40 (20.07)		6797.18 (21.19)		6463.02 (19.63)		6159.28 (20.02)	
II	Labour Cost	Family Labour	Hired Labour	Family Labour	Hired Labour	Family Labour	Hired Labour	Family Labour	Hired Labour	Family Labour	Hired Labour
	Field Preparation	700.25 (2.47)	300.75 (1.06)	695.25 (2.34)	325.75 (1.09)	650.00 (2.02)	385.35 (1.20))	622.50 (1.90)	525.37 (1.59)	667.00 (2.16)	384.31 (1.25)
	Manure/Fertilizer Application	412.00 (0.14)	0 (0.00)	380.00 (1.28)	100 (0.33)	311.11 (0.97)	200.00 (0.62)	302.00 (0.92)	250.00 (0.76)	351.28 (1.14)	137.50 (0.44)
	Sowing/Transplanting	1220.83 (4.30)	450.00 (1.59)	1035.12 (3.48)	525 (1.76)	1007.50 (3.15)	650.00 (2.02)	950.00 (2.89)	835.00 (2.53)	1053.36 (3.42)	615.00 (1.99)
	Intercultural Operation	1062.50 (3.75)	600.00 (2.11)	1087.50 (3.66)	625 (2.10)	1000.00 (3.11)	785.00 (2.48)	965.00 (2.93)	875.00 (2.66)	1028.75 (3.34)	721.25 (2.34)
	Irrigation	708.33 (2.50)	0 (0.00)	812.00 (2.73)	0 (0.00)	745.02 (2.32)	225.00 (0.70)	723.25 (2.19)	512.00 (1.67)	747.15 (2.43)	184.25 (0.60)
	Plant Protection	487.50 (1.72)	0 (0.00)	520.37 (1.75)	0 (0.00)	480.00 (1.50)	250.00 (0.78)	350.00 (1.06)	550.00 (1.67)	459.47 (1.49)	200.00 (0.65)
	Harvesting	737.50 (2.60)	600.00 (2.11)	896.87 (3.01)	900 (3.02)	850.67 (3.81)	1100.00 ()3.43)	810.00 (2.46)	1230.00 (3.73)	823.76 (2.67)	957.50 (3.11)
	Threshing	829.17 (2.92)	550.00 (1.94)	812.00 (2.73)	650 (2.19)	798.00 (2.49)	723.00 (2.25)	550.00 (1.67)	900.00 (2.73)	747.29 (2.43)	705.75 (2.30)
	Transportation	200.17 (0.71)	254.00 (0.89)	245.17 (0.82)	254 (0.85)	580.56 (1.81)	354.00 (1.10)	485.00 (1.47)	150.00 (0.456)	377.73 (1.228)	253.00 (0.822)
	Bullock/ Machinary Labour	100.00 (0.35)	530.00 (1.87)	100.00 (0.33)	530.00 (1.78)	350.00 (1.09))	300.00 (0.93)	450.00 (1.36)	150.00 (0.456)	250.00 (0.81)	377.50 (1.22)
	Sub total	**6458.25 (22.78)**	3284.75 (11.58)	**6584.28 (22.15)**	3909.75 (13.15)	**6772.8 (21.11)**	4972.35 (15.50)	**6207.7 (18.86)**	5977.37 (18.16)	**6505.79 (21.14)**	4536.06 (14.74)
	Total of Labour Cost	**9743.00 (34.36)**		10494.03 (35.30)		11745.21 (36.61)		12185.12 (37.01)		11041.84 (35.85)	
Total of Operational Cost		**15153.50 (53.44)**		**16460.43 (55.37)**		**18542.39 (57.8)**		**18648.14 (56.64)**		**17201.12 (55.90)**	
B.	**Fixed Cost**										
1	Land revenue and	14.00		14.00		14.00		14.00		14	

	Taxes	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
2	Depreciation on implements and building	104.17 (0.37)	150.00 (0.50)	275.00 (0.86)	535.00 (1.62)	266.04 (0.86)
3	Interest on fixed capital	584.35 (2.06)	599.93 (2.01)	746.84 (2.33)	1225.00 (3.72)	789.03 (2.56)
4	Rental value of owned land and rent paid for leased in land.	12500 (44.08)	12500.00 (42.05)	12500.00 (38.97)	12500.00 (37.97)	12500 (40.62)
	Total of Fixed Cost	**13202.52 (46.56)**	**13263.93 (44.62)**	**13535.84 (42.20)**	**14274.00 (43.36)**	**13569.07 (44.10)**
	TOTAL (A+B)	**28356.02 (100)**	**29724.36 (100)**	**32078.23 (100)**	**32922.14 (100)**	**30770.19 (100)**

Note: Figures in parentheses indicate percentage to total (A+B).

Table 2: Different cost concepts in paddy cultivation among various categories of farms:

S. No	Particulars	Marginal	Small	Medium	Large	Overall
1	Cost A_1	8813.42	10040.15	12058.53	12989.39	10975.37
2	Cost A_2	8813.42	10040.15	12058.53	12989.39	10975.37
3	Cost B_1	9397.77	10640.08	12805.37	14214.39	11764.40
4	Cost B_2	21897.77	23140.08	25305.37	26714.39	24264.40
5	Cost C_1	15856.02	17224.36	19578.23	20422.14	18270.19
6	Cost C_2	28356.02	29724.36	32078.23	32922.14	30770.19
7.	Cost C_3	31191.62	32696.80	35286.05	36214.35	33847.21

Measures of farm profit by size of farms

The table 3 reveals that per hectare yield was maximum 45 quintals per hectare in case of small farm while yield of by product was maximum i.e. 47 quintals per hectare in small farms. Minimum support price for normal paddy was taken as price of main product. Net income, Family labour income, Farm business income, Farm investment income, were calculated for each category of farms. It was Rs. 18452.79, Rs. 28035.60, Rs. 41324.63 and Rs. 34818.84 respectively at all farm size.

Table 3: Measures of farm profit by size of farms (In Rs./ha)

S. No	Particulars	Marginal		Small		Medium		Large		Overall	
1	**Gross income**	50800		54400		53200		50800		52300	
	a. Main Product (@ Rs.1000/qt)	**Qt.**	**Total Value**	**Qt.**	**Total Value**	**Qt.**	**Total Value**	**Qt.**	**Total Value**	**Qt.**	**Total Value**
		42	42000	45	45000	44	44000	42	42000	43.25	43250
	b. By Product (@ Rs. 200/qt)	44	8800	47	9400	46	9200	44	8800	45.25	9050
2	**Net income (**Net income = Gross income - Cost C_3)	19608.38		21703.20		17913.95		14585.65		18452.79	
3	**Family labour income** (= Gross income – Cost B_2)	28902.23		31259.92		27894.63		24085.61		28035.60	
4	**Farm business income** = Gross income – Cost A_1	41986.58		44359.85		41141.47		37810.61		41324.63	
5	**Farm investment income** = Net income + rental value of own land + interest on fixed capital	35528.33		37775.57		34368.61		31602.86		34818.84	

Net Return per Rupee of Investment

Table 4 gives the per hectare Input : Output ratio on different size of farms. Net return on per rupee investment was maximum on small farms and minimum on large farms.

Table 4: Net Return per Rupee of Investment by Size of Farms

Category	Input (Rs.)	Output (Rs.)	Input-Output ratio
Marginal	31191.62	50800	1:1.63
Small	32696.80	54400	1:1.66

Medium	35286.05	53200	1:1.51
Large	36214.35	50800	1:1.40
Overall	33847.20	52300	1:1.55

CONCLUSION AND POLICY RECOMMENDATION

Labour cost was the main component of operational cost covering 35.85 percent of total operational cost for all farm sizes. While Rental value of owned land and rent paid for leased in land was the dominating cost item in fixed cost items covering 40.62 percent of the total fixed cost. Net income, Family labour income, Farm business income, Farm investment income were maximum in case of small farm size *i.e*. Rs. 21703.20, Rs.31259.92, Rs. 44359.85 and Rs. 37775.57 respectively. Calculated net return per rupee of investment was also higher (1:1.66) in small size farm while it was 1:1.55 for all farm size. Based on the findings and observations it can be suggested that the government should pay attention on the problems of fragmentation and scattered holding by initiating consolidation of holdings and land reforms. The cooperative farming should be encouraged to increase the production and eliminate all forms of exploitation and social injustice in order to provide security to the tillers and to assure equality of status. The findings of the study also reveal that though paddy cultivation in the study area, is economically viable but their profitability may further improved by increasing the capacity utilization.

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SHORT COMMUNICATION

GRAFT AND DODDER TRANSMISSION OF JATROPHA MOSAIC VIRUS DISEASE

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Abstract: The plant of *Jatropha curcas L*. suffer from several diseases, among them Jatropha mosaic virus disease is a newly emerging disease that challenges the productivity of a prospective biofuel crop, *Jatropha curcas*. Jatropha mosaic virus(JMV) disease could not be transmitted either through the vector aphids or through mechanically, but disease could be transmitted by grafting from donor *J. curcas* to healthy *J. curcas* and also from *J. gossypiifolia* to *J. gossypiifolia* but not from *J. curcas* to *J. gosypiifolia* and vice versa and the disease could also be transmitted successfully through dodder. 80% of the dodder transmitted *J.curcas* plant developed distorted symptoms within 15 days after inoculation.

Keywords: JMV, *Jatropha curcas, Jatropha gossypiifolia,*Grafting, Dodder

INTRODUCTION

Jatropha curcas L. is a major commercial biodiesel crop grown on 98 million acres in India. *Jatropha curcas* L. belongs to family Euphorbiaceae and is a drought-resistant bush or small tree Which attain a height of upto eight to ten meters under favourable conditions (Jones and Miller, 1992). *Jatropha curcas* is fast growing plant and can easily be propagated using either seeds or stem cutting. Plants raised from seeds will be more robust, live for longer periods. The propagation of branch cutting is easy and results fast growth of plant and the bush can be expected to start bearing fruit within one year of planting (Kaushick, 2001). Its life span is around 45-50 years (Takeda, 1982). The tree is of significant economic importance for its numerous industrial and mechanical uses. The preparation of all parts of the plant, including seeds, leaves and bark fresh or as a decoction are used in traditional medicine and for the veterinary purposes. The oil extracted from Jatropha seeds is being used as a biofuel for diesel engines thus Jatropha has a great potential to contribute to the renewable energy sources. In India the area under the cultivation of Jatropha is increasing in recent years with the ever increasing demand for fossil fuels that are exhausting at a rapid rate. JMD was first reported on Jatropha plant in Puerto Rico (Bird, 1957). In India JMD was first reported from Karnataka state, South India in (2004) by (Rangaswamy *et al.,* 2005; Aswatha Narayana *et al.,* 2006).Birds (1957) reported that Jatropha mosaic virus disease was transmitted by grafting to weed species such as *J.multifida L.,*
J.podogrica L. and Croton lobatus L. Similarly, graft transmissible nature of mungbean yellow mosaic gemini virus was previously reported by Nariani (1960), Ahmed and Harwood (1973), Chenulu and Verma (1988).The disease also successfully transmitted by dodder to *Jatropha gossypiifolia L.* (Bird, 1957).

MATERIAL AND METHOD

To determine the graft transmission of JMV Infected plants of *Jatropha curcas* maintained in insect proof cage were used as source plants for the study. The diseased scions from JMV infected plants were made into a 'V' shaped structure. The scions were inserted into slanting cut made on the healthy stock plants of *Jatropha*. The grafted portion was tied tightly with a high-density polythene strip. The inoculated plants were kept in insect proof cage for symptom development under observation.
The ability of the dodder (*Cuscuta reflexa* Roxb.), a natural parasite on *Jatropha* to transmit the virus was also tested. Few vines of the dodder were collected from healthy weeds (*Lantana camara*) and allowed to grow on the infected *Jatropha* plants. The dodder developed on the infected *Jatropha* plants were then allowed to grow on the healthy *Jatropha* (3-5 leaf stage) seedling and this set up was maintained for 30 days (Plate-5). Afterwards the target plants were separated from the dodder and maintained for 3-months in an insect proof cage for symptoms development under observation.

RESULT AND DISCUSSION

Table-1 indicated that the virus under study was transmitted by core grafting from donor host *J.cucas* to receptor healthy *J.curcas* and donor host *J.gossypiifolia* to receptor healthy *J.gossypiifolia* as 90% of *J.curcas* plants and 75% of *J.gossypiifolia* plants developed symptoms in 25-30 days and 30-35 days after grafting respectively. None of the *J.curcas* plants grafting with infected *J.gossypiifolia* scions and *J.gossypiifolia* with infected *J.curcas* scions developed any symptoms even after upto 90 days.

Table 1. Transmission of JMV through grafting

S.No.	Donor plant	Receptor plant	No. of plants		Percent transmi-ssion	Time taken for symptoms expression (Days)
			Inoculated	Infected		
1.	*J.curcas*	*J.curcas*	20	18	90	25-30
	J.curcas	*J.gossypiifolia*	20	00	00	---
2.	*J.gossypiifolia*	*J.gossypiifolia*	20	15	78	30-35
	J.gossypiifolia	*J.curcas*	20	00	00	---

It is clear from the table-2 that the JMV was transmitted by dodder from *J.curcas* to *J.curcas*, but not from *J.curcas to J.gossypiifolia, Glycine max, Manihot esculenta* and *Nicotiana tabaccum*. 80% of the dodder transmitted *J.curcas* plants developed distorted symptoms within 15 days after inoculation. These results are in agreement with the findings of Hollings *et al*. (1976) who reported the transmission of a rod shaped East African whitefly (*B. tabaci*) borne sweet potato mild mottle virus via dodder (*Cuscuta compestris* L.) to *Calystegia sepium* R. Br. Prod. successfully.

Table 2. Dodder transmission of JMV

S.No.	Test plants	No. of plants		Percent Transmission	Time taken for symptoms expression (Days)
		Inoculated	Infected		
1.	*J.curcas*	10	08	80	10-15
2.	*J.gossypiifolia*	10	00	00	---
3.	*Glycine max*	10	00	00	---
4.	*Nicotiana tabaccum*	10	00	00	---
5.	*Manihot esculenta*	10	00	00	---

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SHORT COMMUNICATION

CALCIUM OXALATE CRYSTALS AS AN IMPORTANT CHARACTER OF PERICARP IN COMPOSITAE- A SHORT COMMUNICATION

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Abstract: Calcium oxalate is a chemical compound, which produce crystal in plants and is known as raphides. The chemical formula of calcium oxalate crystal is-CaC_2O_4 or $Ca(COO)_2$.They are not universally present in all parts of the plant organ, but instead they are confined to specific parts and certain plant tissues in some restricted taxa only. Accumulation of calcium oxalate crystal is found to be reported in approximately 1000 different genera of plants (Francesci and Nakata, 2005). So, presence of this crystal is very important in taxonomic view points, as it is not universially present in all parts of the plant organ and is restricted in certain plant parts. These crystals are usually of the common rectangular type but seldom druses (from cross sectional view of the cypselar wall). Within the family Compositae, calcium oxalate crystal is present in the pericarp and testal region of mature fruit (Cypsela) and it act as a taxonomic marker. Within the cypsela, the distribution of crystals is also very specific. In some cases, they are distributed in the epicarpic zone of cypselas {*Aster thomsonii, Brachycome heterodonta, Carpesium cernuum, Carpesium nepalense, Inula ensifolia, Buphthalmum speciosissimum*) and in such cases, they are also visible in dry condition from the scanning electron photographs of cypselas. In some another cases, they are only observable from histological structure. In *Anthemis tinctoria, Arctium lappa, Bothriocline laxa, Brachycome campylocarpum, Catananche caerulea, Elephantopus scaber* and *Tanacetum macrophyllum* crystals are found in different parts of the mesocarpic zone of pericarp. So, the distribution pattern of Calcium oxalate crystals in the cypsela is variable. According to the observation of Martin, Matteo, Daniel, Jakob, Guillaume, Michel, Daniel, Eric and Pila (2012), Calcium oxalate crystal is associated to the detoxification of Calcium in the plant. It is a poisonous substance, which can produce sores and numbing on ingection and could be fatal. Calcium oxalate crystals may be antagonistic to the formation of phytomelanin pigment in cypsela (Mukherjee and Nordenstam, 2010). Many authors {Hanausek,1911; Metcalfe & Chalk 1950, 1983; Dormer,1961; Gochu (1973); Robinson & King (1977); Mukherjee and Nordenstam, (2010) etc.} have been contributed, regarding the distributional pattern of Calcium oxalate crystals in Compositae.

