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Contents

SHORT COMMUNICATION

PALYNOASSEMBLAGE AND ENVIRONMENT OF DEPOSITION IN THE LOWER GONDWANA SEDIMENT (RANIGANJ FORMATION) OF SONEPUR-BAZARI COALFIELD IN BURDWAN DISTRICT, WEST BENGAL

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Abstract: Palynological study of the bore hole sediments (BZ-070) from Sonepur-Bazari Open Cast coalmine (Raniganj Formation) in Burdwan district, West Bengal has revealed the presence of Upper Permian palynoflora. A total of 12 species of palynomorphs belonging to 9 genera have been recovered. From the comparison of early records of miospores from Lower Gondwana it is revealed that present miospore assemblage dominated by striate disaccate grains. A warm, temperate climate is suggested during the deposition of sediments based on microfloral assemblage.

Keywords: Palynoflora, Raniganj Formation, Upper Permian, Sonepur-Bazari Coalfield

INTRODUCTION

Feistmantel (1880) first proposed the classification of Gondwana rocks by suggesting a tripartite division of the rocks of India on the basis of floral evidences. Subsequently the classification was supported by Vredenburg (1914), Wadia (1926), Saksena (1952, 1974) and Lele (1964). Bose (1966), Roy Choudhuri *et al.* (1973), Acharyya *et al.* (1977), and Sastry *et al.* (1977) expressed similar views on the classification of Gondwana rocks. Three floral assemblage zones in the Indian Gondwana were identified by Shah *et al.* (1971).

The Lower Gondwana flora is commonly known as Glossopteris flora on the basis of rich assemblage of *Glossopteris* plant fossils (Shah *et al.* 1971). The Lower Gondwana basins in the Indian Peninsula occupy well defined linear belts and occur as isolated patches of coal measures in the Rajmahal coalfields, exposed along the western flanks of the north-south trending Rajmahal Hills, in the east-west trending Damodar-Koel valley basins and Satpura basin, north-west-southeast trending Son-Mahanadi valley and Pranhita-Godavari valley basins respectively, all of which tend to coverage towards the heart of the Peninsula. In extra Peninsular region, detached exposures of Lower Gondwana are known from the frontal zones of the Eastern Himalayan Foothills, window zone of Sikkim and the Tethyan domain of Kashmir, Spiti and Sikkim.

The Lower Gondwana sedimentation was conducted during Early Permian by widespread glacial advances as evidenced by the presence of boulder beds at the base of the 6-7 km thick Gondwana succession. This resulted in deposition of a varying pile of glacial, glacio-lacustrine and fluvio-glacial sediments. With the retreat of the cold glacial age, the irregular topography of the Indian Peninsula was filled in by swamps rich in vegetative matter, emerged due to the amelioration of the climate that continued till the end of the Permian. The rich vegetation ultimately got transformed into thick coal seams. The environmental facies however, changed with the gradual change of climate through the entire sequence of coal deposition proceeded by the glacial activity during Talchir Formation in Early Permian.

Though the Lower Gondwana sediments are said to be chiefly of fluviatile or lacustrine origin, evidences of thin marine transgression are known to occur in Peninsular India at Umaria and Manendragarh in Madhya Pradesh, Bap and Badhaura in Rajasthan and Daltonganj in Bihar during Early Permian times. In extra Peninsular India, Permian marine incursions are reported from Abor Hills, Dikrong valley and Subansiri in Eastern Himalaya, Khemgaon and Wak in west Sikkim, Salt Range and Kashmir (Ghosh and Bandopadhyay 1967; Singh 1979, Singh I.B. 1981).

The vast coal deposits of Peninsular India are mostly confined to the Barakar and Raniganj Formations of Damuda Series and also Karharbari Formation of Talchir Series while Talchir and Kulti Formation (Barren Measure - Sastry *et al.* 1977) are devoid of any reputable coal deposits. Most of the thick coal strata in the different coal fields of Indian Peninsula belong mainly to Barakar Formation of Lower Permian and Raniganj Formation of Upper Permian age. Raniganj Formation provides the dominant assemblage of *Glossopteris* flora among all the Formations of Indian Lower Gondwana.

The vegetation that flourished for about fifty million of years during Lower Gondwana is the major source of coal in India. Both megaflora and palynoflora were extensively studied in Lower Gondwana Sediments of Raniganj Formation by several authors (Banerjee 1987, 1994; Tiwari 1999). It is well known that floral assemblages of the Indian Lower Gondwana sequence whether macroscopic mega plant fossils or microscopic spore-pollen, are extremely useful in understanding environment of deposition, classification, correlation and also for

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assigning age of the sediments due to the scarcity of faunal evidence.

Recent studies on the *Glossopteris* flora from all the continents of Lower Gondwana including India have revealed the fact that further exhaustive exploration of the flora is essential to understand not only the diverse pattern of the flora and the strategic phases in the evolution of plant groups but also the significant role of the flora in geological investigations including palaeogeography, plate tectonic, coastal area identification, etc.

For this purpose, present work has been taken up in Sonepur-Bazari area, a second biggest Open Cast mine of the Eastern Coalfield Ltd. to investigate the palynofloral assemblage and its depositional environment as the area is totally unexplored in this regard.

MATERIAL AND METHOD

Study Area

Sonepur-Bazari combined open cast project of Eastern Coalfield Limited (ECL) is situated between two villages namely Sonepur and Bazari in the eastern part of Raniganj coalfields in Burdwan district **(Fig. 1)** of West Bengal (latitudes $23^0$40′00″ N and $23^0$43′06″ N, longitude $87^0$11′14″ E and $87^0$17′42″ E). The area is 14 km away from G. T. Road, 30 km away from Asansol and 35 km away from Durgapur (source from Eastern Coalfields Limited, GOI).

Material

Sediments are collected from the shale layer between the coal seam numbers V and VI **(Fig. 2)** of bore hole (BZ-070). The samples are catalogued properly and kept at repository of Pteridology-Palaeobotany Section, Department of Botany, University of Kalyani.

Method

About 10 gm from each sample were first treated with 40% hydrofluoric acid (HF) for a minimum period of 24 hours to dissolve and remove silica and hence concentrate the organic matters. The samples were then macerated by freshly prepared Schulze solution (concentrated HNO_3:$KClO_3$:3:1) and were then treated with 10% potassium hydroxide (KOH) solution to make the palynomorphs free. The treated samples were again thoroughly washed with distilled water and centrifuged at 3000 rpm for 15 minutes. Then the samples were slide fixed in polyvinyl alcohol and mounted using DPX and observed under the microscope (Leitz Laborlux-D). Photomicrographs were taken from the suitable preparation and subsequently magnified.

Microfloristic composition of each of the macerated sample was determined through the identification of taxa using original diagnostic characteristics with illustrations of genera and species in Genera File of Jansonius and Hills (1976) and available literatures including paleo-databank. The identification of taxa and differentiation of genera and species were made after thorough study of prepared slides kept in the repository of Pteridology-Palaeobotany Section, Department of Botany, University of Kalyani.