Keywords: Calcium oxalate, Compositae, Plant tissues

INTRODUCTION

The presence of calcium oxalate crystals in flowering plants is appears to be more or less widespread in different plant parts, such as leaves, stems, roots, floral parts, fruits and seeds. These crystals may be of two types, extracellular and intracellular. The former type is reported initially in about 160 angiospermic families, but most prevalently in the Amaranthaceae, Rubiaceae and Solanaceae (Metcalfe & Chalk 1950, 1983), and the later is reported from 215 families including Compositae (Franceschi & Nakata 2005). Most of the crystals look like a hexagonal prism, rectrangular type, some times, look like a pointed picket form (Fig-1). Though, hexagonal form of crystal is usually very common type in the cypsela, than other type. According to Dormer (1961), the distribution and shape of such crystals appear to be genetically controlled and hence taxonomically significant. Robinson & King (1977) stated that calcium oxalate crystals are absent in the achene walls within the tribe Eupatorieae.

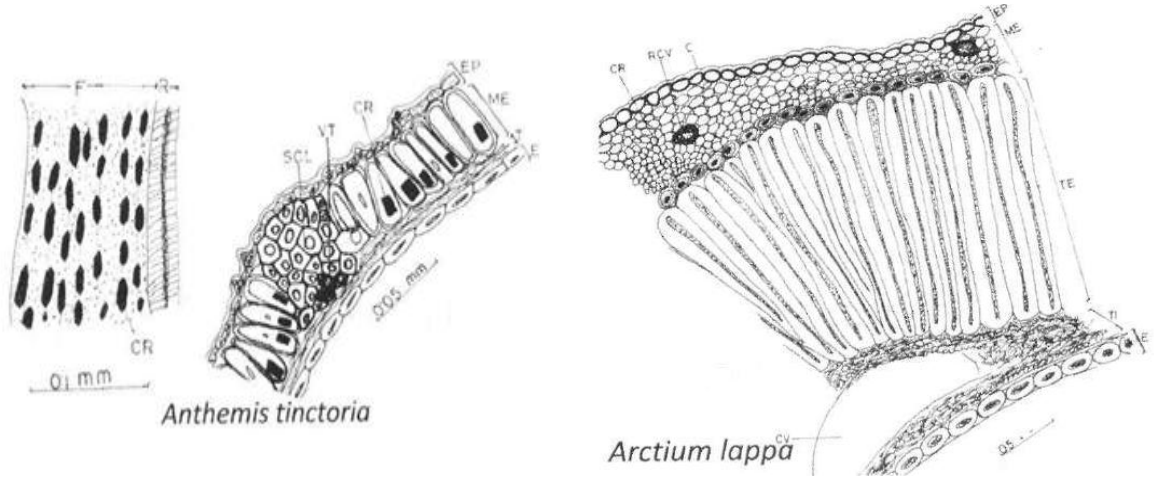

Fig.1. Showing the shape and distribution of crystals in the surface and pericarpic region of cypselas.

Although, the general morphology and mode of distributional pattern of calcium oxalate crystals are now somewhat known, their functional aspects are not clearly known or understood till now.

There are various opinions regarding the possible functions of oxalate crystals, which are as follows:

i) Help in the regulation of the calcium levels in plant cells and tissues (Franceschi & Nakata 2005).

ii) Help in the enhancement of the strength of the plant tissue or tissues (Franceschi & Horner 1980).

iii) Help in the protection of the animals especially herbivores (Molano-Flores 2001) .

iv) Act as a storage tissue of calcium and oxalic acid (Franceschi & Horner 1980, Prychid & Rudall 1999).

v) Help in the detoxification of heavy metals (Nakata 2003) .

vi) Help in the precipitation of calcium salt in same specific environmental condition (White & Broadley 2003).

vii) To remove the toxic substances (Borchert 1984).

viii) Help to overcome the salt stress and homeostasis (Hurkman & Tanaka 1996).

ix) Help in the regulation of light intensity in plant tissues (Franceschi & Horner 1980).

x) Provide mechanical support to the plant tissues (Nakata 2003).

xi)Participate in the transformation of light energy to the chloroplast of the parenchyma cells of leaves during photosynthetic process (Kuo-Huang et al. 2007).

xii)Facilitate the pollination, by providing a visual signal or a scent interesting to insect (Chase & Peacor 1987, Darcy et al. 1996).

Not only the above mention function, this crystal is very important in bulk calcium regulation.

Although crystal formation is gene controlled, various external factors such as -temperature, air pressure, light intensity, pH of soil and other environmental factors may affect the formation of calcium oxalate crystals (Franceschi & Horner 1980, Garty et al. 2002 , Kuo-Huang et al. 2007 , Meric 2008 , 2009) . Ilarslan et al. (1997 , 2001) have also suggested that deposition of these crystals serves as a storage source for calcium and it is assumed that both the mitosis and cytokinesis are regulated by calcium ions (Hepler & Wayne 1985).The climatic condition of an area is associated with the phenology controls of the formation of calcium oxalate crystals in the cambial zone of *Citharexylum* (Verbenaceae), which has been observed by Marcati & Veronica (2005) . They have indicated that an abundance of crystals was observed during water deficit condition, whereas during flowering time associated with rainy season, crystals were rarely observed. Therefore, further detailed critical studies regarding the distribution of calcium oxalate crystals in mature cypselar walls of Compositae will help to improve the classification of the family Compositae.

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SHORT COMMUNICATION

GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN (*DOLICHOS LABLAB* L.)

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Abstract: An experiment was carried out to identify suitable genotypes for commercial cultivation in Chhattisgarh. Sixty three genotypes of Dolichos bean were evaluated during *kharif* and *Rabi* season of 2009-10. Wide range of variability was observed for all the characters *viz.*, leaf length, leaf width, inflorescence length, number of flower per inflorescence, number of pod per inflorescence, pod length, pod width, number of pod per plant, hundred seed weight and pod yield. The analysis of variance revealed that the high genotypic and phenotypic coefficient of variation were recorded for leaf length (cm), leaf width (cm), inflorescence length (cm), number of flower per inflorescence, pod length (cm), pod width (cm), number of pod per plant, hundred seed weight (g) and pod yield per plant (kg). It was also revealed that relative magnitude of phenotypic coefficient of variation was higher than the genotypic coefficient of variation under the study. Higher heritability coupled with high genetic advance as percent of mean were observed for pod length followed by pod width, length of inflorescence, hundred seed weight, number of flower per inflorescence and number of pods per inflorescence. Correlation and path analysis revealed that number of pod per plant influenced the green pod yield per plant (kg) with high direct effect and significant positive correlation. Through D^2 analysis, all the genotype could be grouped into six clusters and inflorescence length, number of pod per inflorescence, number of pod per plant and green pod yield per plant were found to be major characters

Keywords: Genetic divergence, Correlation, Path analysis, D^2 analysis, Dolichos bean

INTRODUCTION

Dolichos bean or Hyacinth bean or Egyptian bean or Sem (*Dolichos lablab* L.) is an important vegetable crop throughout India and especially in Chhattisgarh due to its local acceptability by the people. It is grown on almost all types of soil of average fertility as in case of other beans (Nath, 1976). Gupta *et al.* (1995) reported that Eastan M.P. (Now Chhattisgarh State) has wide genetic variability for various traits like plant habit, branching habit, stem pigmentation, leaf veination, flower colour, pod colour, pod characters, *viz.*, shape, size, weight and seeds per pod etc. Hitherto, very little attention is given by the workers on systematic crop improvement work of Dolichos bean. But the genetic variability in Chhattisgarh provides a better opportunity for crop improvement work. Considering these points a study was undertaken at Department of Horticulture, I.G.K.V. Raipur (C.G.).

MATERIAL AND METHOD

The experimental material comprised of sixty three diverse genotypes of Dolichos bean. The trials were evaluated during *kharif* and *Rabi* season of 2009-10 at the Department of Horticulture, Horticulture Farm, under All India Coordinated Research Project on Vegetable Crops, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was conducted in a Randomized Block Design (RBD) with four replications. Each entry was sown in 3.6x3.0 m^2 plot area with a spacing of 60cm x 30cm. All the standard agronomical practices and plant protection measures were followed timely to raise the crop successfully. Five plants were selected randomly for recording different yield related traits however green pod yield and days to first picking were recorded on plot basis. After recording data analysis of the genetic diversity and Mahalonobis D^2 analysis was done and genotypes were grouped in various clusters following Torcher's method as suggested by Rao (1952).

RESULT AND DISCUSSION

Analysis of variance revealed that genotypic differences were significant for all the characters. The variability parameters are given in (Table-1). The range of variation was wider in green pod yield that was from 0.134 kg per plant or 66.78 q/ha to 0.279 kg per plant or 155.09 q/ha. Largest pod length was recorded 15.30 cm, whereas smallest pod length recorded in 4.12 cm. The highest value of genotypic coefficient of variation (GCV) was recorded for pod width (30.68%) followed by pod length (26.07%), number of pods per inflorescence (23.08%), length of inflorescence (23.07%), hundred seed weight (21.76%), number of pod per plant (20.99%), marketable green pod yield per plant (19.27%). Whereas, rest of the traits exhibited moderate genotypic coefficient of variation. The magnitude of phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation for most of the characters. The highest heritability estimate was observed for hundred seed weight (98.11%) followed by pod length (97.29%), pod width (96.20%), days to first flowering (95.46), days to 50% flowering (94.79%), length of inflorescence (92.54%), marketable green pod yield

per plant (88.22%), number of pods per inflorescence (78.05%). While, moderate heritability estimates is being recorded in leaf breath (68.33%) followed by leaf length (60.77%) also low heritability recorded by pedicel length (23.41%) and number of pods per plant (23.40%). Higher heritability estimates coupled with high genetic advance as percent of mean were observed for pod length followed by pod width, length of inflorescence, hundred seed weight, number of flower per inflorescence and number of pods per inflorescence. These above results were supported by Joshi (1971) and Pandita *et al.*(1980).

The estimate the direct and indirect contribution of various traits towards green pod yield is given in (Table-2) maximum positive direct effect on green pod yield per plant was exhibited by number of pod per plant followed by hundred seed weight, number of pod per inflorescence, pod length and leaf width negative direct effect on green pod yield per plant was exhibited by number of flower per Inflorescence, pod width and leaf length.

Phenotypic and genotypic correlation coefficients among ten traits are presented in (Table-3). At phenotypic level, highest correlation with green pod yield per plant was recorded by the character number of flower per inflorescence followed by pod width and leaf length. At genotypic level high correlation with green pod yield per plant was recorded by the characters number of flower per inflorescence, leaf length and hundred seed weight. These above results were supported by Rai, *et al.* (2008).

In the present study all of the sixty three genotypes could be grouped into six clusters (Table-4). Maximum number of genotypes (17) was retained by cluster III followed by cluster VI (15) genotypes, cluster I and IV almost equal (11) genotypes, cluster V (05) genotypes and cluster II (04) genotypes. Among six cluster the maximum inter cluster distance (D^2 Value) was observed between cluster III and I (4.984), followed by cluster III and VI (2.585), cluster III and I (1.998), cluster IV and III (1.617), cluster V and III (1.781) and cluster VI and II (1.420).These above results were supported by Baswana *et al*. (1980), Borah and Khan (2001) and Golani *et al.* (2007).

In this study, group constellation showed that IS-02, IS-04, IS-28 and IS-38 were highly divergent from all other genotypes and may be used as parents in transgenic breeding programme and may directly be used as a pure line variety for green pod yield and quality characters in Indian bean (*Dolichos lablab* L.) for Chhattisgarh state and country as well.

Table 1: Estimation of Mean, Range, GCV, PCV, Heritability and Genetic advance as (%) of mean of different characters of Dolichos bean

S. No.	Characters	MEAN	RANGE		GCV (%)	PCV (%)	h^2(bs) (%)	Genetic advance as % of mean
			Min.	Max.				
1.	**Leaf length (cm)**	11.95	9.37	14.45	8.62	11.05	60.77	13.72
2.	**Leaf breath (cm)**	11.15	8.35	13.51	9.89	11.96	68.33	16.86
3.	**Length of inflorescence (cm)**	18.73	8.90	27.03	23.07	23.98	92.54	45.70
4.	**Number of flower / inflorescence**	22.36	10.50	29.00	19.51	20.07	94.53	39.08
5.	**Number of pod per inflorescence**	7.18	4.50	11.75	23.08	26.11	78.05	41.92
6.	**Pod length (cm)**	9.33	4.12	15.30	26.07	26.43	97.29	52.94
7.	**Pod width (cm)**	1.79	1.10	3.76	30.68	31.27	96.2	62.01
8.	**No. of pods per plant**	32.86	21.00	49.77	20.99	22.98	23.40	39.42
9.	**Hundred seed weight (g)**	38.59	22.58	52.61	21.27	21.97	98.11	44.41
10.	**Green pod yield / plant (kg)**	0.200	0.134	0.279	19.27	20.52	88.22	40.00

Table 2: Direct and indirect effect of developmental characters on pod yield at phenotypic and genotypic level in Dolichos bean

Characters Number & Name		Character number										
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Leaf length	P	0.322*	0.347**	-0.091	-0.031	0.087	-0.061	0.178	-0.014	0.217	0.308*	0.287*
(cm)	G	0.433	0.428	-0.089	-0.030	0.085	-0.063	0.272	-0.015	0.232	0.343	0.297
(2) Leaf width	P		0.459**	-0.098	-0.068	-0.271	-0.088	0.184	0.276*	0.188	0.186	0.277*
(cm)	G		0.715	-0.138	-0.103	-0.402	-0.056	0.293	0.358	0.241	0.209	0.362
(3) Length of	P			-0.070	-0.079	-0.315	-0.060	0.084	0.140	0.125	0.128	0.278*
Inflorescence (cm)	G			-0.078	-0.095	-0.387	-0.059	0.109	0.178	0.128	0.199	0.332
(4) Number of	P				0.679**	0.349**	0.333*	0.053	-0.088	-0.310	0.080	-0.172
Flower/ inflorescence	G				0.730	0.425	0.365	0.054	-0.089	-0.332	0.088	-0.179
(5) Number of	P					0.375**	0.297*	0.013	-0.167	-0.179	0.060	-0.185

pod /inflorescence	G	0.430	0.340	0.038	-0.174	-0.187	0.066	-0.193	
(6) Number of	P		0.049	0.040	-0.187	-0.106	0.009	-0.234	
Pod/ plant	G		0.096	0.045	-0.218	-0.119	-0.011	-0.267	
(7) Number of	P			-0.001	-0.076	0.021	0.249	-0.341	
Seeds/ pod	G			-0.002	-0.090	0.027	0.229	-0.377	
(8) Pod length	P				0.350	-0.061	0.332**	0.309*	
(cm)	G				0.564	-0.131	0.599	0.501	
(9) Pod width (cm)	P					0.055	0.355**	0.464**	
	G					0.056	0.378	0.474	
(10) Marketable	P						-0.048	-0.011	
green pod yield /plant (kg)	G						-0.052	-0.014	
(11) Hundred	P							0.415**	
seed weight (g)	G							0.447	

*: Significant at 0.05%, **: Significant at 0.01%, P=Phenotypic; G=Genotypic

Table 3: Genotypic correlation of green pod yield and its development characters in Dolichos bean

Characters	Leaf length (cm)	Leaf width (cm)	Inflorescence length (cm)	Number of flower per Inflorescence	Number of pod per Inflorescence	Pod length (cm)	Pod width (cm)	Number of pod / plant	Hundred seed weight (g)	Yield per plant (kg)
Leaf length (cm)	**-0.017**	-0.012	0.003	0.002	0.007	-0.006	-0.004	0.001	-0.006	0.213
Leaf width (cm)	0.074	**0.103**	-0.008	-0.008	-0.040	0.018	0.013	-0.006	0.034	0.202
Inflorescence length (cm)	-0.006	-0.003	**0.047**	0.047	0.020	-0.004	-0.015	0.017	-0.008	0.088
Number of flower per Inflorescence	0.014	0.008	-0.107	**-0.107**	-0.045	0.009	0.035	-0.039	0.019	0.089
Number of pod / Inflorescence	-0.071	-0.069	0.076	0.075	**0.178**	-0.039	-0.021	0.017	-0.048	-0.013
Pod length (cm)	0.063	0.031	-0.016	-0.015	-0.038	**0.176**	0.009	-0.016	0.084	0.371
Pod width (cm)	-0.018	-0.009	0.025	0.025	0.009	-0.004	**-0.076**	-0.002	0.001	-0.052
Number of pod per plant	-0.025	-0.027	0.169	0.168	0.044	-0.041	0.012	**0.547**	-0.174	0.226
Hundred seed weight (g)	0.201	0.180	-0.100	-0.099	-0.148	0.261	-0.006	-0.206	**0.461**	0.449

Residual value: 0.0839, Diagonal and bold underline figures shows direct effect on pod yield

Table 4: Distribution of sixty three Genotypes of Dolichos bean on the basis of Mahalanobis D^2 statistics

Cluster Number	Number of genotypes included	Genotypes
I	**11**	IS-05, IS-13, IS-14, IS-15, IS-16, IS-22, IS-25, IS-31, IS-47, IS-53, IS-61.
II	**04**	IS-02, IS-04, IS-28, IS-38.
III	**17**	IS-06, IS-07, IS-08, IS-19, IS-21, IS-32, IS-34, IS-36, IS-39, IS-46, IS-49, IS-54, IS-55, IS-56, IS-57, IS-58, SwarnaUtkrishti (St. Check)
IV	**11**	IS-01, IS-03, IS-09, IS-10, IS-18, IS-20, IS-23, IS-37, IS-40, IS-44, IS-52.
V	**05**	IS-29, IS-45, IS-48, IS-50, IS-60.
VI	**15**	IS-11, IS-12, IS-17, IS-24, IS-26, IS-27, IS-30, IS-33, IS-35, IS-41, IS-42, IS-43, IS-59, IS-62, IS-63.