RESULT

Twelve species of palynomorphs belonging to nine genera have been identified through the maceration of samples. Among the recovered palynomorphs both the striate and non striate disaccate grains are present along with monocolpate grains of *Gnetaceaepollenites sinuosus* **(Fig. 5)** but occurrence of trilete spores are totally absent. Overall dominance of striate disaccates **(Figs. 12-14)** along with fairly consistent and occasional dominance of non striate disaccates is clearly recorded in the present assemblage. Non-striate disaccates mainly genus *Scheuringipollenites, Primuspollenites, Cuneatisporites, Rhizomospora, Aurangapollneites* and *Ranigangisaccites* are documented from the assemblage. The frequency distribution of each of the taxa is presented graphically in **Fig. 15**. Brief descriptions of each of the miospore are given below:

Non Striate Grains

Aurangapollenites gurturiensis Sriv.: Bilateral, diploxylonoid, size range 75-99 µm × 30-60 µm, central body oval intra-micropunctate, saccus hemispherical, distal sulcus broad, finely intra-reticulate **(Fig. 3)**.

Cuneatisporites sp.: Bilateral, diploxylonoid (sac larger than central body), size range 75-95 µm × 54-69 µm, central body vertically oval, intramicroreticulate, saccus hemispherical, distal zone of saccus attachment associated with semilunar fold, laterally sacci coming very close to each other, sulcus biconvex broad, intrareticulate **(Fig. 4)**.

Gnetaceaepollenites sinuosus (Balme & Henn) Bhar: Fusiform, two longitudinal crescentic folds running full length and converging at extremities, exine laevigate, longitudinally sparsely striated, occasionally branched **(Fig. 5)**.

Scheuringipollenites maximus (Hart) Tiw: Circular to subcircular pollen grains, size 75-165 µm, central body thin, indistinct, subcircular to broadly oval, saccus hemispherical, distally very close to each other in the median region, forming an ill-defined sulcus, reticulation coarse to medium meshed **(Fig. 6)**.

Primuspollenites obscurus Tiw: Bilateral, diploxylonoid, size 110-145 µm × 60-85 µm, central body outline indistinct, vertically oval, proximally retculoid striations, saccus subhemispherical, sulcus convex, coarsely intrareticulate **(Fig. 7)**.

Primuspollenites levis Tiw: Bilateral, diploxylonoid, size 90-160 µm × 60-150 µm, central body vertically oval, proximally bearing reticuloid striations, saccus hemispherical, distal attachment distinct, full length;

sulcus convex accompanied by characteristic thickening, coarsely reticulate **(Fig. 8)**.

Primuspollenites densus Tiw: Bilateral, diploxylonoid, size 114-153 µm × 75-105 µm, central body dense, vertically oval, proximally bears reticuloid striations, saccus hemispherical, distal attachment well defined, full length, sulcus narrow, accompanied by thickenings, finely intrareticulate **(Fig. 9)**.

Raniganjiasaccites ovatus Kar: Bilateral, diploxylonoid, size 81-120 µm × 45-75 µm, central body subcircular to oval, intra-microreticulate, saccus hemispherical, sulcus distinct broad, coarsely intrareticulate **(Fig. 10)**.

Rhizomaspora indica Tiw: Bilateral, monosaccoidal, size 93-154 µm × 60-75 µm, central body circular to subcircular, dense proximally bearing reticuloid striations, saccus sub-spherical invading central body on proximal side, many radiating folds of saccus continuing from body subequatorial region into saccus, sulcus ill-defined, sccci laterally deeply notched or continuous, intrareticulate **(Fig. 11)**.

Striate Grains

Striatopodocarpites magnificus Bharad & Sal: Bilateral, diploxylonoid or central body and saccus of same height, size 120-150 µm × 66-90 µm, central body circular to subcircular, proximally horizontally striated, intra-microreticulate, saccus hemispherical, sulcus broad, intrareticulate **(Fig. 12)**.

Striatites obtusus Bharad. & Sal.: Bilateral, diploxylonoid, size 75-105 µm × 54-75 µm, central body thick, vertically oval, with a thin marginal ridge, proximally horizontally striated with few vertical partitions, microverrucose. Saccus subspherical to hemispherical, sulcus convex, medially intrareticulate **(Fig. 13)**.

Striatites ornatus Venk. & Kar: Bilateral, diploxylonoid, size 60-90 µm × 36-54 µm, central body vertically oval, proximally horizontal, striated, infrastructure, saccus subspherical to hemispherical, sulcus narrow, infrareticulate **(Fig. 14)**.

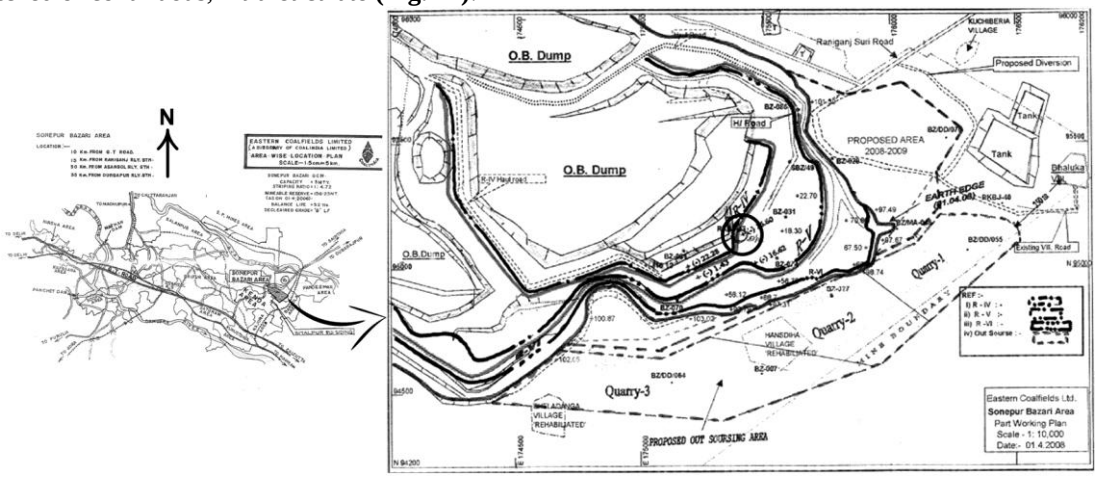

Fig. 1. Map of Sonepur-Bazari Coalfield showing study area - marked in circle. (Courtesy: Eastern Coalfields Limited, GOI).

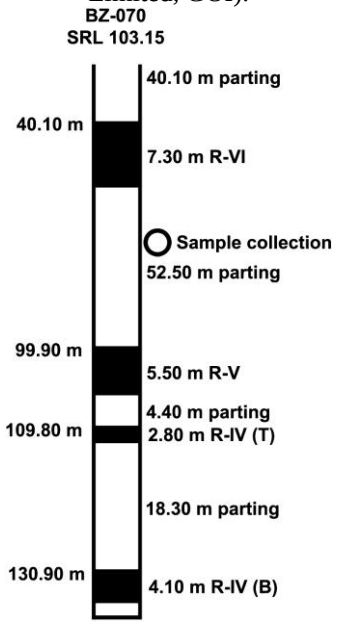

Fig. 2. Lithological column of bore hole BZ-070. (Courtesy: Eastern Coalfields Limited, GOI).

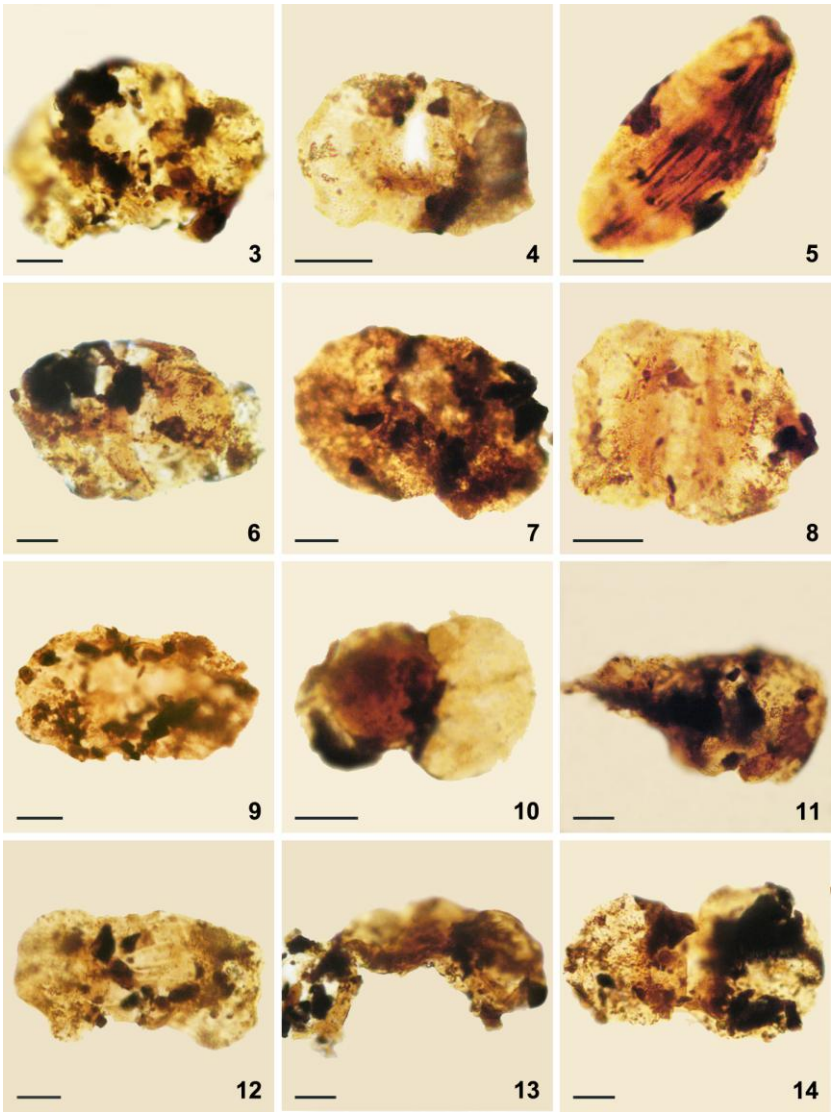

Fig. 3-14. Recovered palynomorphs (**3**) *Aurangapollenites gurturiensis* (**4**) *Cuneatisporites* sp. (**5**) *Gnetaceaepollenites sinuosus* (**6**) *Scheuringipollenites maximus* (**7**) *Primuspollenites obscurus* (**8**) *Primuspollenites levis* (**9**) *Primuspollenites densus* (**10**) *Raniganjiasaccites ovatus* (**11**) *Rhizomaspora indica* (**12**) *Striatopodocarpites magnificus* (**13**) *Striatites obtusus* (**14**) *Striatites ornatus*.

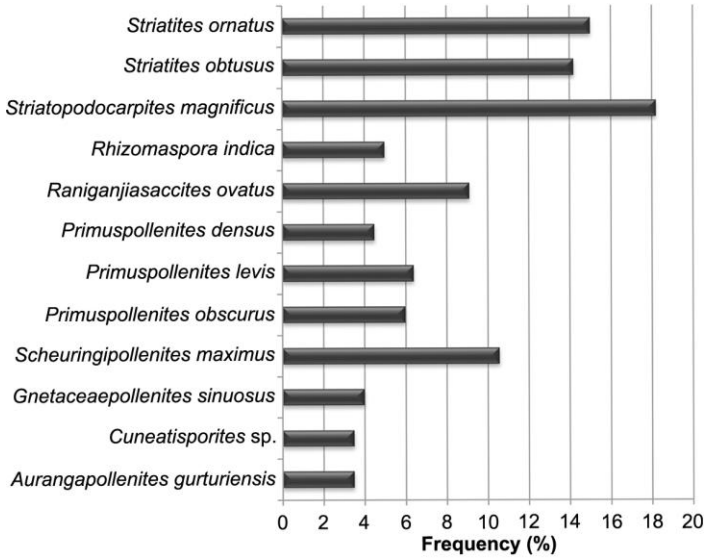

Fig. 15. Frequency distribution of the recovered palynomorphs.

DISCUSSION AND CONCLUSION

Palynomorphs are being widely used as effective tools in high resolution palynostratigraphic zonation, correlation and age determination of the Lower Gondwana sedimentary sequence of the Permo-Carboniferous age in several basins of the Gondwanaland (Banerjee and D'Rozario 1990; Scotese *et al.* 1999; Beri *et al.* 2010). Several schemes of palynostratigraphic zonation have been proposed for the Indian Lower Gondwana sedimentary sequence. In the Indian Gondwana sequence, the Talchir Series (Talchir and Karharbari Stages) of the Early Permian is characterized by a dominance of radial monosaccates, like *Parasaccites*, *Plicatipollenites* along with laevigate triletes, like *Callumispora*, etc. whereas, lower part of the Damuda Series, the Barakar Stage of the middle and late Early Permian is dominated by non-striate disaccates, like *Scheuringipollenites.* The Kulti/Barren Measures Stage of Middle Permian age is dominated by dense bodied monosaccate pollen, like *Densipollenites* along with other saccates, but the predominance of striate disaccates, like *Faunipollenites*, *Striatopodocarpites*, *Striatites*, etc. are the characteristics of Raniganj Stage of the Upper Permian age (Bharadwaj 1971; Tiwari 1991; Tiwari and Tripathi 1988, 1992; Banerjee and D'Rozario 1990; Kulshrestha 1990; Vijaya and Tiwari 1992; Hait and Banerjee 1994). In addition, it is commonly seen that *Scheuringipollenites* dominates in the Early Barakar Stage of the middle to late Early Permian age, whereas, striate disaccates, like *Faunipollenites* dominance in association with non-striate disaccates, like *Scheuringipollenites* are recorded from the Late/Upper Barakar Stage of late Early Permian (Tiwari and Tripathi 1992; Vijaya and Tiwari 1992). The lowermost and middle parts of the Lower Barakar are also characterized by *Scheuringipollenites* with a significant share of radial monosaccates, zonates and apiculates (Bharadwaj 1962, 1971, 1975; Tiwari 1973, 1974a, b, 1991).