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SHORT COMMUNICATION

EFFECT OF FERTILIZER LEVELS ON RELAY CROPS IN RICE

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Abstract: The effect of varying fertilizer level on relay crops in rice experiment was conducted at Instructional cum research Farm of Assam Agricultural University, Jorhat, during the *kharif* and *rabi* season of 2001-02. The grain and stover yield, rice equivalent yield are significantly affected by the different treatments combination. The highest value recorded at 125 per cent recommended levels of fertilizer. Total N, P and K uptake differed significant due to different treatment. The highest value recorded at 125 per cent recommended levels of fertilizer.

Keywords: Relay crops, Rice equivalent, Stover yield

INTRODUCTION

Relay cropping is profitable under rainfed conditions. In Assam, linseed, pea khesari is grown as relay crop with rice. The productivity of these crops relay cropping is mainly due to lack of proper fertilization (Dutta, 1993). Evaluation of optimum levels of fertilizer for relay crops is therefore very much required, which hitherto, is lacking in Assam. Therefore, the present study was under taken.

MATERIAL AND METHOD

The field experiment was conducted at Instructional cum Research Farm of Assam Agricultural University, Jorhat during *khirf* and *rabi* season of 2001-02. The soil of experimental site was acidic, sandy loam in texture with pH 5.4, organic carbon (0.65%) and available N (285.89 kg/ha), P (26.45 kg/ha) and K (147.84 kg/ha).The experiment was laid out in factorial Randomized block design with twelve treatment combination and three replications. The fertilizer doses were applied on relay crops at 50, 75, 100 and 125 per cent of recommended levels of N-P_2O_5-K_2O kg/ha respectively. The recommended levels of fertilizer for linseed, pea and khesari were 40-20-10, 20-46-10 and 20-40-10 N-P_2O_5-K_2O kg/ha respectively. All P and K and half dose of N as per treatment were applied at sowing of relay crops. The remaining half does of N were splited into two equal doses and top-dressed 30 and 45 days after sowing of relay crops. The rice variety "Ranjit" was grown as per recommended practices; linseed (var.T-397), pea (var.T-163) and khesari (var.LSD-3) were sown in the standing rice field 18 days before the harvest of rice.

RESULT AND DISCUSSION

The grain and stover yields of relay crops were significantly influenced by different treatment. The highest grain and stover yield was recorded at 125 per cent recommended fertilizer (Table 1). The interaction effect of relay crops and fertilizer levels was found to be significant. The highest grain and stover yield was recorded at 125 per cent recommended levels of fertilizer in all the relay crops. This might be due to the increase in growth and yield attributing character, which were increased significantly with increasing levels of fertilizers.The highest rice equivalent yields were recorded in pea followed by khesari and linseed at 125 per cent recommended levels of N-P_2O_5-K_2O kg/ha. Total N, P and K uptake differed significantly due to different treatment. The highest N, P and K uptake was recorded in pea followed by khesari and linseed respectively (Table 1). The interaction effect of relay crops and fertilizer levels was found to be significant.The highest N, P and K uptake was recorded at 125 per cent recommended levels of fertilizer, which might be due to higher nutrient content in seed and stover as well as higher seed and stover yield of relay crops (Table 2).

Table 1: Yield and Nutrient uptake by relay crops as influenced by fertilizer levels

Treatment	Grain Yield (kg/ha)	Stover Yield (kg/ha)	REY (kg/ha)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
Linseed	349.63	662.36	4713	21.56	4.66	17.39
Pea	658.56	1426.07	6319	50.29	13.28	20.93
Khesari	593.58	1239.88	5104	34.21	9.84	17.60
CD (P=0.05)	4.02	3.48	53	1.43	0.11	0.15
Fertilizer level: N-P_2O_5-K_2O						
50%	439.64	969.84	5182	27.69	8.78	16.94
75%	496.48	1061.95	5273	32.05	9.11	18.13

100%	583.07	1176.31	5473	38.82	9.42	19.67
125%	616.50	1229.65	5585	42.85	9.72	19.82
CD (P=0.05)	4.64	4.02	61	1.65	0.13	0.17

Rice recommended dose= 40:20:20 N-P_2 O_5-K_2O kg/ha

Tables 2: Grain yield and Rice equivalent yield (kg/ha) of relay crops due to interaction of different levels of fertilizers.

Fertilizer Levels	**Grain yield (kg/ha)**			**REY (kg/ha)**		
	Linseed	Pea	Khesari	Linseed	Pea	Khesari
50%	313	550	455	4693	5973	4872
75%	332	608	548	4701	6166	4960
100%	368	712	669	4712	6472	5236
125%	384	763	701	4745	6663	5358
Mean	349	658	593	4713	6319	5104
CD P=0.05)	8.04					

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SHORT COMMUNICATION

GENETIC VARIABILITY STUDIES IN CHILLI (*CAPSICUM ANNUUM*L.)

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Abstract: The present studies were carried out to assess the genetic variability, heritability and genetic advance for different characters in nine genotypes (six lines and three testers) in diverse genotypes of Chilli. The experiment was conducted in RandomisedBlock Design (RBD) with three replications during the *rabi* season 2011-2012 at Department of Horticulture under All India Coordinated research Project on Vegetable Crops, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.), India. The analysis of variance indicated the sufficient genetic variation among the genotypes from all the characters studied. Among the genotypes KA-2 (580 g/plant) was the highest green fruit yielder. Number of fruits/plant was highest in Indira Chilli-1 (191.00), fruit length was maximum in 2011-03 (10.37 cm) and average per fruit weight in 2011-03 (4.77 g). The high phenotypic coefficient of variation and genotypic coefficient of variation were observed for fruit length, number of seeds/fruit, plant height and fruit weight. High heritability coupled with high genetic advance were observed for all characters studied, except number of primary branches, number of secondary branches, days to first picking, fruit bearing period, fruit width, duration of crop (sowing to last harvest days) indicating these characters are governed by additive gene action.

Keywords: Genetic variability, Genetic advance, Heritability, *Capsicum annuum*

INTRODUCTION

Chilli (*Capsicum annuum* L.) is an important spice crop, grown extensively in different states of India. It is the most common ingredient in Indian diet. Chilli is valued for its characteristic pungency, colour value and pleasant flavor. Hence, the development of plant breeding strategy for any crop depends mainly on the support provided by the genetic information of the major quantitative characters associated with fruit yield. A rich diversity of capsicum exists due to varied geoclimatic regions of Indian continent. It is widely cultivated from July to December in northern states of India (Choudhary and Samadia, 2004). It is an annual herbaceous plant of the Solanaceae family including hot pepper and sweet or bell pepper. The great phenotypic diversity in plant habit and especially in shapes, sizes (Andrews 1995; DeWitt and Bosland, 1996). For hybridization, existence of variability and relative divergence among the genotypic is must. Hitherto, very little attention is given by the workers on systematic crop improvement work of chilli. Since it has wide range of variability in order to know extent of variability among the available genotypes, so that genetic variability studies in chillies was undertaken.

MATERIAL AND METHOD

The experimental material comprised of nine diverse genotypes of Chilli (6 lines and 3 testers) which were received from All India Coordinate Research Project on Vegetable Crops, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.).The trials were evaluated during *Rabi* season of 2011-12 at the Horticulture Farm, Department of Horticulture. The soil of the experimental field was sandy loam in texture which is locally known as "*Matasi*" and is neutral in reaction with the pH 7.5. The experiment was conducted in a Randomized Block Design (RBD) with three replications.

The six week old seedlings of nine parents (6 line and 3 testers) were transplanted in a randomized block design with three replications. Each plot consisted of 4.2 x 3.5 m^2 areas and a gap was kept in 60 cm between rows and 30 cm between plants and only one seedling sown per hill.All the standard agronomical practices and plant protection measures were followed timely to raise a crop successfully. Five plants were selected randomly for recording different yield related traits. However green fruit yield, days to first and 50% flowering and days to first picking were recorded on plot basis. After recording data Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) were calculated as per the formula suggest by Comstock and Robinson (1952). Heritability in Board sense and expected genetic advance were calculated as per formula given by Jonson *el al.* (1955).

RESULT AND DISCUSSION

Analysis of variance (Table-1) revealed that wide range of variability was observed for all the characters *viz.*,days to 50% flowering, plant height, days to fruiting, fruit bearing period, number of seeds/fruit, number of fruits/plant, duration of crop (sowing to last harvest days), green fruit yield/plant (g). These findings were supported by Choudhary and Samadia (2004) &Danduayaka (2008).

The genotypic and phenotypic coefficients of variations are presented in (Table-2). High genotypic as well as phenotypic coefficient of variations were recorded for traits *viz*., fruit length (31.64 and 30.97 percent), number of seeds per fruit (30.91 and 30.77 percent), plant height (27.41 and 26.65 percent) and fruit weight (24.96 and 24.32 percent).

Moderate genotypic and phenotypic coefficients of variations were observed for Stalk/pedicel length (19.98 and 19.67 percent), number of fruits/plant (15.90 and 14.26 percent), number of secondary branches (15.35 and 11.42 percent), days to first flowering (15.34 and 15.07 percent), green fruit yield/plant (14.89 and 14.72 percent),number of primary branches (14.55 and 10.91 percent), days to fruiting (13.99 and 13.68 percent), days to 50 % flowering (13.07 and 12.85 percent) and fruit width (12.27 and 10.14 percent).

Whereas, low genotypic and phenotypic coefficient of variations were observed for days to first picking (9.01 and 8.90 percent), duration of crop (3.91 and 3.17 percent) and fruit bearing period (3.86 and 2.85 percent).These findings are in accordance with the findings of Verma*et al.* (2004) and Datta and jana (2010).

The broad sense heritability estimates and genetic advance expressed as percentage of mean have been presented in (Table-2). Most of the characters showed high broad sense heritability except for fruit bearing period (54.55 percent), number of secondary branches (55.30 percent) and number of primary branches (56.20 percent).

Whereas, all the characters recorded high genetic advance except number of primary branches (16.85 percent), number of secondary branches (17.49 percent), fruit width (17.26 percent), days to first picking (18.10 percent),duration of crop (sowing to last harvest days) (5.28 percent) and fruit bearing period (4.34 percent). These findings are in accordance with the findings of Krishana*et al*. (2007) and Lahbib*et al.* (2012).

Table 1: Mean performance of genotypes (six lines and three tester)

Parents	Characters															
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Line (Female)																
2011-07	35.667	43.333	76.333	2.733	4.500	39.667	63.667	118.667	5.267	1.100	2.600	3.500	70.000	156.333	158.333	403.333
2010-03	44.667	52.667	66.000	3.367	6.867	47.333	75.333	115.000	8.200	1.400	4.333	3.833	77.333	123.000	153.667	530.000
2011-08	49.667	56.667	54.667	2.600	5.767	53.333	78.000	124.000	7.400	1.300	4.000	3.000	93.667	131.000	154.000	520.000
2010-06	51.000	58.000	73.333	3.300	6.700	54.000	79.667	119.000	8.067	1.367	3.267	3.100	105.000	141.667	149.000	458.333
2011-03	55.333	63.000	61.000	3.200	6.500	57.667	81.333	120.000	10.367	1.233	4.767	4.333	101.000	122.667	150.000	570.000
2011-01	52.000	59.000	64.667	2.500	5.567	54.333	85.667	125.000	3.533	1.167	2.567	2.500	35.000	155.000	164.000	390.000
Average	**48.056**	**55.445**	**66.000**	**2.950**	**5.984**	**51.056**	**77.278**	**120.278**	**7.139**	**1.261**	**3.589**	**3.378**	**80.333**	**138.278**	**154.833**	**478.611**
Tester (Male)																
KA-2 (Check)	37.333	45.333	22.667	3.600	7.000	40.000	67.333	123.333	6.600	1.367	3.600	2.500	50.333	165.667	157.333	580.000
LCA-334	40.667	47.333	79.000	3.233	6.167	43.333	75.667	127.333	6.567	1.200	3.733	3.300	66.333	150.667	160.000	560.000
Indira Chilli-1	43.000	49.333	63.000	3.033	5.867	46.000	77.333	118.667	4.467	1.000	2.300	2.600	73.667	191.000	148.667	440.000
Average	**40.333**	**47.333**	**54.889**	**3.289**	**6.345**	**43.111**	**73.444**	**123.111**	**5.878**	**1.189**	**3.211**	**2.800**	**63.444**	**169.111**	**155.333**	**526.667**
Overall average	**45.482**	**52.741**	**62.296**	**3.063**	**6.104**	**48.407**	**76.000**	**121.222**	**6.719**	**1.237**	**3.463**	**3.185**	**74.704**	**148.556**	**155.000**	**494.630**
SEm±	**0.754**	**1.806**	**2.359**	**0.170**	**0.362**	**1.609**	**0.620**	**1.821**	**0.251**	**0.049**	**0.137**	**0.065**	**1.261**	**6.043**	**2.057**	**6.558**
CD at 5%	**2.259**	**5.415**	**7.044**	**0.511**	**1.085**	**4.826**	**1.858**	**5.458**	**0.752**	**0.148**	**0.411**	**0.194**	**3.782**	**18.116**	**6.167**	**19.637**
CV %	**2.870**	**5.932**	**6.533**	**9.632**	**10.265**	**5.759**	**1.413**	**2.601**	**6.470**	**6.914**	**6.863**	**3.523**	**2.925**	**7.045**	**2.299**	**2.293**

01 Days to first flowering **02** Days to 50% flowering **03** Plant height (cm) **04** Number of primary branches
05 Secondary branches **06** Days to fruiting **07** Days to 1st picking **08** Fruit bearing period
09 Fruit length (cm) **10** Fruit width (cm) **11** Fruit weight (g) **12** Stalk/pedicel length (cm)
13 Number of seeds /fruit **14** Number of fruits/ plant **15** Duration of crop (sowing to last harvest days) **16** Green fruit yield /plant (g)

Table 2: Genotypic and phenotypic coefficients of variation (GCV and PCV), Heritability (h^2), Genetic advance as % of mean and components of variance for greenfruit yield and its component characters of genotypes

Characters		Days to first flowering	Days to 50% flowering	Plant height (cm)	Number of primary branches	Secondary branches	Days to fruiting	Days to first picking	Fruit bearing period	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Stalk/ pedicel length (cm)	Number of seeds per fruit	Number of fruits per plant	Duration of crop (sowing to last harvest days)	Green fruit yield per plant (g)
Range	Max.	55.33	63.00	79.00	3.60	7.00	57.67	85.67	127.33	10.37	1.40	4.77	4.33	105.00	191.00	164.00	580.00
	Min.	35.67	43.33	22.67	2.50	4.50	39.67	63.67	115.00	3.53	1.00	2.30	2.50	35.00	122.67	148.67	390.00
PCV%		15.34	13.07	27.41	14.55	15.35	13.99	9.01	3.86	31.64	12.27	24.96	19.98	30.91	15.90	3.91	14.89
GCV%		15.07	12.85	26.65	10.91	11.42	13.68	8.90	2.85	30.97	10.14	24.32	19.67	30.77	14.26	3.17	14.72
Heritability (%)		96.50	96.71	94.53	56.20	55.30	95.71	97.54	54.55	95.82	68.27	94.93	96.89	99.10	80.37	65.47	97.77
Genetic advance as % of mean		30.49	26.04	53.38	16.85	17.49	27.57	18.10	4.34	62.46	17.26	48.82	39.88	63.10	26.33	5.28	29.98

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SHORT COMMUNICATION

A STUDY ON PRE-HARVEST FORECAST OF RICE YIELD USING CLIMATIC VARIABLES

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Abstract: A suitable statistical model has been developed for forecasting the yield of the rice in Raipur district (1981-2013) using the data and weekly weather variable viz., average maximum and minimum temperature, relative humidity morning evening sunshine hours and total weekly rainfall. The forecast model was developed using generate weather variables as regression in model. The generated weather variables were developed using weighted accumulated of weekly data on weather variable, weights being the correlation coefficient of the weather variables, in respective weekly with yield. The data for a period of (1981-13) was used to develop the forecast model. The validation of the model was done using the data from (2011-13).

The results revealed that the forecast model developed was able to explain 57% of variation in the rice yield. And it is possible to forecast rice yield successfully two month before harvest.

Keywords: Generate weather variables, Regression weekly data, Correlation Coefficient, Forecast model

INTRODUCTION

Rice is one of the important food crops in the world and ranks, second in terms of area and production .It is the staple food for about 50 per cent of the population in Asia, where 90 per cent of the world's rice is grown and consumed. Asia's food security depends largely on the irrigated rice fields, which account for more than 75 per cent of the total rice production.(Virk et al. 2004) Rice is a proliferate user of water, consuming half of all fresh water resources. In Asia, 17 million ha of irrigated rice area may experience "physical water scarcity'' and 22 million ha may have "economic water scarcity"by 2025 (Tuong and Bauman, 2001). Water has become a scarce resource in the world as well as in India. Water needs of rice are two to four times more than that of the other crops of the same duration because of water loss by percolation, seepage, field preparation etc under submerged conditions.

In Asia, India has the largest area under rice occupying 29.4 per cent of the global area, but India has the lowest yield. The conventional paddy growing tracts are in worst crisis due to special, biological and technical setbacks. Well acclaimed rice bowls in several parts of the nation are facing a decline in area, production and productivity.

In India, there is growing demand for rice due to ever burgeoning population. It is estimated that rice demand by the year 2011 will be of 100 million tonnes. To assure food security in the rice-consumingcountries of the world, rice production would have to be increased by 50 per cent in these countries by 2025 and, this additional yield will have to be produced on less land with less usage of water, labour and chemicals (Zeng et al., 2004)

In Chhattisgarh State, rice is the staple food and it is grown in an area of 3.48 million hectare with a production of 6.15 million tonnes and productivity of 1517 kg per hectare during 2010-11 and area, production and productivity reduced in the subsequent year.

A number of statistical techniques such as multiple regressions, principal component analysis, Markov chain analysis (Ram Subramanian and Jain, 1999), Discriminant function (Rai, 1999) and agro-meteorological models (Baweja, 2002, Bazgeer et al. 2008, Ravi Kiran and Bains, 2007, Muralidhara and Rajegowda, 2002) have been used to quantify the response of crops to weather. Individual effects on weather factors on rice yield were studied by Jain et al. (1980) and Agrawal et al. (1986). Agrawal et al. (1983) studied the joint effect of weather variables on rice yield. In the above models generated weather variables were used. Weather indices and principal components of weather variables were used in the models developed by Agrawal et al. (1980). Composite models, combining biometrical characters and weather variables were developed by Mehta et al. (2000). Yield forecast models were developed for wheat and rice using weather variables and agricultural inputs on agro-climatic zone basis by Agrawal et al. (2001).Four different approaches, two on original weather variables and two on generated weather variables were used by Khistaria et al. (2004) and Varmola et al. (2004). By coupling technology trend with weather variables, models were developed by Mallick et al. (2007). The present study provides yield forecast models for rice production of Raipurdistrict using weather variables.

MATERIAL AND METHOD

The yield figures of rice for a period of (1981-2013) collected data from season and crop report, issued by the state government of Chhattisgarh and department of agriculture has been used for the present study. The daily data on weather parameters such as temperature (maxi & mini.), relative humidity (morning & evening), and amount of rainfall for 28

years period has been collected from weather station located at college of agriculture university, Raipur

Data and variables used in the study

Weekly data on weather variables have been for the study namely, X_1-Max. Temp. (^oC), X_2- Mini. temp.(^oC) X_3-Rel. hum. Morning(%), X_4-Rel. Hum. Evening (%), X_5-Rainfall (mm), X_6-Sunshine (hours). The forecast models were developed using the partial crop season data. *i.e*. the data on weather variables during the active vegetative phase has been used for our study. The data the period (1981-2010) has been used in developing the forecast model and the remaining three years data from (2011-2013) has been used for the validation of the models.

Yield forecast model

The yield forecast model is given by

where,

Here Y is the rice yield (kg/ha.)

Xiw is the value of the i-th weather variable in the w-th week.

Riwrii'w is correlation coefficient of Y with i-th weather variable/ product of I-th and I'-th weather variable in w-th week

'm' is the week of weather variable =6

I = I' = 1,2 =6 correspond respectively to maximum and minimum temperature, relative humidity at 7 hr , 14 hr and rainfall.

a, b and c are constants

T is year number included to correct for the long term upward or downward trend in yield and 'e' is the error term.

For each weather variables, two variables were generated- one as simple accumulation of weather variable and the other one as weighted accumulation of weekly data on weather variable, weighted being the correlation coefficients of the weather variables, in respective weeks with yield. Similarly, for effect of weather variables, weekly interaction variables were generated using weekly products of weather variables taking 2 at time.

Stepwise regression was used to select significant generated variables Zij and Z ii'j further analysis was carried out including significant generated variables only.

In order to study the consistency of forecast, predicted values of subsequent years (not included in the forecast equation) were worked out. Yield of subsequent years were forecast two months before harvest. For forecasting, observed weather was used up to the time of forecast and normal values of weather variables for the remaining period up to harvest.

RESULT AND DISCUSSION

The results of ANOVA are present in table 1. The results of F-test show that the regression equation is significant.

Table 1: The results of ANOVA for the regression equation

Model	df	SS	MS	F	Significance
Regression	1	242794.4	242794.4	3.112*	0.089
Residual	28	2184773	78027.6		
Total	29	2427567			

*- significant at 1% level

The result of t-test shows that the generated weather variables Z131 and Z161 are significant at 5% and 1% level. The result of t-test along with the value of partial regression coefficients is presented in table 2.

Table 2: The results of t-test partial regression coefficients

Variables	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	1822.958	351.039	5.193	.000
Z131	2.241	.692	3.237**	.003
Z161	7.438E-02	.025	2.918*	.007

*- significant at 5% level

**- significant at 1% level

Yield forecast model

The yield forecast equation has been developed using the significant generated weather variables based on equation 1. The final yield forecast function using important important weather variables along with its R2 value has been presented below.

$Y = 1822.958 + 2.241 (Z161) + 0.07438 (Z131)$

$R^2 = 0.574$

R2 value which is measure of goodness of fit indicates that generated weather variables are able to explain 57 % of variation in the rice yield.

The performance of the rice yield forecast equation has been tested by comparing the predicted values (which were not included in the forecast equation) with the observed values for a period of three year from (2011-2013) which are presented in table 4. The predicted values of rice yield were deviation (3.8 %) values for the year 2011.

Table 3: Performance of the rice yield model

year	Actual yield (kg/ha.)	Predicted yield (kg/ha.)	% of Deviation
2011	1270.0	1318.2	3.8
2012	1244.0	1401.1	12.6
2013	-	1667.5	-

Table 4: Actual and Predicted yield in Raipur district. (1981-2013)

Year	Act.Yield	Pre. Yield	% deviation
1981	989.9	1160.3	17.2
1982	772.3	775.4	0.4
1983	1229.6	1247.5	1.5
1984	1156.2	1170.3	1.2
1985	1483.6	1650.9	11.3
1986	1015.1	1004.2	-1.1
1987	1145.9	1264.3	10.3
1988	812.6	1093.9	34.6
1989	1247.6	1208.0	-3.2
1990	1340.5	1406.4	4.9
1991	1400.6	1131.6	-19.2
1992	1579.8	1168.4	-26.0
1993	1564.2	1346.3	-13.9
1994	1411.1	1504.8	6.6
1995	1406.0	1180.7	-16.0
1996	1193.5	1128.4	-5.4
1997	1057.2	1344.7	27.2
1998	1091.0	1145.4	5.0
1999	1471.0	1345.8	-8.5
2000	405.0	863.7	113.3
2001	1191.0	1314.5	10.4
2002	748.0	789.1	5.5
2003	1367.0	1533.2	12.2
2004	1201.0	1119.1	-6.8
2005	1545.0	1620.0	4.9
2006	1543.0	1365.5	-11.5
2007	1577.0	1293.9	-17.9

2008	1369.0	1163.8	-15.0
2009	1534.0	1493.0	-2.7
2010	1470.0	1490.1	1.4

SUMMARY AND CONCLUSION

Using the forecast model, pre-harvest estimates of rice yield for Raipur district could be computed successfully very much in advance before the actual harvest. As the data used for developing this model is of high degree of accuracy, its reliability is also high. Further, this model will produce more accurate result depending on the accuracy of input data provided.

The district government authorities also can make use of the forecast model developed using weather indices, this study, for obtaining accurate pre-harvest estimates of rice crop.

Till the final production of crops becomes known, decision have to be made on the basis of inform predictions or scientific forecasts. The main beneficial are farmers trader, exporters and importers (for planning their logistics, inventories and contracts). The processing companies can also plan in advance about the capacity, manpower and marketing strategy.

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SHORT COMMUNICATION

PHARMACOGNOSTIC STUDIES ON THE LEAVES OF *MURRAYA KOENIGII* (L.) SPRENG

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Abstract: *Murraya Koenigi* (L.) (Mithaneem) spreng of family, Rutaceae is an important medicinal Plant that has many thereopeutic values and contain crystalline glucoside, koenigin, murrayin and resin. The leaves are used as anti-dysentric, anti-vomiting, anti-bacterial, stomachic purposes, anti-inflammatory, anti-feedant. Pharmacognostical studies including macromorphological and microscopic characters such as Palisade ratio, stomatal number, stomatal index, vein-islet number, veinlet termination numbers, histochemical colour reaction, fluorescence behaviour, extractive values and loss of drying were studied.

Keywords: Pharmacognostic, *Murraya Koenigii*, Rutaceae

INTRODUCTION

Murraya Koenigii (L.) spreng of family Rutaceae is commonly known as 'Curry leaf '. It is commonly found in foot hills of Himalaya, evergreen area and in moist forests. It is a large shrub or small tree up to 5 m. tall. It is an important tree spice grown in homesteads. Leaves are commonly used as flavouring agent in Indian curry preparation since ancient time. The leaves are ovate-lanceolate with an oblique base, leaves are aromatic and contain crystalline glucoside , koenigin, resin and murrayin. The leaves, bark and roots are used to cure many disorders and diseases like skin diseases, piles, bacterial infection, antivomating, anti-inflammatary, antifeedant and stomachi purposes. Curry leaf is used in ayurveda and Unani system of medicine. Pharmacognostic studies help in identification and authentication of plant material. Simple pharmacognostic technique used in standardization of Plant material includs its morphological, macroscopical and biochemical characteristics.

Vernacular names

Murraya koenigii (L.) spreng has several names in each language. Curry leaf tree, limblee tree in **English**- mitha-neem, gandhela, kadhi-neem, katnim or harri in **Hindi**, karepaku in **Telugu**, Kariveppu in **Malayalam** Purohit & Vyas.

MATERIAL AND METHOD

The fresh material was collected from the Botanical garden of Meerut College, Meerut. The were studied macroscopically and then fixed in F.A.A. for microscopical studies. The healthy plant material which was dried in shade made it to fine powder for phytochemical screening for histochemical colour reaction Johansen (1940), Youngken (1951), Cromwell *et al* (1955), Trease and Evans (1983) and Physical evaluation CI.P. 1966) were followed.

Cultivation

Murraya Koenijii (L) spreng has been considered as acultivated plant. It is used in Indian System of medicine. It contains important theropeutic values. It is cultivated either by root suckers or seeds. It is cultivated in tropical climate and all type of Soil.

Observations

The data collected is shown in table 1 and 2.

Table 1. Macromorphological characters of *Murrya Koenigii*.

Parameter	Results
1. Plant height	4 to 6 m.
2. Petiole Size	20 to 30 cm
3. Colour of leaf	Green
4. Venation	Reticulate

Table 2. Leaf characters of *Murrya Koenigii.*

Parameter	Range
1. Palisade Ratio	11-12.5-14
2. Stomatal Number Upper Surface	0
3. Stomatal Number lower surface	67-75-82
4. Stomatal Index Upper surface	0
5. Stomatal Index lower surface	13.47-14.28-15.42
6.Vein-islet number	12-13-15
7.Veinlet Termination number	9-10-12

RESULT AND DISCUSSION

a. **Macromorphology**
The Macromorphological studies of *murrya koenigii* revealed that the leaves are exstipulate, bipinnately compound and the leaflets are obliquely ovate with acute apex.

b. **Microscopical study** :- The following characters are observed under the compound microscope. The leaf were cleared in hydrogen peroxide and Acetic acid in equal amount. Presence or absence of stomata. The type to stomata was noted anomocytic. The uniseriate multicellular trichome were present on both the surface more frequent on upper surface of midrib portion. Leaf microscopy to determine, stomatal number, stomatal index, Palisade ration, vein islet number, veinlet termination number etc. Powder leaves were used to determine physicochemical character like water soluble extractive & alchol soluble extractive and moisture content etc. The result are shown in table No. 2

c. Chemical Evaluation : Prelimnary chemical studies shown presence of alka loids, carbohydreates, Protein, Tannin, Saponins, Flavonoids, Glycoside, Volatile oil and absence of Gum/mucilage. Difference in colour reaction tests are given in table - 3

d. Physical Evaluation

(a) Fluorescene behaviors of the w leaf of *Murraya Koenigii* variously tested are presented in table - 4

(b) Extractive values and moisture content are presented table – 5

Table 3. Phytochemical examination of leaves of *Murraya Koenigii.*

Qualitative Tests	Results
Carbohydrates	+
Protein	+
Tannin	+
Gum/Mucilage	_
Flavonoids	+
Alkoloid	+
Saponins	+
Glycoside	+
Volatile oil	+

Table 4. Fluorescence behaviour of leaves of *Murraya Koenigii.*

Treatment	Day Light	UV Light
Powder as such	Pale Green	Same
Powder in distilled	Bluish Green	Same
Water		
Powder in absolute	Olive Green	Orange
Alcohol		
Powder in 10% NaOh	Light Brown	Dark Brown
Powder in 50% HNO_3	Yellow	Black
Powder in 50% H_2SO_4	Dark Green	Yellow with green

Table 5. Physio-chemical Parameters of *Murraya Koenigii*.

Parameters	Value obtained on dry weight basis (W/W)
Loss of drying	10.15%
Water soluble extractives	9.45%
Alcohol soluble extractives	7.65%

Above mentioned the characters of the plants useful for treating different ailments and have a useful drug of luman use. It will also help in achieving desired therapeutic values. The Pharmaco-gnostic parameters will help for sub-standard quality of drug & checking the adulteration.

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SHORT COMMUNICATION

EFFECT OF CALCIUM IN THE FORM OF GYPSUM ON STORAGE QUALITY AND ECONOMICS OF POTATO

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Abstract: The experiment was carried out at Horticulture Farm, Department of Horticulture, Indira Gandhi KrishVishwavidyalaya, Raipur (Chhattisgarh) during the *rabi* 2010-2011.The skin damaged tuber yield per hectare and skin damaged tuber number was found significant lowest in under T_5-80 kg ha^{-1} FDG. Under the treatment combinations T_4- 60 kg ha^{-1} FDG, T_6- 100 kg ha^{-1} FDG, T_{11}-50 kg ha^{-1} SDG and T_{10}- 40 kg ha-^{1} split dose of gypsum at planting and earthing up performs better regards storage quality, yields attributes and vegetative parameters. In T_5-80 kg ha^{-1} FDG given better response related to during storage at 30, 60, and 90 days after harvest found that lowest rotted tuber, tuber weight loss and skin damaged tuber number and weight.