By comparing the present miospore assemblage with early records of miospores from Lower Gondwana it is revealed that dominant occurrence of striate disaccate grains namely *Striatopodocarpites*, *Striatites*, etc. in assemblage confirms the Upper Permian age of the sediments.

Biostratigraphic and environmental classification of Lower Gondwana sediments of India have been proposed from time to time by various workers (Feistmantel 1880; Vredenburg 1910; Wadia 1926; Saksexa 1952, 1974; Lele 1964, 1976; Roy Choudhury *et al.* 1973; Shah *et al.* 1971; Sarbadhikari 1974; Sastry *et al.* 1977, 1979). The generalized environmental classification of Indian Lower Gondwana (Shah *et al.* 1971; Lele 1976) is given in **Table 1**. The present miospore assemblage recovered from the Upper Permian sediments of Sonepur-Bazari Open Cast mine and their distribution pattern suggested a warm, temperate climate during the deposition of sediments. This study needs to be further extension to ascertain the comprehensive knowledge of *Glossopteris* flora in Raniganj Formation of Sonepur-Bazari Open Cast mine area.

Table 1. Environmental phases in Indian Lower Gondwana (after Lele 1976)

Stage	Series	Formation	Environment	Palaeoclimatic Floral Phase	
Lower Gondwana	Damuda Series	Raniganj	Warm	Temperate	*Glossopteris*
		Barren Measure			
		Barakar			
	Talchir Series	Karharbari	Cool		*Gangamopteris*
		Talchir			
		Boulder beds	Glacial		

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GROWTH AND YIELD OF CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA* L.) UNDER MULCH WITH DRIP IRRIGATION IN RAICHUR CONDITION

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Abstract: An experiment was conducted to investigate the effect mulch and without mulch with three level of drip irrigation *viz.*,80% 100% and 120% ET and furrow irrigation on cabbage growth and yield under Raichur climate. The study showed that the drip irrigation saved water at the levels of 80, 100 and 120 per cent ET over furrow irrigation system was found to be 62.06, 54.50 and 46.94 per cent respectively. The better plant growth, more number of leaves per plant and higher leaf area were observed in under plastic mulch with drip irrigation. The highest yield was recorded in 100% ET with mulch plot ((92.95 t ha^{-1}) and lowest yield was observed in furrow irrigation without plastic mulch (50.64 t ha^{-1}). The plastic mulch increased the yield 8.82% more than the without plastic mulch field.

Keywords: Cabbage, Growth, *Brassica oleracea*

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important vegetable under extensive cultivation in India and other countries. It can be grown in wide range of soils ranging from light sandy loams to heavy clay soils and requires moderate p^H. India is the second largest cabbage grower (after China) in the world. India is one of the most important cabbage growing countries in Asia with an area of 369 thousand ha and a production of 7,949 Mt with a productivity of 21.5 Mt ha^{-1}(Anonymous, 2011). West Bengal is the largest grower of cabbage followed by Orissa and Bihar occupying second and third position respectively. The other major growing states of cabbage are Assam, Karnataka, Maharashtra and Gujarat. Karnataka occupies an area of 7,967 ha with a production of 1,48,974 t and productivity of 25,025 kg ha^{-1} (Anonymous, 2005). In Karnataka, Belgaum district is having maximum area under cabbage cultivation and ranks first in area and production in the state. The area during the year 2007-08 was 1,021 ha which accounted for 14.10% of the total area under cabbage in the state with the production of 24,400 t, which is accounted for 16.18% of the total cabbage production of the state.

Maximising of the yield is essential to serve the increasing population of our country. Adoption of recent agricultural techniques can also help to full fill the requirement. The use of both plastic mulch and drip irrigation system is the best method to improve the growth and yield of the crop (Jumah and Nassim, 2005). The mulching of soil reduces water loss through evaporation, and therefore increases the water available to plants (Langdale *et al*., 1992) this will leads to the better plant growth, higher yield of the crop (Andino and Motsenbocker, 2004). Adoption of surface drip irrigation system along with plastic mulch, save irrigation water by 15–51% with 11–80% more yield compare to the conventional irrigation system (Zotarelli *et al*., 2009).

The main objective of the study was to know the effects of mulch, without mulch, drip irrigation and furrow irrigation on cabbage growth and yield under Raichur condition.

MATERIAL AND METHOD

Field experiments were conducted during the year 2012-13 in rabi season. The experiments were located at New Orchard of Main Agricultural Research Station, University of Agricultural Sciences, Raichur. The soil of the experimental plot was sandy loam, having sand 74.62%, silt 11.35% and clay 14.03%. The p^H of the soil was 7.70 and organic carbon 0.24%. The maximum temperature and ET during the cropping period was 35.4 °C and 5.8 mm day^{-1} and the minimum was 27.8 °C and 1.2 mm day^{-1} respectively.

Shila F1 hybrid variety of cabbage was transplanted in the experimental plot at a spacing 0.5 x 0.45 m in a paired row. In the experiment 25µ thickness plastic mulch were used. The experiment was laid out in split plot design with two main treatments, four sub treatments and three replications. Design treatments are as follows.

- Main treatments
  M_1 - Cabbage with mulch condition
  M_2 - Cabbage without mulch condition
- Sub-treatments

T_1- water application at 80% ET using drip irrigation

T_2- water application at 100% ET using drip irrigation

T_3- water application at 120% ET using drip irrigation

T_4- water application at 100% ET using surface irrigation

*Corresponding Author

In each treatment the length of bed was 10 m long, 0.8 m width and 0.4 m spacing was given between the beds. In furrow irrigation 1.0m spacing was given to avoid the moisture movement from one plot to another plot. Drippers at 2 litres per hour (l h^{-1}) capacity of inline drip were used at a spacing of 40 cm for in drip irrigation treatments.

Amount of irrigation water applied to drip treatments were based on daily pan evaporation readings. The water requirement of the crop was calculated based on the following equation.

$$WR = \frac{A \times B \times C \times D}{E}$$

WR = Water requirement of a plant, (l $day^{-1}plant^{-1}$)
A = Pan Evaporation, (mm),
B = Amount of area covered with foliage (canopy factor), fraction
C = Crop co-efficient, fraction
D = spacing of the crop (0.5 x 0.45 m)
E = efficiency of drip irrigation, (considered as 90 per cent)

The plant height and leaf area was calculated using scale. Leaf area was calculated by following formula suggested by Rao (1978), expressed as cm^2 per plant.