The treatment combination 5 (T_5-80 kg ha^{-1} FDG) and with recommended NPK @ 150:100:100 found remarkably superior to all the other treatment combinations as regards to all morphological traits, yields attributes and storage quality parameters.The results indicated that the highest gross return (Rs. 212000 $ha^{-1)}$, net return (Rs. 141671 ha^{-1}) and benefit: cost ratio (Rs. 2.01) was obtained under T_5-80 kg ha^{-1} FDG and with recommended NPK.

Keywords: Calcium Gypsum, Horticulture, Potato

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable cum starch supplying crop believed to be originated in South America. Potato has high production per unit area per unit time. It can substitute the cereals for human consumption to a greater extent. Potato can be grown in winter as well as in rainy season depending upon the climatic situation. Although it is a temperate crop but can be grown successfully in sub-tropical regions. It is one of the most remunerative and profitable crop for the growers due to its higher yield potential within a limited time. Potato is a short duration crop, which is highly responsive to high inputs and capable to produce high yield under wide range of soils and climatic conditions. Low calcium concentration often occurs in organs with low rates of transpiration, such as potato tubers. There are many potato disorders, such as brown center, hollow heart, that were thought to be related to tuber calcium level. Application of optimum level of calcium had also been suggested for management of disorders and increase growth, yield and quality of potato.

Calcium also plays vital role in plant membrane structure and function, it also protects the cell membrane and gives strength to the cell walls, and thus plays significant role in tuber quality and plant growth when plants are subjected to abiotic and biotic stresses. Applying additional calcium can increase calcium content of the tubers and result in improved quality.India is the second largest producer of potato in the world after China. The area under potato cultivation in India is about 1.96 million hectare with production of 44.42 million tonnes and average productivity of 22.76 t/ha (NHB 2012). In Chhattisgarh potatoes are mainly cultivated in Surguja, Jashpur, Raigarh, Bilaspur, Bastar and Raipur districts during *Rabi* season except in Mainpat and Samaripat hills of Surguja district.The area under potato in Chhattisgarh state is 43.34 thousand hectare with annual production of 648 thousand tonnes (DOH ,CG,2012) with the average productivity (14.96)

MATERIAL AND METHOD

The experiment was carried out in 2010-11 atHorticulture Farm, Department of Horticulture, IndiraGandhi Krishi Vishwavidyalaya, Raipur (Chhattigarh) during the *rabi* 2010-2011. The soil of experimental field was clay in texture containing 0.58% organic matter with *p*H 7.4. The potato cultivar was used Kufri Pukhraj.The experiment was laid out in randomized complete block design with eleven treatments each replicated thrice (Gomez and Gomez 1984). Application of manure and fertilizers in treatment wise T_1-control, T_2-20, T_3-40, T_4-60, T_5-80, T_6-100, kg/ha full dose of gypsum with recommended dose of NPK @ 150:100:100 at planting and T_7-10, T_8-20, T_9-30, T_{10}-40, T_{11}-50 kg/ha along with recommended dose of NPK @ 150:100:100 half dose at time planting and half dose earthing up (30 DAP) 250 q/ha of FYM are also applied at time of field preparation Therefore, full dose of phosphorus and potassium @ 100 kg ha-1 each was applied through single super phosphate and muarate of potash respectively at the time of planting, whereas, nitrogen was applied in each plot into two split doses. Basal dose of nitrogen @ 75 kg ha^{-1} was applied through urea and remaining dose of nitrogen i e 75 kg ha^{-1} through urea (30 DAP). The pre emergence irrigation was provided at one day after planting at regular interval of 10 days. Irrigation was given by ridge and furrow method (number of irrigation 6) and spraying of monocrotophos was done 50 day after planting and Dithan-M-45 at 60 days after planting to protect the crop from aphids and blights respectively. The

observations of different growth parameters and yield parameters were recorded on five randomly selected competitive plants from each plot in each replication. Percent emergence was observed by counting the emerged plant up to 30 days after planting. The observations on growth attributes namely plant height, number of shoot plant-1 number of leaves plant^{-1} fresh weight of plant^{-1} recorded at 60 DAP and yield attributes namely number of tuber grade wise (0-25g, 25-50g, 50-75g, and >75g) plot-1 yield of tuber grade wise(0-25g, 25-50g,50-75g, and >75g) plot^{-1}, skin damage tuber plot-1, total potato yield, total number of tubers, skin damage during storage at 30, 60, 90, days after harvest were recorded. Grade tuber yield were recorded after digging of tuber on net plot basis in each replication at the time of harvest.

RESULT AND DISCUSSION

Taking 5 kg tubers of random size and weight stored in room temperature and data was recorded at 30, 60, and 90 days after harvest and data presented in Table No. 1

At 30 days after harvest the data of storage parameter just like skin damaged tuber number and weight indicated that the lowest skin damaged tuber number (7) and weight (0.39 kg) was obtained under the T5 where as the highest skin damaged tuber number (19) and weight (0.83 kg) was recorded in T_1-control.

At 60 days after harvest the lowest skin damaged tubers numbers (3) and weight (0.21 kg) observed under T5 and highest skin damaged tuber number (7) and weight (0.42 kg) found in T1-Control and T5 better than other Treatment combination related to skin damaged tuber number and weight.

At 90 days after harvest, T5 showed that lowest skin damaged tuber number (5) and weight (0.45 kg) and showed superiority over rest of Treatment combination followed. However T1- control exhibited the highest skin damaged tuber number (11) and weight (0.86 kg).

The data of other skin damaged storage parameter, tuber weight loss (kg) at 30, 60 and 90 days after harvest, sprouted tuber numbers and weight are presented in Table-1

In case of tuber weight loss was recorded lowest under the T5 at 30 and 60 (0.14g and 0.25g) in case 90 days after harvest tuber weight loss higher (0.31 kg) in under T5 compare to 30 and 90 days after harvest.

In case of sprout, healthy and rotted tuber which was related to storage parameter the data presented in Table No. 1.

The data showed that sprout tuber (0.002 kg) and rotted tuber (0.65 kg) was recorded lowest in T5 and healthy tuber was recorded highest also in T5 (4.35 kg)

Above results is better due to the application of different dose of gypsum with recommended dose of NPK because of that calcium is important for enhancing the membrane structural stability and maintaining the cell wall rigidity.

Calcium also important in increasing plant tissue resistance due to application of gypsum as increase calcium content in tuber therefore reduced the internal brown spot disorder which is associated with calcium deficiency, and improves storage quality of potato. The present result was in confirmity with the finding obtained by Spillman (2003) reported that preplant strip application of gypsum in the sandy soil resulted in improved tuber grade and size due to increased periderm calcium concentration in tuber and Bangerth (1979) found that application of optimum level of calcium for management of disorders (IBS) and increase quality of potato.

The economics of treatment per hectare are given in Table 2. The input cost per hectare varied from Rs. 68961 to Rs. 72421 under different treatments. The input cost maximum in treatment combination T_{11}-50 kg SDG (72421Rs/ha), T_{10}-40 kg SDG(72079 Rs/ha), T_9-30 kg SDG (71737 Rs/ha), T_8-20 kg SDG (71395 Rs/ha)), T_7-10 kg SDG (71053 Rs/ha) and lowest cost of input was found in treatments combinationsT_2- 20 kg FDG (69303 Rs/ha) T_3-40 kg FDG (69645 Rs/ha), T_4-60 kg (69987 Rs/ha) , T_5- 80 kg FGD (70329 Rs/ha) , and T_6- 100 kg FDG (70671 Rs/ha).

The net income/ha ranged from Rs/ha 41679 to Rs. 141671. Thus, the maximum income (both gross and net) were obtained with T_5- 80 kg full dose gypsum (212000 and 141671 Rs/ha) and lowest income (both gross and net) were obtained with T1- no application of gypsum (110640 and 41679 Rs/ha).

The benefit cost ratio ranged from 0.60 to 2.01 depending on different treatments. It was found to be highest 2.01 under T_5- 80 kg full dose gypsum and lowest 0.60 under T1- no application of gypsum. Above finding under the study are in close proximity with the finding Anon (2009).

Table 1. Damaged tuber during 30, 60 and 90 days after harvest in store at room temperature

	Skin damage during storage						Tuber wt loss (kg)			Sprouted tuber at 90 days		Wt (kg)		
Treatments	**30 Days**		**60 days**		**90 days**									
	Wt (kg)	**No. of tuber**	**Wt (kg)**	**No. of tuber**	**Wt (kg)**	**No. of tuber**	**30 days**	**60 days**	**90 days**	**No.**	**Wt (kg)**	**sprout**	**Healthy tuber**	**Rotted tuber**
T_1- control	0.83	19	0.42	7	0.95	6	0.17	0.31	0.37	9	0.17	0.009	2.01	1.47
T_2-20 kg FDG	0.61	8	0.27	5	0.75	8	0.26	0.20	0.34	6	0.15	0.006	3.91	0.69
T_3 -40 kg FDG	0.51	9	0.25	4	0.72	7	0.15	0.37	0.33	5	0.22	0.009	4.12	0.70
T_4 -60 kg FDG	0.42	10	0.25	3	0.65	7	0.19	0.24	0.29	3	0.18	0.007	4.21	0.68
T_5-80 kg FDG	0.39	7	0.21	3	0.45	5	0.14	0.31	0.25	3	0.14	0.002	4.35	0.65

T_6-100 kg FDG	0.45	11	0.27	4	0.67	6	0.16	0.25	0.30	5	0.20	0.005	4.14	0.72
T_7 -10 kg SDG	0.55	11	0.30	4	0.80	9	0.25	0.22	0.38	5	0.16	0.005	3.00	0.75
T_8-20 kg SDG	0.65	13	0.32	6	0.82	9	0.28	0.32	0.41	6	0.18	0.006	3.20	0.76
T_9 -30 kg SDG	0.69	12	0.33	5	0.84	8	0.29	0.29	0.39	6	0.17	0.008	3.57	0.78
T_{10} -40 kg SDG	0.72	11	0.36	5	0.86	11	0.32	0.34	0.42	7	0.15	0.003	3.78	0.80
T_{11}-50 kg SDG	0.80	14	0.38	6	0.92	10	0.35	0.37	0.41	8	0.16	0.004	4.0	0.90

Table 2: Economics and net returns of different treatments

Treatments	**Yield (t/ha)**	**Cost of cultivation (Rs/ha)**			**Cost (Rs/ha)**		**Sale price (Rs/q)**	**Net returns* (Rs/ha)**	***Benefit cost ratio***
		Seed	**Fertilizer**	**Cultivation**	**Inputs**	**Produce**			
T1	13.83	40000	5211	23750	68961	110640	800	41679	0.60
T_2-20	19.00	40000	5553	23750	69303	152000	800	82697	1.19
T_3 -40	21.43	40000	5895	23750	69645	171440	800	101795	1.46
T_4 -60	25.34	40000	6237	23750	69987	202720	800	132733	1.90
T_5 -80	26.50	40000	6579	23750	70329	212000	800	141671	2.01
T_6-100	24.31	40000	6921	23750	70671	194480	800	123809	1.75
T_7-10	15.52	40000	5553	25500	71053	124160	800	53107	0.75
T_8-20	17.10	40000	5895	25500	71395	136800	800	65405	0.92
T_9-30	16.71	40000	6237	25500	71737	133680	800	61943	0.86
T_{10}-40	21.39	40000	6579	25500	72079	171120	800	99041	1.37
T_{11}-50	22.09	40000	6921	25500	72421	176720	800	104299	1.44

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SHORT COMMUNICATION

COMPARATIVE EFFICACY OF NOVEL INSECTICIDES AND BIO- PESTICIDES ON LARVAL POPULATION DENSITY OF GRAM POD BORER (*HELICOVERPA ARMIGERA* HUBNER) ON CHICKPEA

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Abstract: Field study was conducted to determine the comparative efficacy of lambdacyhalothrin 5 EC, fenvalerate 10 EC, indoxacarb 14.5 SC, quinalphos 25 EC, spinosad 45 SC, neemarin 1500 ppm and *Ha* NPV against the larval population of gram pod borer, *Helicoverpa armigera* on chickpea in the experimental research area of Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110 (U.P.) during Rabi 2011-12. The efficacy of the insecticides was ascertained by comparing treated plots with the control plots. All the insecticides resulted in significant reduction in the larval population density of the pest in comparison with control. However, indoxacarb 14.5 SC proved to be the best insecticide followed by spinosad 45 SC, lambda-cyhalothrin 5 EC, quinalphos 25 EC, fenvalerate 10 EC, neemarin 1500 ppm and *Ha* NPV respectively**.**

Keywords: Chickpea, Gram pod borer, Larval populattion

INTRODUCTION

Chickpea, *Cicer arietinum* (Lineus) is an important pulse crop and commonly known as chana, or Bengal gram. Chickpea is a very important component of cropping systems of the dry, rainfed areas, because it can fix 80 to 120 kg nitrogen per hectare through symbiotic nitrogen fixation (Papastylanou, 1987). Various Factors responsible for low production and productivity the crop are poor genetic base, weeds, diseases and insect pests. Major insect pests of chickpea are cutworm, *Agrotis sp.* (Hufnagel), gram pod borer, *Helicoverpa armigera* (Hubner), gram semilooper, *Autographa nigrisigna* (Walker), aphid, *Aphis craccivora* (Koch) and tur pod bug, *Clavigralla gibbosa* (Spinola).

The moths begin ovipositing on chickpea at the seedling stage but this behavior is checked by the adverse climatic and geographical conditions (Tahhan *et al*., 1982; Lal, 1996). *H. armigera* starts devouring the young shoots, leaves and pods whatever available soon after hatching. A large number of entomologists studied the population fluctuations of *H. armigera* on chickpea (Dakwale and Singh, 1980; Deka *et al*., 1989; Prasad *et al*., 1989; Patel and Koshiya, 1997) and observed population peaks in different months of the year. The population peaks generally corresponds to the full bloom and pod formation stage of chickpea (Deka *et al*., 1987; Lal, 1996 and Patel and Koshiya, 1999). Many other factors including temperature and humidity (Yadava *et al*., 1991; Yadava and Lal, 1988), rainfall (Tripathi and Sharma, 1985), predators (Thakur *et al*., 1995; Gunathilagaraj, 1996) and parasitoids (Bhatnagar, 1980; Srinivas and Jayaraj, 1989; Thakur *et al*., 1995) can also affect *H. armigera* population. The extent of damage inflicted by *H. armigera* to chickpea depends not only on the number of larvae but also on its developmental stages (Tripathi and Sharma, 1984). No study has so far reported population fluctuations with reference to eggs and larval instar densities under field conditions. Therefore, the aim of this study was to describe the population dynamics of *H. armigera* in terms of eggs and larval instars. The role of environmental factors affecting these variations has also been described.

Choudhary and Sachan (1995), Lal (1996) tested various insecticides and biopesticides against gram pod borer on chick pea at various stage of growth like 50% flowering, pod formation and dough stage. They reported that the application of insecticides at proper stage resulted in less pod borer population and increased yield as compared to check.

MATERIAL AND METHOD

The present study was carried out at the experimental field Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110 (U.P.) during Rabi 2011-12. The experiment was laid in randomized block design with 3 replications. Chickpea variety WCG-3 was sown on 14th November at a distance of 30 X 8 cm apart. Similar agronomic practices were applied to all 8 treatments from sowing to harvesting. First spray was applied at pod formation stage and second spray after 10 days of the first spray. Observations regarding pest population were recorded from 5 randomly selected plants from each plot 24 hours before spray and 3, 7 and 10 days of first and second spray.

RESULT AND DISCUSSION

Pre-treatment larval population of *Helicoverpa armigera* was insignificant but larval population differed significantly among the treatments after the application of insecticides (Table I and II). A sharp decline in the larval population density of *H.*

armigera was noted third day after the application of each spray as compared to control. All the treatments were effective in managing the larvae of *H. armigera* than control. The most effective treatment was indoxacarb 14.5 SC @ 500 ml/ha after first spray of 1.00 (3 DAS), 1.67 (7 DAS) and 2.33 larvae/five plants (10 DAS) and the minimum larval population after second spray of 1.33 (3 DAS), 2.00 (7 DAS) and 3.67 larvae/five plants (10 DAS), respectively. The treatments spinosad 45 SC @ 200 ml/ha and lambda cyhalothrin 25 EC @ 500 ml/ha were found at par. Next effective treatment after first spray i.e. spinosad 45 SC @ 200 ml/ha 1.33 (3 DAS), 2.33 (7 DAS), 3.00 (10 DAS), lambda-cyhalothrin 5EC @ 500 ml/ha 2.00 (3 DAS), 2.67 (7 DAS), 3.67 (10 DAS), quinalphos 25 EC @ 1000 ml/ha, 2.67 (3 DAS), 3.33 (7 DAS), 4.33 (10 DAS), fenvalerate 10 EC @ 1000 ml/ha 3.00 (3 DAS), 3.67 (7 DAS), 4.67 (10 DAS), neemarin 1500 ppm @ 3000 ml/ha 3.67 (3 DAS), 4.33 (7 DAS), 5.00 larvae/five plants (10 DAS), and after second spray i.e. spinosad 45 SC @ 200 ml/ha 1.67 (3 DAS), 2.67 (7 DAS), 4.33 (10 DAS), lambda-cyhalothrin 5EC @ 500 ml/ha 3.00 (3 DAS), 3.67 (7 DAS), 4.67 (10 DAS), quinalphos 25 EC @ 1000 ml/ha, 3.67 (3 DAS), 4.33 (7 DAS), 6.00 (10 DAS), fenvalerate 10 EC @ 1000 ml/ha 4.00 (3 DAS), 4.67 (7 DAS), 7.67 (10 DAS), neemarin 1500 ppm @3000 ml/ha 3.67 (3 DAS), 4.33 (7 DAS), 5.00 larvae/five plants larvae/five plants (10 DAS), respectively. The lowest effective treatment was found *Ha* NPV 500 LE/ha after first spray of 4.00 (3 DAS), 4.67 (7 DAS) and 5.67 larvae/five plants (10 DAS) and the minimum larval population after second spray of 5.00 (3 DAS), 5.67 (7 DAS) and 10.67 larvae/five plants (10 DAS) respectively. The present findings are supported by Singh and Yadav (2007) who reported that efficacy of four insecticides *i.e.*, indoxacarb, thiamethoxam, spinosad and endosulfan; three bio pesticides (two *Bacillus thuringiensis*-based bio insecticides) namely Halt, Biolep and *H. armigera* nuclear polyhedrosis virus (*Ha* NPV) and two neem formulations *viz.*, nimbicidine and neemarine revealed that indoxacarb was effective in reducing larval population at the minimum. Anandhi *et al*. (2011) reported that indoxacarb was the most effective in comparison to spinosad, quinalphos, NSKE etc in chickpea crop. Dhaka *et al.* (2011), Biradar *et al.* (2001) reported that indoxacarb caused minimum larval population in chickpea. The present findingare contrary to finding of Randhawa *et al.* (2009) reported that spinosad 48 SC was found to be the most effective insecticide for the control of *H. armigera*.

Table 1: Larval population of *Helicoverpa armigera* on chick pea after first spray of various insecticides and bio-pesticides.

Treatment	**Mean no. of Larvae/five plants**				
	1 DBS	**3 DAS**	**7 DAS**	**10 DAS**	**Mean**
Lambda-cyhalothrin 5 EC	10.67 (3.41)	2.00 (1.71)	2.67 (1.91)	3.67 (2.15)	2.78
Fenvalerate 10 EC	9.67 (3.26)	3.00 (1.98)	3.67 (2.15)	4.67 (2.37)	3.78
Indoxacarb14.5 SC	10.33 (3.35)	1.00 (1.38)	1.67 (1.62)	2.33 (1.82)	1.66
Quinalphos 25 EC	11.00 (3.44)	2.67 (1.91)	3.33 (2.07)	4.33 (2.30)	3.44
Spinosad 45 SC	9.67 (3.26)	1.33 (1.52)	2.33 (1.82)	3.00 (1.98)	2.22
Neemarin 1500 ppm	11.33 (3.50)	3.67 (2.15)	4.33 (2.30)	5.00 (2.44)	4.33
Ha NPV	10.67 (3.41)	4.00 (2.22)	4.67 (2.36)	5.67 (2.58)	4.78
Control	9.67 (3.26)	15.00 (3.99)	16.33 (4.16)	18.67 (4.35)	16.66
SE(m)± **CD at 5%**	0.154 NS	0.147 0.450	0.113 0.347	0.098 0.300	

DBS = Day before spray, DAS = Days after spray

* Figures in parentheses square root values

Table 2: Larval population of *Helicoverpa armigera* on chick pea after second spray of various insecticides and bio-pesticides.

Treatment	Mean no. of Larvae/five plants				
	1 DBS	3 DAS	7 DAS	10 DAS	Mean
Lambda-cyhalothrin 5 EC	3.67 (2.15)	3.00 (1.98)	3.67 (2.15)	4.67 (2.37)	3.78
Fenvalerate 10 EC	4.67 (2.37)	4.00 (2.22)	4.67 (2.37)	7.67 (2.93)	5.44
Indoxacarb14.5 SC	2.33 (1.82)	1.33 (1.52)	2.00 (1.71)	3.67 (2.15)	2.33
Quinalphos 25 EC	4.33 (2.30)	3.67 (2.15)	4.33 (2.30)	6.00 (2.70)	4.66
Spinosad 45 SC	3.00 (1.98)	1.67 (1.62)	2.67 (1.91)	4.33 (2.30)	2.89
Neemarin 1500 ppm	5.00 (2.44)	4.33 (2.30)	5.00 (2.44)	9.33 (3.20)	6.22
Ha NPV	5.67 (2.58)	5.00 (2.44)	5.67 (2.57)	10.67 (3.41)	7.11
Control	18.67 (4.35)	21.00 (2.69)	23.67 (4.96)	22.33 (4.79)	22.34
SE(m)± **CD at 5%**	0.098 0.300	0.118 0.361	0.138 0.424	0.117 0.358	

DBS = Day before spray, DAS = Days after spray
* Figures in parentheses square root values

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SHORT COMMUNICATION

SCREENING OF SORGHUM GENOTYPE ENOTYPES FOR SHOOT FLY, *ATHERIGONA SOCCATA* RONDANI (DIPTERA: MUSCIDAE) OVIPOSITIONAL BEHAVIOR

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Abstract: The twenty five sorghum genotypes evaluated against shoot fly, genotypes SU 1394, SU 1397 and SU 1400 performed better being less preferred for oviposition on the 14th and 21st day after germination with a mean oviposition of 55.77 and 61.14, 56.84 and 60.00 and 54.75 and 61.33 per cent, respectively and next to resistant check IS 2312.

Keywords: Shoot fly, Oviposition, Dead heart

INTRODUCTION

Sorghum, *Sorghum bicolor* (L.) Moench is an important cereal crop in Asia, Africa, and Australia. It is grown all over the world and is a staple food and fodder Crop in India. The losses due to insects have been estimated to be over US$ 1000 million annually in the semi-arid tropics. Among cereals, sorghum is the fourth most important crop after rice, wheat and maize in India. The major sorghum growing areas are in the states of Maharashtra, Andhra Pradesh, Karnataka, Gujarat, Tamil Nadu and Rajasthan. Insect pests play an important role in lowering the yield of sorghum. The shoot fly and stem borer are the key pests in most of sorghum growing area. Of which, the shoot fly, *Atherigona soccata* Rondani is considered to be the most severe pest in Rajasthan as well as in India causing tremendous damage at the seedling stage by killing the central shoot. Acknowledge of the mechanisms and the factors contributing to host-plant resistance to insects is useful in deciding suitable selection criteria and breeding methods for the genetic improvement of sorghum for resistance to insects (Sharma, 1993).

MATERIAL AND METHOD

A field trail was conducted the Instructional Farm at Rajasthan College of Agriculture, Udaipur during *kharif* 2011 in a Randomized Block Design with 3 replications. Sowing was done in four rows plots with 3.75 meter length. The row to row distance was maintained at 45 cm while plant to plant distance was maintained at 15 cm. The plot size was maintained 3.75m x 1.80m = 6.75 m^2. Twenty five experimental genotypes were tested under natural conditions of shoot fly infestation together with one resistant check and one susceptible check. Manual thinning operation was carried out 10 days after germination to maintain 30 plants in each row.

Twenty five experimental genotypes included were as SU 1382, SU 1383, SU 1384, SU 1385, SU 1386, SU 1387, SU 1388, SU 1389, SU 1390, SU 1391, SU 1392, SU 1393, SU 1394, SU 1395, SU 1396, SU 1397, SU 1398, SU 1399, SU 1400, SU 1401, SU 1402, SU 1403, SU 1404, IS 2312 (resistant check) and DJ 6514 (susceptible check).

Oviposition. The total count of plants with shoot fly eggs from 20 tagged plants (5 plants per row) from each genotype were recorded on 14th and 21st day after germination.

$$\text{Oviposition} \quad \% = \frac{\text{Number of plants with eggs}}{\text{Total number of plants observed}} \times 100$$

Dead hearts. Dead hearts formed due to shoot fly infestation was recorded on 20 tagged plants on 28th day after germination and the data were expressed as a per cent of dead heart.

$$\text{Dead heart} \quad \% = \frac{\text{Number of plants with dead heart}}{\text{Total number of plants observed}} \times 100$$

RESULTS AND DISCUSSION

It is evident from Table 1 that the maximum per cent oviposition was recorded in the susceptible check DJ 6514 (65.95); whereas, the minimum was recorded in the resistant check IS 2312 (53.73). The mean oviposition varied from 54.75 (SU 1400) to 62.29 (SU 1382). Among the test entries, SU 1400 was found better and closely at par to resistant check IS 2312. The genotype SU 1382 has maximum oviposition followed by SU 1385 and SU 1401 which were found significantly more oviposition than the remaining genotypes. SU 1389, SU 1399, SU 1400, SU 1402, SU 1394 and SU 1393 identified the less susceptible genotypes among the rest of the genotypes except DJ 6514. Though, SU 1382, SU 1385 and SU 1401 were found significantly at par with susceptible check DJ 6514 while remaining were significantly better over DJ 6514.

The data recorded 21st day after germination revealed that the maximum oviposition was recorded in the susceptible check DJ 6514 (71.95), while the minimum was recorded in the SU 1397 (60.00). Among the test entries, SU 1400 and SU 1383 were better over the rest of the genotypes and equal to resistant check IS 2312. The genotype SU 1401 had

the maximum oviposition followed by SU 1389 and SU 1391 which have significantly more oviposition and susceptibility towards resistance over the genotypes. SU 1394, SU 1383, SU 1386, SU 1397 and SU 1400 which were the least susceptible over the rest of the genotypes. Genotype SU 1397 was found most promising among rest of the genotypes.

The data on dead heart formation revealed that the maximum percentage of dead hearts were recorded in the susceptible check DJ 6514 (59.86), whereas the minimum was recorded in the resistant check IS 2312 (27.85). The dead heart formation in all the tested genotypes were significantly lower than susceptible check (Table 1). The per cent dead heart ranged from 36.90 (SU 1384) to 47.07 (SU 1393 and SU 1396). Among the test entries SU 1384, which was statistically at par with the SU 1383, SU 1402, SU 1403, SU 1392, SU 1391 and SU 1387 while SU 1384 and SU 1404 were performed significantly better over SU 1388, SU 1389, SU 1390, SU 1393, SU 1396, SU 1398, SU 1399, SU 1400 and SU 1401.

The present findings are in confirmation with Singh and Jotwani (1980); Krishananda *et al.* (1970); Ameta and Dadheech (2001), who reported that least eggs in resistant varieties in comparison to susceptible ones. Somashekhar (1985); Khandare and Patil (2010) reported that IS 2312 and IS 5490 recorded minimum number of eggs per plant followed by SPV 221, SPV 105, SPV 247 and SU 774.

Table 1: Effect of different sorghum genotypes on oviposition of Shoot fly corresponding to dead heart during, *kharif*, 2011

Genotypes	**14th Days after germination**	**21st Days after germination**	**Mean dead heart (%) at 28th day after germination**
	Oviposition	**Oviposition**	
SU 1382	62.29 (78.33) **	63.55 (80.00)	42.92 (46.39)
SU 1383	59.05 (73.33)	61.33 (76.67)	40.82 (42.78)
SU 1384	56.84 (70.00)	64.81 (81.67)	36.90 (36.06)
SU 1385	61.22 (76.67)	62.48 (78.33)	42.30 (45.33)
SU 1386	57.91 (71.67)	62.29 (78.33)	46.00 (51.65)
SU 1387	60.07 (75.00)	63.86 (80.00)	39.54 (40.53)
SU 1388	60.07 (75.00)	63.55 (80.00)	44.63 (49.36)
SU 1389	55.77 (68.33)	68.66 (86.67)	44.07 (48.37)
SU 1390	56.84 (70.00)	66.14 (83.33)	44.29 (48.69)
SU 1391	57.98 (71.67)	67.40 (85.00)	39.48 (40.52)
SU 1392	61.14 (76.67)	63.55 (80.00)	37.57 (37.19)
SU 1393	56.84 (70.00)	62.29 (78.33)	47.07 (53.34)
SU 1394	55.77 (68.33)	61.14 (76.67)	41.02 (43.14)
SU 1395	56.96 (70.00)	66.26 (83.33)	44.56 (44.05)
SU 1396	60.07 ()75.00	66.84 (83.33)	47.07 (53.34)
SU 1397	56.84 (70.00)	60.00 (75.00)	41.45 (43.83)
SU 1398	57.98 (71.00)	64.69 (81.67)	44.76 (49.60)
SU 1399	54.89 (66.67)	63.93 (80.00)	43.63 (47.62)
SU 1400	54.75 (66.67)	61.33 (76.67)	44.96 (49.92)
SU 1401	61.14 (76.67)	70.11 (88.33)	43.68 (47.70)
SU 1402	55.77 (68.33)	63.43 (80.00)	40.58 (42.32)
SU 1403	56.84 (70.00)	65.19 (81.67)	37.77 (37.52)
SU 1404	58.93 (73.33)	64.81 (81.67)	36.97 (36.18)
IS-2312 (R)	53.73 (65.00)	61.14 (76.67)	27.85 (21.91)
DJ-6514 (S)	65.95 (83.33)	71.95 (90.00)	59.86 (74.75)
S.Em.±	1.977	2.692	2.210
CD(5%)	5.622	7.655	6.285
CV (%)	5.881	7.237	9.057
Correlation Co-efficient (r)			

* 1 = Light green leaf with shining 2 = Medium green leaf with shining 3 = Dark green leaf without shining

** Figures in parentheses are angular re-transformed per cent values

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SHORT COMMUNICATION

EFFECT OF NITROGEN AND SULPHUR LEVELS ON GROWTH, YIELD AND NUTRIENT UPTAKE OF HYBRID RICE IN INCEPTISOL

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Abstract: A field experiment was conducted at the Instructional Farm of the Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *kharif* season, 2010 and 2011 to evaluate the nitrogen and sulphur requirement of hybrid rice in Inceptisol. The Sixteen treatments comprising 4 levels each of N (0, 80, 160 & 240) and S (0, 20, 40 & 60 kg ha^{-1}) were laid out in randomized block design with three replications. Hybrid rice variety PHB-71 was taken as test crop. The experimental soil was silt loam in texture having bulk density 1.38 M gm^{-3}, water holding capacity 23.11 %, pH (1:2.5) 8.80, EC 0.41 dSm^{-1}, Organic carbon 2.7 g kg^{-1}, exchangeable sodium percentage 29.9, available N 203, P_2O_5 15.25, K_2O 265 and S 13.38 kg ha^{-1}.The required quantity of fertilizer was applied through urea and sulphur with elemental sulphur before transplanting. The growth, yield and yield attributes increased with increasing nitrogen and sulphur doses up to 240 $kgha^{-1}$ and 60 kg ha^{-1}, respectively. Maximum yield, yield attributes were recorded with the application 240 kg ha^{-1}, which was significantly superior over 80 kg N ha^{-1} and at pat with 160 kg N ha^{-1}. Likewise maximum yield and yield attributing parameter and nutrient uptake were recorded with 60 kg S ha^{-1} which was significantly superior over 20 kg S ha^{-1} and statistically at par 40 kg S ha^{-1}. The maximum net return (Rs. 54559.72) and cost benefit ratio (1.874) were obtained by applying 160 kg N ha^{-1} with 40 kg S ha^{-1} by PHB-71 in Inceptisol of Uttar Pradesh.