$A = 0.9817 \times B^{1.1270} \times L^{0.7503}$

Where,
A = actual area, (cm^2)
B = Maximum breadth, (cm)
L = Length of leaf, (cm)

RESULT AND DISCUSSION

Before start of the experiment both drip and furrow irrigation moisture content was brought to the level of field capacity so as to monitor the moisture depletion critically in all the treatments. Subsequently the irrigation water was delivered under drip irrigation as per treatments and in furrow irrigation the crop was irrigated at variable frequency (100% ET) and depth of irrigation was calculated. The amount of water delivered per month from October to January to cabbage under different levels of drip irrigation and furrow irrigation are presented in Table 1.

Table 1. Monthly amount of water applied to cabbage under different levels of drip and furrow irrigation

Month	Amount water applied through drip irrigation at different irrigation levels, (l)			T4 (Water Applied in furrow irrigation)
	T1 (80% ET)	T2 (100% ET)	T3 (120% ET)	
15th October	9.38	9.38	9.38	9.38
October (16 days)	1.81	2.26	2.72	10.95
November	8.88	11.10	13.32	20.53
December	16.45	20.56	24.67	29.10
January (16 days)	7.36	9.20	11.04	14.45
Total	43.88	52.51	61.13	84.41
% saving water over furrow	48.01	37.80	27.58	

For drip irrigation at 80% ET in both mulch and without mulch, the monthly water requirement varied from 18.81 l in October to 16.45 l in December. Similarly, the amount of water required for 80, 100 and 120 % ET as given in table. For furrow irrigation in both mulch and without mulch, the water requirement varied from 10.95 l in October to 29.10 l December in December. The water saving under drip irrigation system at the levels of 80%, 100% and 120% ET over furrow irrigation system was found to be 48.01%, 37.80% and 27.58% respectively. From the experimental results it was observed that there is considerable amount of water saving by drip irrigation system as compared to furrow irrigation system. This was be due to the fact that maximum amount of water will be stored in the root zone and deep percolation losses will be minimum at lower irrigation levels. These results are agreement with the findings of Tagar *et al.* (2012).

The capacity of unit quantity of water to irrigate a crop is an important factor for any irrigation system. Table 2 presents the capacity of one m^3 of water to irrigate cabbage crop during its growth period. It can be seen from the table that, with increase in the level of irrigation the amount of water applied also showed an increasing trend, whereas the irrigation capacity was found on a decreasing pattern. It was also observed that, the irrigation capacity was lowest (0.0002 ha m^{-3}) for furrow irrigation. The highest irrigation capacity of 0.0004 ha m^{-3} was obtained for the treatment water application at 80% ET. It is observed from the table that delta was highest (46.43 cm) for furrow irrigation and among the drip irrigation treatments, it was lowest (24.13 cm) for water application at 80% ET and it was highest (33.62 cm) for water application at 120% ET.

Table 2. Irrigation capacity (duty) of $1m^3$ of water and delta of water for different treatments for the crop period

Treatment	Water applied in (l $plot^{-1}$)	Water applied in (m^3 ha^{-1})	Irrigation capacity (ha m^{-3})	Delta (cm)
T_1	1930.73	2413.41	0.0004	24.13
T_2	2310.23	2887.79	0.0003	28.88
T_3	2689.73	3362.17	0.0003	33.62
T_4	3714.04	4642.55	0.0002	46.43

Growth Parameters

The effects of mulch and without mulch with different levels of drip irrigation were compared with furrow irrigation treatment on the basis of vegetative parameters of cabbage crop. The results of the same are presented below.

1). Plant height: The effect of mulch, without mulch and irrigation at different level on plant height at 30, 60 days after transplanting and at the time of harvest are presented in Fig. 1. The results indicated that the maximum height of the plant was recorded in mulch with drip irrigation in different periods of the crop as compare to the without mulch treatments with drip irrigation.

2). Number of leaves: The data pertaining to number of leaves 30, 60 days after transplanting, and at the time harvest are presented in Fig. 2. It can be seen from the Fig. that the treatment with 100% ET with plastic mulch showed the highest number of leaves in all stages if the crop as compare to furrow irrigation without mulch.

3). Leaf area: The effect of mulch, without mulch and irrigation at different level on leaf area at 30, 60 days after transplanting and at the time of harvest are presented in Fig. 3. The maximum leaf area was observed in plastic mulch with drip irrigation as compare to mulch with furrow irrigation.

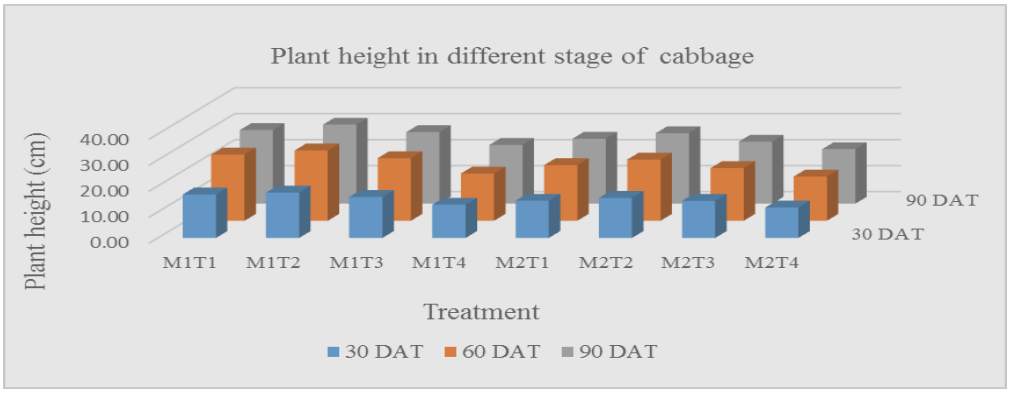

Fig. 1. Effect of mulch, without mulch, irrigation methods and irrigation level on plant height in cabbage

The crop with plastic mulch has shown the better plant growth. This was due to the fact that plant under mulch has got the better soil moisture, soil temperature and the competition from the weed is less than the without mulched plot. Thus the mulch treatment exhibited better plant growth in terms of plant height, number of leaves and leaf area. These results are in agreement with the findings of and Paul *et al.* (2013) and Ashrafuzzaman, *et al.* 2011).