Keywords: Hybrid Rice, Nitrogen, Sulphur

INTRODUCTION

Rice is an important leading cereal crops grown all over the world. It is staple food of more than 70 per cent of the world population. India needs to produce more rice to feed the ever grown population for which the hybrid cultivation is only available strategy. The suitable dose of fertilizer is of prime importance that promotes the efficient utilization of nutrients. The present strategy of increasing food production essentially involves the balanced use of fertilizers to hybrid rice because all the varieties give their full yield potential with adequate supply of nutrients. Among major essential nutrients, nitrogen and sulphur play very pivotal role for growth and metabolic process in rice plant. Among major nutrients nitrogen is most important particularly in our country. Most of the Indian soils are deficient in this nutrient. The deficiency of nitrogen and sulphur are also coming up as a serious problem in rice, mostly in light textured and salt affected soils. The relationship between nitrogen and sulphur has been studied by several workers in different crops but the interaction between nitrogen and sulphur in hybrid rice, especially in sodic soil is of great importance and very little investigation has been made so far in this regard. Thus, present investigation was carried out to study the nitrogen and sulphur requirement of hybrid rice for salt affected soil of eastern Uttar Pradesh.

MATERIAL AND METHOD

The filed experiment was conducted during *Kharif* season, 2010 and 2011at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). Sixteen treatments comprising 4 levels each of N (0, 80, 160, and 240) and S (0, 20, 40, and 60 $kgha^{-1}$) were evaluated in randomized block design replicated thrice. The variety of hybrid rice PHB-71 was taken as test crop. The experimental soil was silt loam in texture having bulk density 1.38 Mgm^{-3}, water holding capacity 23.11 %, pH (1:2.5) 8.80, EC 0.41 dSm^{-1}, organic carbon 2.7 g kg^{-1}, exchangeable sodium percentage 29.9, available N 203, P_2O_5 15.25, K_2O 265 and S 13.38 kg ha^{-1}.The required quantity of fertilizer was applied through urea and sulphur with elemental sulphur before transplanting. Common doses of fertilizers were applied through diammonium phosphate and muriate of potash. One third dose of nitrogen and total phosphorus and potash were applied as basal before puddling and incorporated in the top 15 cm soil, remaining dose was applied as top dressing in two equal splits each at tillering and panicle initiation stage, respectively. The various physico-chemical properties of soil were determined as per standard procedures.

RESULT AND DISCUSSION

Growth, yield and yield attributes

The results presented in table-1 indicated that the plant height, number of tillers m^{-2} , number panicles m^{-2} , number of seeds $panicle^{-1}$, test weight and grain & straw yield increased with increasing levels of nitrogen up to 240 kg N ha^{-1}. The maximum response was recorded at nitrogen 240 kg N ha^{-1} which was at par with 160 kg N ha^{-1}. This might be due to better utilization of nutrients. These results are in close conformity with the findings of Meena *et. al.* (2003), Malik and Kaleem (2007), Zaidi and Tripathi (2007). Application of sulphur also increased yield and yield attributes with increasing levels of sulphur.

The increase in yield and yield attributes by the application of S might be due to maximum response of sulphur was recorded with the application of 60 kg S ha^{-1} which was significantly superior over 20 kg ha^{-1} and at par with 40 kg S ha^{-1}.

Protein Content

The maximum protein content (table-1) in grain (8.00%) was recorded with the application of nitrogen 240 kg N ha^{-1} which was found significantly superior over 80 kg Nha^{-1} (6.44%) and at par with 160 kg ha^{-1} (7.63%). The increase in protein content due to application of N might be due to the fact that N is constituent of protein. These results also corroborated with the findings of Dwivedi *et. al.* (2006). Application of sulphur also increased the protein content with increasing levels. Maximum response of sulphur was recorded with 60 S kg ha^{-1}which was significantly superior over 20 kg S ha^{-1} and at par with 40 kg S ha^{-1}. This might be due to increased sulphur assimilation in plants because nitrogen and sulphur are major component of amino acids and protein. Similar findings were also reported by Chandel *et. al.* (2003).

Nutrient Uptake

The uptake of nutrients (table-2) increased with increasing levels of nitrogen up to 240 kg N ha^{-1} which was found significantly superior over 80 kg Nha^{-1} and at par with 160 kg ha^{-1}. The maximum uptake of the nutrients viz. N, P, K and S were recorded with the application of 240 kg Nha^{-1}. It was mainly due to increase in concentration of nutrients in grain and straw along with increase in yields. Similar findings were also reported by Om *et.al.* (1998). the uptake of nutrients also increased with the application of sulphur. The highest nutrients (N, P, K and S) uptake were recorded at 60 kgSha^{-1} which was significantly superior over 20 kgSha^{-1} and at par with 40kg S ha^{-1}.This might be due to increased assimilation of sulphur because sulphur is a constituent of amino acids that work as building block of the plant. These results also corroborated the findings of by Singh *et.al.* (1993).

Table 1. Effect of nitrogen and sulphur on growth and yield attributes of hybrid rice at harvest stage.

Treatments	Plant height(cm)	No. of tillers m^{-2}	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Test weight (g)	Harvest index (%)
Nitrogen levels (kg ha^{-1})								
N_0	100.06	284.33	257.15	112.46	46.45	58.11	21.24	44.38
N_{80}	112.67	345.83	284.95	131.92	58.25	72.20	22.74	44.58
N_{160}	123.18	370.17	336.59	149.13	68.51	83.03	23.17	45.17
N_{240}	128.40	375.83	337.79	151.56	68.95	85.40	23.70	44.65
SEm ±	2.38	4.99	6.09	2.81	1.25	1.53	0.20	0.60
C.D. at 5%	6.89	14.43	17.58	8.12	3.61	4.41	0.58	NS
Sulphur levels (kg ha^{-1})								
S_0	103.06	307.08	263.32	115.55	52.19	66.37	21.66	43.96
S_{20}	111.69	343.08	282.61	130.11	57.72	71.50	22.45	44.58
S_{40}	122.36	361.42	334.16	148.21	65.81	79.51	23.24	45.30
S_{60}	127.21	364.58	336.38	149.21	66.45	81.44	23.49	44.94
SEm ±	2.38	4.99	6.09	2.81	1.25	1.53	0.20	0.60
C.D. at 5%	6.89	14.43	17.58	8.12	3.61	4.41	0.58	NS

Table 2. Effect of nitrogen and sulphur on uptake of hybrid rice at harvest stage.

Treatments	Nutrient Uptake (kg ha^{-1})							
	Nitrogen		Phosphorus		Potassium		Sulphur	
Nitrogen levels (kg ha^{-1})	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
N_0	44.38	39.51	13.10	7.22	26.94	52.90	17.90	12.36
N_{80}	60.22	54.27	17.90	10.43	37.97	72.17	25.06	17.52
N_{160}	84.01	66.42	23.47	13.48	47.95	106.71	33.56	21.95
N_{240}	88.43	69.24	24.55	14.86	48.95	107.35	34.47	23.40
SEm ±	2.21	2.47	0.47	0.50	0.81	1.95	0.89	0.88
C.D. at 5%	6.40	7.13	1.38	1.45	2.34	5.36	2.58	2.55
Sulphur levels(kg ha^{-1})								

S_0	44.88	45.79	15.36	8.18	29.22	64.37	19.59	13.46
S_{20}	64.50	53.13	18.38	10.87	36.36	80.08	25.17	16.68
S_{40}	78.97	62.81	21.96	12.77	46.72	93.02	32.69	21.68
S_{60}	80.40	65.15	23.33	14.18	47.84	96.09	34.38	23.23
SEm ±	2.21	2.47	0.47	0.50	0.81	1.95	0.89	0.88
C.D. at 5%	6.40	7.13	1.38	1.45	2.34	5.36	2.58	2.55

Table 3. Economic parameters of hybrid rice.

Treatment combinations	Grain yield ($qha^{-1)}$	Straw yield (qha^{-1})	Cost of cultivation ($Rs.ha^{-1}$)	Gross return ($Rs.ha^{-1}$)	Net return ($Rs.ha^{-1}$)	Benefit cost ratio
N_0S_0	39.82	51.24	23892.135	44944	21051.865	0.881
$N_0 S_{20}$	44.25	56.32	25539.185	49882	24342.815	0.953
N_0S_{40}	50.62	61.28	27186.185	56748	29561.815	1.087
N_0S_{60}	51.10	63.58	28833.285	57458	28624.715	0.992
$N_{80}S_0$	49.64	64.33	24848.655	56073	31224.345	1.256
$N_{80} S_{20}$	55.33	68.62	26495.705	62192	33696.295	1.347
$N_{80}S_{40}$	63.39	77.23	28142.755	71113	42970.247	1.526
$N_{80}S_{60}$	64.64	78.62	29789.805	72502	42712.195	1.433
$N_{160}S_0$	58.85	73.25	25805.175	61175	40369.825	1.564
$N_{160}S_{20}$	65.32	78.27	27452.225	73147	49694.775	1.664
$N_{160}S_{40}$	74.63	90.29	29099.275	83659	54559.725	1.874
$N_{160}S_{60}$	75.25	90.32	30747.325	84282	53534.675	1.741
$N_{240}S_0$	60.43	76.66	26761.645	68096	41334.335	1.544
$N_{240}S_{20}$	65.98	82.81	27718.165	74261	46542.835	1.679
$N_{240}S_{40}$	74.60	89.23	30055.745	83523	53467.255	1.789
$N_{240}S_{60}$	74.80	93.25	31702.795	84125	52422.205	1.653

CONCLUSION

On the basis of experimental results, it may be concluded that the application of 240 $kgNha^{-1}$ as well as 60 kg Sha^{-1} produced highest grain and straw yield, protein content and uptake of nutrients (N, P, K, and S). However these levels of nutrients were statistically at par with the application of 160KgN and 60 kg S ha^{-1}.

Thus, the recommendation of 160 N and 40kg S ha^{-1} may be given for better performance of hybrid rice.

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SHORT COMMUNICATION

CORRELATION AND PATH ANALYSIS IN CHILLI (*CAPSICUM ANNUUM* L.)

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Abstract: Correlation and path coefficient analysis for nine genotypes of chilli were evaluated during *rabi*season of 2011-12. The studies revealed that green fruit yield per plant had highly significant and positive association with days to 50% flowering at phenotypic and genotypic level, number of primary branches at genotypic level, fruit length at phenotypic level, fruit bearing period and plant height at environmental level. Whereas, path coefficient analysis revealed that among the developmental characters *viz*., days to 50% flowering, plant height (cm), number of primary branches, secondary branches, fruit bearing period, fruit width (cm), fruit weight (g), stalk/pedicel length (cm), number of seeds per fruitand number of fruits per plant showed high positive direct effect on green fruit yield per plant (g).

Keywords: Correlation, Path anlysis, *Capsicum annuum* L.

INTRODUCTION

Chilli (*Capsicum annuum* L.) is mainly used in culinary to add aroma, colour and taste. In India no dish is complete without chillies. It is belongs to family solanaceae. A few varieties are still recommended for commercial cultivation, there is a need for genetic evaluation of the available chilligermplasm for increasing the productivity considering the preference of the consumer's demand. Correlation studies of yield and its components characters are useful in developing an effective basis of phenotypic selection and path analysis further helps to elucidate the intrinsic nature of the observed association and impact confidence in the selection of breeding programme. As more variables are included in the correlation study, the association becomes more complex. In such situation, path coefficient analysis devised by Wright (1921) provides effective means of finding out direct and indirect causes of association and permits a critical examination of the specific forces acting to produce a given correlation and measures the relative importance of each casual factor. Considering these points a study was undertaken at Department of Horticulture, I.G.K.V. Raipur (C.G.), to studied about relationship among green fruit yield and its components and determines the correlation and path analysis in chilli.

MATERIAL AND METHOD

The experimental material comprised of nine diverse genotypes of Chilli (6 line and 3 testers) which were received from All India Coordinate Research Project on Vegetable Crops, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.).The trials were evaluated during *Rabi* season of 2011-12 at the Horticulture Farm, Department of Horticulture. The soil of the experimental field was sandy loam in texture which is locally known as "*Matasi*" and is neutral in reaction with the pH 7.5. The experiment was conducted in a Randomized Block Design (RBD) with three replications.

The six week old seedlings of nine parents (6 line and 3 testers) were transplanted in a randomized block design with three replications. Each plot consisted of 4.2 x 3.5 m^2 areas and a gap was kept in 60 cm between rows and 30 cm between plants and only one seedling sown per hill.All the standard agronomical practices and plant protection measures were followed timely to raise a crop successfully. Five plants were selected randomly for recording different yield related traits. However green fruit yield, days to first and 50% flowering and days to first picking were recorded on plot basis. After recording data phenotypic correlation coefficient and genotypic correlation coefficient and direct and indirect effects were computed by using procedure given by Deway and Lu (1957).

RESULT AND DISCUSSION

The correlation coefficient at phenotypic, genotypic and environmental levels for green fruit yield and developmental characters are presented in (Table-1). Characters like days to 50% flowering showed significant and positive correlation with green fruit yield per plant (g) at phenotypic and genotypic levels, number of primary branches at genotypic level, fruit length at phenotypic level, fruit bearing period and plant height at environmental level. Whereas, among the component traits positive correlation was observed the pair of traits*viz.*, days to first flowering at phenotypic level,fruit width, fruit weight and number of secondary branches at genotypic level, days to 1st picking, number of seeds/fruit, duration of crop(sowing to last harvest days) atphenotypic and genotypic levels. While, number of fruits/plant and plant height at phenotypic and environmental levels.The above results supported the revelations of Reddy (2006) who reported that fruit yield had positive and highly significant association with number of fruits per

Table 1: Genotypic (G), phenotypic (P) and environmental (E) correlation coefficient for fruit yield and its component characters in nine genotypes

Characters.			DFF	D50%	PH	NPB	SB	DF	D1st	FBP	FL	FWi	FWe	S/PL	NS/F	NF/F	DC	GFY/P
DFF	Days to first flowering	G	1.000	0.992**	0.148	-0.289	0.284	0.999**	0.903**	0.023	0.403	0.212	0.353	0.247	0.423	-0.544	-0.309	-0.010
		P	1.000	0.990**	0.116	-0.248	0.315	0.996**	0.873**	-0.024	0.447	0.265	0.403	0.288	0.425	-0.589	-0.316	0.023
		E	1.000	0.717*	0.132	-0.394	-0.503	0.169	0.230	-0.189	-0.062	-0.406	-0.186	0.397	0.276	-0.175	-0.012	-0.457
D50%	Days to 50% flowering	G		1.000	0.091	-0.188	1.047	-0.331	-0.321	-0.390	0.608	0.722*	0.480	0.211	0.205	0.000	-0.472	0.765**
		P		1.000	-0.219	-0.173	0.180	0.237	0.249	-0.061	0.612	0.885**	0.667	0.085	0.239	-0.314	-0.414	0.800**
		E		1.000	-0.455	-0.279	0.200	0.994**	0.888**	-0.001	0.402	0.199	0.338	0.254	0.462	-0.553	-0.337	-0.041
PH	Plant height (cm)	G			1.000	0.201	-0.373	0.985**	0.874**	0.209	0.090	0.008	0.133	-0.016	0.138	-0.277	-0.123	-0.108
		P			1.000	0.078	0.550	0.153	0.845**	-0.013	-0.290	-0.084	-0.047	-0.477	-0.466	0.154	0.579	0.189
		E			1.000	0.053	-0.219	-0.233	0.214	-0.025	0.383	0.653	0.912**	0.769**	0.765**	-0.802**	-0.580	0.715*
NPB	Number of primary branches	G				1.000	-0.253	0.132	-0.220	-0.093	0.423	0.154	0.739	0.216	0.271	-0.774**	-0.114	0.602
		P				1.000	-0.061	0.871**	0.196	-0.090	-0.056	0.205	0.343	0.690*	0.493	-0.840**	-0.262	0.845**
		E				1.000	-0.077	0.722*	0.848**	-0.150	0.376	-0.281	0.385	0.238	0.589	-0.754**	-0.335	0.359
SB	Number Secondary branches	G					1.000	-0.162	-0.074	-0.013	0.541	0.245	-0.173	0.277	0.411	-0.533	-0.879**	0.258
		P					1.000	0.073	-0.103	0.155	0.380	0.510	0.360	0.372	0.414	-0.487	0.095	-0.433
		E					1.000	-0.289	-0.175	-0.236	0.083	0.143	0.498	0.179	0.256	-0.538	-0.278	-0.212
DF	Days to fruiting	G						1.000	0.171	-0.063	-0.280	0.006	0.329	0.099	0.139	-0.153	-0.255	-0.010
		P						1.000	0.127	0.271	-0.115	-0.101	0.116	0.235	0.180	-0.097	0.010	0.016
		E						1.000	-0.300	0.281	-0.190	0.561	-0.057	-0.002	0.442	-0.234	-0.249	-0.440
D1st	Days to 1st picking	G							1.000	-0.258	0.070	-0.172	0.875**	-0.365	0.141	-0.492	-0.328	0.561
		P							1.000	-0.089	-0.517	-0.100	0.553	0.740**	-0.361	-0.223	-0.279	0.578
		E							1.000	0.021	0.695	0.343	0.114	0.150	0.750*	0.143	-0.113	-0.040