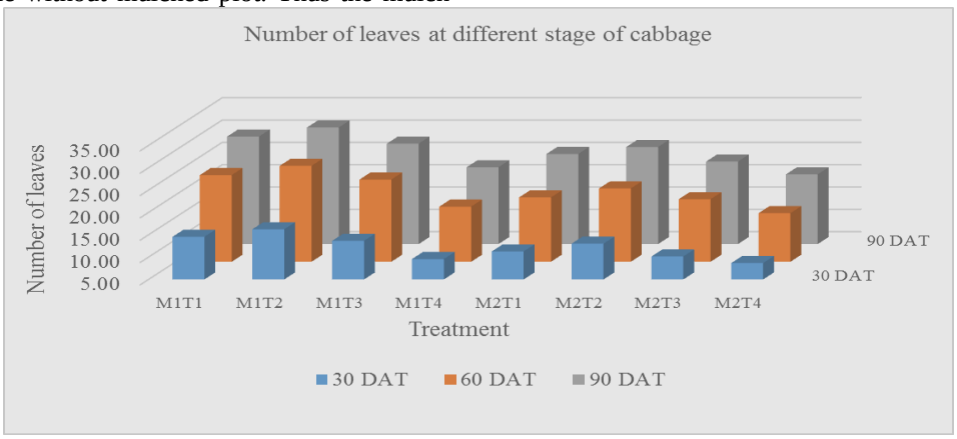

Fig. 2 Effect of mulch, without mulch, irrigation methods and irrigation level on Number of leaves on cabbage

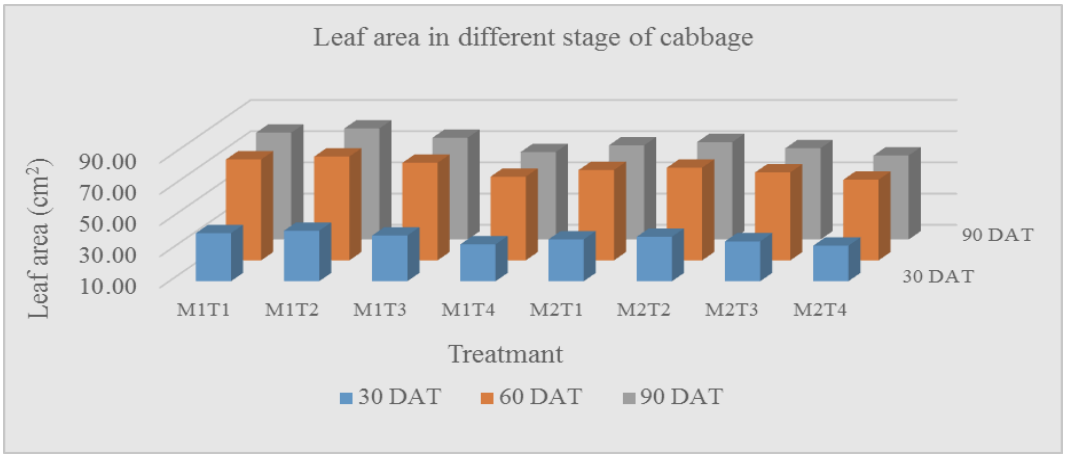

Fig. 3. Effect of mulch, without mulch, irrigation methods and irrigation levels on leaf area of cabbage

Yield of the crop

The total marketable yield per hectare as influenced by mulch and without mulch, irrigation methods and levels of drip irrigation are presented in Table 3. Significant differences were noticed in yield due to irrigation methods as well as drip irrigation levels. In the main plot the plant under mulch recorded the maximum yield (81.24 t ha^{-1}) and the without mulch recorded the minimum yield (74.08 t ha^{-1}). A similar result has been reported in Mukherjee *et al.* (2010). Among the different irrigation level the plants receiving water at 100 per cent ET recorded significantly maximum yield (88.57 t ha^{-1}). The lowest yield was noticed in furrow irrigation treatment (52.93 t ha^{-1}). This was due to less percolation of water in the drip compare to furrow irrigation. The complimentary soil moisture which was easily available through drip directly to the root zone, will improve the yield of the cabbage. The present results are in line with the findings of Jinhui *et al.* (1999). The interaction effects treatment mulch with 100 per cent ET was recorded the maximum yield (92.95 t ha^{-1}) followed by 80 per cent ET with mulch (89.17 t ha^{-1}) which was on par with mulch and 120 per cent ET (89.63 t ha^{-1}). The minimum yield was noticed in without mulched with control treatment (50.64 t ha^{-1}). This was due to higher transpiration rate from the broader leaf even though plastic mulch reduces the evaporation from the soil. The present results obtained are in line with the findings of Tiwari *et al.* (2003) and Vijay kumar *et al.* (2012).

Table 3. Effect of mulch, without mulch, irrigation methods and irrigation levels on yield for Cabbage

Treatments	Yield (t ha^{-1})				
	T1	T2	T3	T4	Mean
M1	89.17	92.95	87.63	55.22	81.24
M2	81.69	84.19	79.80	50.64	74.08
Mean	85.43	88.57	83.72	52.93	
		SEM ±		CD at 5 per cent	
Main treatment		0.78		4.74	
Sub treatment		0.67		2.08	
T at same M		0.95		2.94	
M at the same or different T		0.99		2.98	

CONCLUSION

The water saved due to different drip irrigation treatments over furrow irrigation was 48.01 per cent under 80 per cent ET, 37.80 per cent under 100 per cent ET and 27.58 per cent under 120 per cent ET. So there was a considerable amount of water can save by using drip irrigation.

The growth components like plant height, number of leaves per plant and leaf area were significantly influenced by irrigation. The maximum plant height, number of leaves per plant and leaf area was recorded under drip irrigation at mulch with 100 per cent ET when compared to others treatments throughout the growing period.

The highest yield of 92.95 t ha^{-1} was obtained for the treatment mulch with drip irrigation at 100 per cent ET but in same level of irrigation in without mulch treatment yield was 84.14 t ha^{-1}. So the use of mulch increases the yield of the crop.

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FLORISTIC DIVERSITY AND STRUCTURAL ANALYSIS OF MANGROVE FORESTS AT AYIRAMTHENGU, KOLLAM DISTRICT, KERALA

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Abstract: Vegetation science is a scientific discipline devoted to studyplant communities, their composition, evolution and the relationships among the component species.The present study focuses on floristic diversity and richness of the Mangroves in Ayiramthengu, Kollam district. A total of 9 species belonging to 6 families were enumerated. The forests showed a dominance of Avicenna marina followed by Avicennia officinalis belonging to Avicenniaceae family, whereas Sonneratia caseolaris recorded lowest density.Maximum relative basal area was represented by Avicennia marina followed by Avicennia officinalis, therefore these species registered the highest Importance value index (IVI) and relative IVI among the 9 mangroves species distributed. Diversity indices such as Shannon Weiner index H' (2.763), equitability (0.872) and Simpson's diversity index (0.825)was worked out for the entire Ayiramthengu island. The mangroves are closely related to the social and cultural life of people in Ayiramthengu and its unique composition has to be protected in its pristine condition.

Keywords: Mangrove forest, Floristic composition, Diversity indices, Important value index

INTRODUCTION

Mangrove wetlands along tropical estuaries are intended as intertidal and ecotones of marine to fresh water biological communities, which have major role in biochemical process, nutrient recycling and often nutrient limited, Alongi, (2009). They act as a shield for marine animals and among the costal ecosystems, mangroves ecosystem is a repository of biological diversity as the tropical rain forest, Swaminathan, (1991).According to the latest estimate of Forest Survey of India, (2005), total area under mangrove cover in India is 4663km^2. Kerala along the west coast of India has a coastline of 590 km and presently the mangrove area is estimated to be about 17 sq. km, Basha, (1991), of which 36 percent is either completely degraded or is degrading. Mangrove vegetation in Ayiramthengu, Kollam occurs adjacent to the back water channels and along the banks of estuarine water bodies, in the form of narrow patches orcontinuous belts. Total of 15 pure mangroves and 33 semi mangroves had been recorded from entire costal area of Kerala, Vidyasagaran *et al*., (2014). The objectives of the investigation was to study the diversity,distribution and structural attributes of Ayiramthengu mangrove vegetation and their ecological status based ondensity, frequency, important value index (IVI) and relative IVI.

MATERIAL AND METHOD

Study site

Kerala lies towards the South-West coast of India, Ayiramthengu is a coastalregion located in Kollam district (90 54' 41.96" N and 760 18' 32.36" E) east of Kayamkulam estuary which opens to the Arabian Sea. Mangrove area in Ayiramthengu share the boundaries of three panchayaths including Alappad panchayath in western area, Clappana panchayath which contributes 70 percent of mangrove area and Devikulangara panchayath in northern part with 30 percent mangrove patches.

Diversity and Structural analysis

The distribution patterns of mangroves in Ayiramthengu were studied using species area estimation and quadrat analysis, Michael, (1998). Fifteen quadrats each of 5×5m size were taken on the basis of data received. Locations of the different transect were resolute based on canopy cover, length of intertidal area and observed vegetation classes. Density, frequency, basal area and their relative values and importance value index (IVI) of mangrove species were intended using standard Phytosociological methods, Curtis and Mclntosh, (1951). Girth of trees exceeding 10cm (1.37m above the ground) diameter at breast height was measured using tree calipers. Importance value index of each species was calculated as the sum of relative density, relative frequency and relative dominance, Ellison,(2001)so as to reveal relative contribution of each species to the overall stand composition.The vegetation data were analyzed to calculate the diversity indices and species richness, Shannon–Weiner diversity (H'), Simpson index and equitability were measured, Legendre and Legendre,(2012). Speciesrichness were measured (total number of species present) byMargalef, (1958).

RESULT AND DISCUSSION

Floristic composition

In the present study, the mangrove flora of Ayiramthengu compriseof totally 9 mangrove species

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belonging to 6 families (Myrsinaceae, Avicenniaceae, Rhizophoraceae, Euphorbiacea, Combretaceae and Sonneratiaceae). Present study on species dominance and species composition revealed that the family Avicenniaceae is the largest family in Ayiramthengu region followed by Rhizophoraceae, which is dominated by a higher density of smaller trees.Diversity of *Avicennia marina*and *Avicennia officinalis* were prioritized among every mangrove in Ayiramthengu, as these species are regarded as salt tolerant pioneers and light demanders and they possess certain adaptive characters for reproduction and survival with efficient mechanism of persistence by producing widely dispersed propagules, Tomlinson,(1986), andthis can contributed much to the marine to fresh water biological ecosystem.Jose, (2003) recorded that *Avicenna officinalis* as the dominant species in Kunhimangalam, Valapatanam and Dharmadam areas of Kannur.Least diverse species in Ayiramthengu are *Sonneratia caseolaris* as well as *Lumnitzera racemosa*in which, *Lumnitzera racemosa*confined to landward margin and also inner fringes of the estuarine areas, found only in Kollam district in the southern Kerala.*L. racemosa* and *Ceriops tagal* are the most threatened species in the west coast, Vidyasagaran *et.al*, (2014).

Structural analysis

Structural analysis revealed that*Avicenniamarina* constituted highest density (5361 ha^{-1}) and frequency (100%) which manifested an erratic distribution, abide by *Avicenniaofficinalis* (3067 ha^{-1}) (*Table.1*).The relative density for *Avicenniamarina* was maximum (30.83) and the lowest relative density was recorded by *Sonneratia caseolaris* (0.46). The highest basal area was recorded for *Avicenna marina*(32.05),*Lumnitzera racemosa* (1.59) and *Sonneratia caseolaris* (0.45) registered lowest basal area among all. The highest IVI value was82.84 and 49.18 for *Avicennia marina* and *Avicennia officinalis* respectivelyfollowed by*Rhizophora apiculata* (40.38) and *Rhizophora mucronata* (36.28), *Excoecaria agallocha* (29.82) *and Aegiceras corniculatum*(25.73).*A.marina* revealed maximum RIVI (27.61), the lowest IVI and RIVI were recorded for *Sonneratia caseolaris* (2.17&0.72 respectively)revealing rarity andsporadic distribution of species. The sightings of *Sonneratia caseolaris* and *Lumnitzera racemosa* were the first record of this species from Ayiramthengu region.Plant diversity indices indicated that Shannon Weiner index (2.763) and equitability (0.872), Simpson's diversity index (0.825) (*Figure.1*)were almost similar to the studies conducted earlier in several parts of Kerala, Vidyasagaran *et al.*,(2011).Analysis of data on different indices, unveiledthatthere was high diversity (more heterogeneous) of species along the different mangrove patches in Ayiramthengu. An ecosystem with H' value greater than 2 has been considered as medium to high diverse in terms of species, Cottom & Curtis, (1956) and thus, Ayiramthengu can be treated as high species diversity zone.

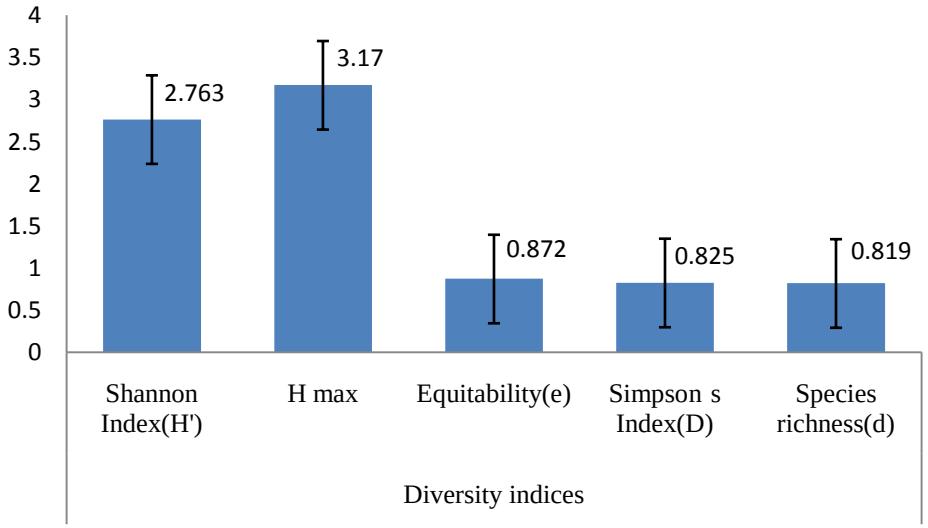

Figure 1. Diversity indices of Mangroves at Ayiramthengu, Kollam district of Kerala.