		G	1.000	-0.116	-0.543	-0.010	0.679	0.227	-0.708	0.658	-0.104		
		P	1.000	-0.116	-0.089	0.065	-0.035	0.472	-0.475	-0.515	0.156		
FBP	**Fruit bearing period**	E	1.000	-0.511	-0.152	0.062	-0.043	0.578	-0.792**	-0.055	0.688*		
		G		1.000	-0.008	0.103	-0.189	-0.162	-0.682*	-0.226	0.488		
		P		1.000	-0.131	0.141	0.198	-0.100	-0.465	-0.277	0.818**		
FL	**Fruit length (cm)**	E		1.000	0.283	-0.342	0.315	-0.470	-0.089	-0.729**	0.355		
		G			1.000	-0.155	-0.254	-0.216	-0.240	0.092	0.256		
FW_i	**Fruit width (cm)**	P			1.000	0.098	0.461	0.052	-0.003	-0.296	-0.344		
		E			1.000	-0.335	-0.151	-0.427	-0.332	-0.034	-0.170		
		G				1.000	-0.029	0.352	-0.083	0.141	0.003		
FWe	**Fruit weight (g)**	P				1.000	-0.263	-0.284	-0.075	0.095	-0.240		
		E				1.000	0.440	0.196	0.321	-0.201	-0.006		
		G					1.000	0.079	0.138	-0.101	-0.059		
S/PL	**Stalk/pedicel length (cm)**	P					1.000	-0.317	-0.045	-0.165	-0.109		
		E					1.000	0.067	0.393	0.789**	-0.003		
		G						1.000	-0.590	-0.460	0.094		
NS/F	**Number of seeds per fruit**	P						1.000	-0.214	0.064	0.180		
		E						1.000	0.268	-0.149	-0.131		
		G							1.000	-0.097	-0.047		
NF/F	**Number of fruits per plant**	P							1.000	-0.387	0.119		
		E							1.000	0.090	0.196		
		G								1.000	0.142		
	Duration of crop	P								1.000	0.594		
DC	**(sowing to last harvest)**	E								1.000	-0.004		
		G									1.000		
GFY/P	**Green fruit yield /plant (g)**	P									1.000		
		E									1.000		

* Significant at P=0.05 level;** Significant at P=0.01 level

Table 2: Genotypic path coefficient analysis (direct and indirect effect) of different characters on green fruit yield in nine genotypes

Characters	**DFF**	**D50%**	**PH**	**NPB**	**SB**	**DF**	**D1st**	**FBP**	**FL**	**FWi**	**FWe**	**S/PL**	**NS/F**	**NF/F**	**DC**	Genotypic correlation coefficient
DFF	**-0.03702**	0.09779	0.07213	-0.16118	-0.05565	-0.34285	-0.17377	0.00693	-0.10975	0.01903	0.14934	0.06927	0.16242	-0.05721	0.11623	-0.0103
D50%	-0.03700	**0.09783**	0.05644	-0.13813	0.06070	-0.34188	-0.16798	-0.00711	-0.12177	0.02381	0.17014	0.08071	0.16287	-0.06191	0.11867	0.02341
PH	-0.00548	0.01132	**0.48765**	-0.21990	-0.09689	-0.05801	-0.04420	-0.05618	0.01700	-0.03646	-0.07869	0.11150	0.10572	-0.01837	0.00443	-0.457
NPB	0.01069	-0.02421	-0.19213	**0.55812**	0.20184	0.11352	0.06170	-0.11610	-0.16547	0.06486	0.20299	0.05917	0.07863	0.00003	0.17724	0.76475
SB	0.01069	0.03082	-0.24519	0.58457	**0.19270**	-0.08136	-0.04781	-0.01825	-0.16674	0.07951	0.28169	0.02386	0.09177	-0.03297	0.15541	0.8004
DF	-0.03697	0.09744	0.08241	-0.18457	0.04567	**-0.34328**	-0.17075	-0.00033	-0.10937	0.01789	0.14289	0.07125	0.17725	-0.05818	0.12649	-0.041
D1st	-0.03345	0.08545	0.11208	-0.17904	0.04791	-0.30476	**-0.19233**	0.06236	-0.02446	0.00076	0.05629	-0.00435	0.05311	-0.02910	0.04606	-0.1084
FBP	-0.00086	-0.00234	-0.09202	-0.21767	-0.01181	0.00038	-0.04029	**0.29770**	0.07888	-0.00753	-0.01986	-0.13388	-0.17866	0.01618	-0.21736	0.18868
FL	-0.01492	0.04374	-0.03043	0.33908	0.11797	-0.13785	-0.01728	-0.08621	**-0.27236**	0.05868	0.38562	0.21575	0.29364	-0.08432	0.21785	0.7147
FWi	-0.00784	0.02594	-0.19799	0.40307	0.17061	-0.06837	-0.00163	-0.02495	-0.17795	**0.08981**	0.31245	0.06074	0.10390	-0.08135	0.04294	0.60167
FWe	-0.01308	0.03939	-0.09080	0.26806	0.12844	-0.11606	-0.02562	-0.01399	-0.24851	0.06640	**0.42263**	0.19362	0.18928	-0.08828	0.09850	0.84515
S/PL	-0.00914	0.02814	0.19375	0.11769	0.01639	-0.08715	0.00298	-0.14203	-0.20940	0.01944	0.29161	**0.28062**	0.22587	-0.07932	0.12588	0.35941
NS/F	-0.01567	0.04153	0.13438	0.11439	0.04610	-0.15860	-0.02662	-0.13864	-0.20847	0.02432	0.20852	0.16522	**0.38364**	-0.05608	0.33013	0.25846
NF/F	0.02014	-0.05760	-0.08519	0.00016	-0.06043	0.18997	0.05324	0.04581	0.21844	-0.06949	-0.35484	-0.21170	-0.20463	**0.10514**	-0.03573	-0.4327
DC	0.01145	-0.03091	-0.00575	-0.00008	-0.07972	0.11558	0.02358	0.17225	0.15794	-0.01027	-0.11081	-0.09404	-0.33714	0.01000	**-0.37566**	-0.2118

Residual effect: 0.04707 **Diagonal bold value show direct effects**

*Significant atP=0.05 level; ** Significant at P=0.01 level

DFF Days to first flowering
D50% Days to 50% flowering
PH Plant height (cm)
NPB Number of primary branches
SB Secondary branches
DF Days to fruiting
D1st Days to 1st picking
FBP Fruit bearing period
FL Fruit length (cm)
FWi Fruit width (cm)
FWe Fruit weight (g)
S/PL Stalk/pedicel length (cm)
NS/F Number of seeds /fruit
NF/F Number of fruits/ plant
DC Duration of crop (sowing to last harvest days)
GFY/P Green fruit yield /plant (g)

plant, number of primary branches, number of secondary branches and average fruit weight. Patil (2007)reported that fruit yield per plant was highly and positively correlated with average fruit weight and pericarp thickness and plant spread at the genotypic level.Kulkarni (2006) found that plant height, fruit diameter, fruit surface area, pericarp weight showed negative direct effect while all other characters showed positive and high direct effect.

Path coefficient analysis at genotypic level (Table-2) reveled thatnumber of primary branches (0.558) showed the highest positive direct effect on green fruit yield per plant (g) though it had negative indirect contribution of fruit length and fruit bearing period respectively.Plant height (0.487) showed the second highest positive direct effect on green fruit yield per plant (g) followed by fruit weight (0.422),number of fruits/plant (0.383), Fruit bearing period (0.297), stalk/pedicel length (0.280), number of secondary branches (0.192) etc. The character days to fruiting had highly significant correlation with green fruit yield per plant (g), although it showed negative direct effect (- 0.343) due to higher positive indirect effect of fruit width, fruit weight, stalk/pedicel length, number of seeds/fruit and duration of crop (sowing to last harvest days).The above results agree with Dipendra and Gautam (2003)&Bhojaraja (2009) who reported that the developmental characters *viz*.,fruit weight, fruit length, fruit diameter, fruit surface area, number of fruit per plant had showed positive significant association with fruit yield per plant.

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SHORT COMMUNICATION

APPLICATION OF HYDROLYTIC ENZYME FROM THERMOPILE FUNGUS IN HYDROLYSIS OF LINGO CELLULOSE

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Abstracts: Lignocelluloses biomass refers to plant biomass that is composed of cellulose, hemicelluloses, and lignin. The carbohydrate polymers (celluloses and hemicelluloses) are tightly bound to the lignin. Lignocelluloses biomass can be grouped into four main categories: agricultural residues (including, corn stopper and sugarcane biogases), dedicated energy crops, wood residues (including saw mills and paper mill discards) and municipal paper waste.

Keywords: Enzyme, Fungus, Cellulose

INTRODUCTION

Lignocelluloses are the most abundant biomass available on earth. It has attracted considerable attention as an alternate feed stock and energy resource because of the large quantities available and its renewable nature. Lignocelluloses biomass in the form of wood fuel has a long history as a source of energy. Hydrolytic enzyme enhances the decomposition of lingo-cellulose and hemicelluloses to smaller molecules (Hendricks and Zeeman, 2009). It can be supposed that this enhanced fluidity of material for anaerobic digestion treated with enzymes. Hemicelluloses are not digestible; they can be selectively fermented by bacteria, yeast and fungi. The polysaccharides yielding pentose's on hydrolysis are caused pentoses. Xylem is an example of a pentose. Cellulose, Hemicelluloses shows variability in both structure and composition. Hemicelluloses are that they are composed mainly of the three Hexodes

MATERIAL AND METHOD

Present investigation at Hari Singh Guar University Sagar (M.P.) By using two substrate (wheat bran and saw dust), firstly 4ml of culture filtrate was taken and 0.1g of substrate (wheat bran, saw dust) are added in different tubes as labeled as reaction and also set a control tubes, after that it can be incubated at 50ºC in water bath at different interval of time (1hrs, 2hrs, 3hrs, 4hrs, 6hrs, 18hrs). After the incubation of 1hrs 0.5ml of solution were taken from reaction tube in another tube and added 0.5ml of distilled water and 3ml of DNS reagent for stopping for stopping the activity. Same processes are done for different interval of time (2hrs, 3hrs, 4hrs, 6hrs, and 18hrs). All the tubes were boiled, boiling water for 5min after that 5ml of distilled water were added in each tubes. Vortex the each tubes and absorbance was taken at 540 nm. The amount of reducing sugar liberated was calculated with the standard curve of glucose.

RESULT

In the study, the three fungi were used for xylanase production in solid state cultures at 45ºC (*Thermomyces lanuginosus, Aspergillus terreus, Malbranchea* Pulechella *var. Sulfurea*).For 7 days on wheat bran moistened with Czapeks mineral medium. The results are presented in table no.4.1 shows the profile of reducing sugar the fungi *Malbranchea* Pulechella var. Sulfurea using the wheat bran as substrate in different interval of time (1hrs, 2hrs, 3hrs, 4hrs, 6hrs, 18hrs).it releases the highest amount of reducing sugar in 18hrs 239.389µg/ml at O.D 0.817 and lowest amount of reducing sugar in 1hrs 727.71µg/ml at O.D 0.277 the amount of releases reducing sugar were increased with respect of increasing of time from 1hrs to 18hrs.in table no. 4.2 shows the profile of reducing sugar by the fungi *Aspergillus terreus* using the wheat bran as substrate in different interval of time(1hrs, 2hrs, 3hrs, 4hrs, 6hrs, 18hrs).it releases the highest amount of reducing sugar in 18hrs(1944.321µg/ml) at O.D (0.67).the lowest amount of reducing sugar in 1hrs (774.1456 µg /ml) at O.D (0.292).

By using the sawdust as a substrate its releases negligible amount of reducing sugar with all the three fungi (*Aspergillus terreus, Thermomyces lanuginosus, Malbranchea pulechella var. sulfurea.).* In this work, from all the three species (*Thermomyces lanuginosus, Aspergillus terreus,Malbranchea pulechella var. sulfurea), Malbranchea pulechella var. sulfurea* releases high amount of reducing sugar with WB and *Malbranchea pulechella* var. *sulfurea* releases negligible amount of reducing sugar with saw dust.

As compare to *Malbranchea Aspergillus terreus* releases less amount of reducing sugar with WB also in saw dust. As compare to both of these (*Malbranchea pulechella var. sulflurea, Aspergillus terreus*) *Thermomyces lanuginosus* releases less amount of reducing sugar with bran, also in saw dust.

High amount of reducing sugar releases within the incubation periods of 18 hrs.The enzymatic degradation of plant polysaccharides is a process of fundamentals important in nature furthermore polysaccharides degrading enzymes are very important in many industrial processes. Therefore the study of enzyme is an important field of research the degradation of plant cell wall is a complex process that involves wide ranges of enzymes mainly produced by microorganism.Temperature is one of the important environment factors that play a key role in survival and growth microorganism in nature. Mostly the thermophilic moulds comparatively growing at high temperature procedures thermostable enzymes which have industrial important. They can utilize complete organic matter such as lignocelluloses for their growth by virtue of extra cellular thermos table hydrolytic enzyme they produces this hydrolytic properties is tightly used for waste managements. Thermostable enzyme offers potential benefits in the hydrolysis of lignocellulosic substrate higher specific activity decreasing the amount of enzyme enhanced stability allowing improved hydrolysis performance and increased flexibility with respect to process configuration. The processing of lignocelluloses biomass into value-added chemicals via fermentation is act at a primitative stage of development when compared with the chemical processing of petroleum and natural gas we strongly believe that give time for process improvements in this fields bioconversion of lignocellulosic will be in high demand.*Aspergillus terreus* reported as the best produce reducing sugar in solid state fermentation. To evaluate the effect of different incubation period on production of period of the medium range was varied from 1hrs to 4hrs and high range was 18hrs.

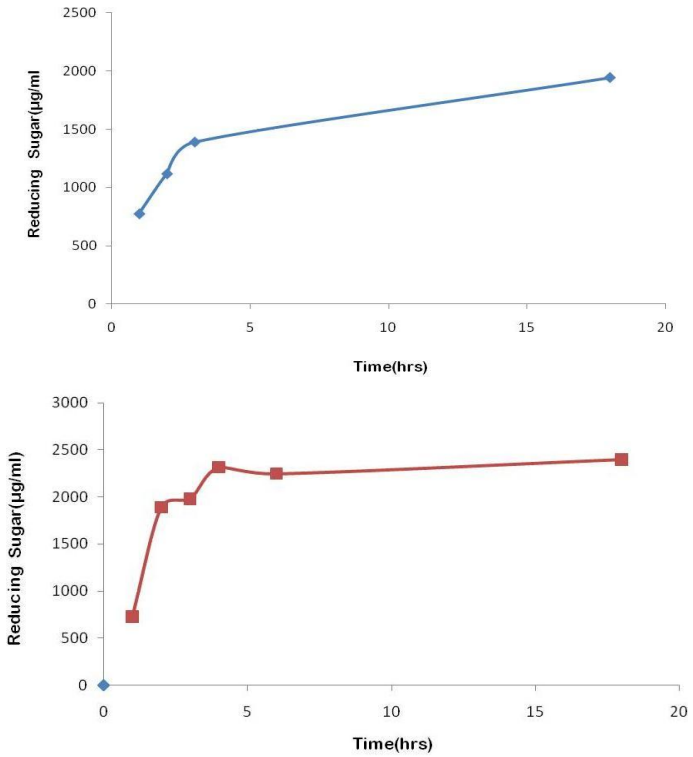

Fig – 4.1: Liberation of Reducing sugars from wheat bran by *Malbranchea pulchella var. sulfurea and Aspergillus terreus*

Table no.4.2: Liberation of Reducing sugars from wheat bran by *Malbranchea pulchella var. sulfurea and Aspergillus terreus*

Incubation time	O.D	Reducing sugar	0.D	Reducing sugar
1hrs	0.292	774.14	0.277	727.71
2hrs	0.403	1117.76	0.652	1888.59
3hrs	0.491	1390.19	0.682	1981.46
4hrs	0.08	117.85	0.79	2315.80
6hrs	0.266	693.65	0.768	2247.7
18hrs	0.67	1944.32	0.817	2399.38

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