Table 1. Phytosociological parameters of mangroves in Ayiramthengu, Kollam district.

SI No.	Name of the Species	F	RF	D	RD	BA	RBA	IVI	RIVI
1	*Aegiceras corniculatum*	53.33	9.88	1520	8.74	6.8	7.11	25.73	8.58

2	*Avicennia marina*	100	18.52	5361	30.83	32.05	33.49	82.84	27.61
3	*Avicennia officinalis*	80.00	14.81	3067	17.64	16.01	16.73	49.18	16.39
4	*Bruguiera cylindrica*	60.00	11.11	1067	6.14	3.89	4.07	21.32	7.11
5	*Excoecaria agallocha*	60.00	11.11	1894	10.87	7.5	7.84	29.82	9.94
6	*Lumnitzera racemosa*	40.00	7.41	560	3.22	1.59	1.66	12.29	4.10
7	*Rhizophora apiculata*	73.33	13.58	2134	12.27	13.9	14.53	40.38	13.46
8	*Rhizophora mucronata*	66.67	12.35	1707	9.82	13.5	14.11	36.28	12.09
9	*Sonneratia caseolaris*	6.67	1.24	80	0.46	0.45	0.47	2.17	0.72

* F= Frequency (%), D = Density (ha^{-1}), BA = Basal Area ($m2\ ha^{-1}$, RF = Relative Frequency, RD= Relative Density,RBA= Relative Basal Area,IVI= Importance Value Index,RIVI= Relative Importance Value Index

Plate.1 *Land filling at mangroves of Ayiramthengu area.*

Threats

In 1991, the mangrove territory in Kerala is estimated to be about $17km^2$, in which 36% of these are degraded or still in degrading condition, Basha, (1991). Mangroves are one of the foremost vulnerable ecosystems of the world. Over the past few years mangroves are disappearing at disturbing rate. Coastal urbanization, conversion to Aquaculture, changes in the local hydrology is the biggest threats to mangroves. This unique biological system is in imminent danger of extinction as a result of indiscriminate and unplanned advancement and needs quick protection and conservation, Subramanian, (2002).Apart from the sites with high diversity, Ayiramthengu has many other small patches of mangroves which are under threats of degradation.Most people does not have legitimate knowledge about mangroves, they consider mangroves spots as places appropriate for dumping trash and other unwanted material. Increasing fish and prawn culture in mangroves of Ayiramthengu ought to be considered seriously, as several studies from different parts of the world pointed out increased aquaculture practices as one of the real dangers to these fragile environments.The species composition and the agents causing maximum destruction, depends upon the localities, Rao, (1986). The present study observed couple of threats to mangroves of Ayiramthengu including land filling, human development, housing, clear cutting, several industrial developments etc.

Land filling is one of the major threats in this region (*Plate.1*) which leads to limiting climate regulation and storm prevention.In order to protect and

conserve the mangrove patches in Ayiramthengu which facing acute threat from development activities and extension of human inhabitation, government should take quick necessary actions to conserve this unique ecosystem

CONCLUSION

Phytosociological studies are important to ascertain the distribution of sustenance plants for wildlife and mandatory for the basic research in tropical ecosystems, Dudley, (2005) andJain S.K, (1976). Ayiramthengu mangrove's areas are large and diverse in species, and are inevitable ecosystem in marine fresh water interface.Floristic diversity indicated that the study area constituted 9 species of true mangroves under 5 genera belonging to 6 families. The pattern of distribution of mangrove species in all the locations were discontinuous and in patches of varying extent. *Avicennia marina* was the most dominant speciesfollowed by *A. officinalis*. *Lumnitzera racemosa*and *Sonneratia caseolaris*are least diverse species in Ayiramthengu, Where, *Lumnitzera racemosa* confined only in Kollam district in the southern Kerala.Structural analysis of mangroves of Ayiramthengu unveiled the domination of *Avicennia marina* having highest IVI and RIVI values owing to high values of relative density and relative frequency. Diversity indices indicated that Shannon-Weiner index of diversity (2.763) considered as medium to high diverse in terms of species. Urbanization, industrialization and chemical discharge are some of the major common threats that dwindle mangrove ecosystems.

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CHARACTER ASSOCIATION FOR OIL CONTENT IN GROWING PLANTS OF PHYSIC NUT [*JATROPHA CURCAS* (L.)]

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Abstract: To study variability and character association for oil content 26 characters which includes vegetative, flowering, fruit and quality characters were recorded on 3 and 4 year old plants of 56 germplasm lines in the years 2007 and 2008. Analysis of variance revealed significant differences among the genotypes for all the traits except for number of primary branches per plant in both the years. Correlation of oil content with plant height, stem girth, number of fruits per fruiting branch, petiole length, number of secondary branches per inflorescence, weight per fruit, 100-seed weight, seed yield per plant, seed content and kernel: shell ratio was significant positive in both the years. The positively correlated characters which exhibited positive direct effects on oil content were seed content, number of fruits per fruiting branch, weight per fruit and kernel: shell ratio at both the ages. Significant inter correlations were also existed among the characters associated with oil content.

Keywords: Genetic variability, Oil Content, Correlation, *Jatropha*

INTRODUCTION

Physic nut (*Jatropha curcas* L.) is a multipurpose shrub of family Euphorbiaceae. It has high degree of adaptability ranging from tropical to subtropical climate. It grows almost everywhere, even on gravely, sandy and saline soils, on the poorest stony soil and in the crevices of rocks. Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves to reduce transpiration loss. In our country which has 175 m ha. of waste and barren agricultural land, the cultivation of jatropha could indeed prove a boon because of it's perennial habit and multiple uses in commerce, industry and agriculture. Jatropha seeds possess 40-50 per cent (at 7 per cent moisture) oil which can be directly used as fuel because of its unique fatty acid composition. This non-conventional source of energy will be boon for the countries like India which are deficit in natural reserves of petroleum and have to import about 75 per cent of its total demand.

To make jatropha cultivation a viable option for biofuel production there is great need to increase oil yield per unit area. As *J. curcas* is still a wild plant, there is big scope for improvement of oil content in seeds and by thus oil yield per unit area. Due to its importance as a biofuel crop, there is a great need to develop improved high yielding varieties with high oil content for commercial cultivation. For this a systematic breeding approach is to be followed, which depends upon genetic variability in the important traits, their mutual association and association with oil content. The Path coefficient analysis provides an accurate picture of relative importance of direct and indirect factors influencing the oil content. Therefore, components of oil content can be identified and selected.

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MATERIAL AND METHOD

The stem cuttings of 56 selected plants collected from different locations of Aravali hills of southern Rajasthan were planted at Instructional Farm of Horticulture, Rajasthan College of Agriculture, Udaipur. The selection of plants was done based on area, location and density of plants in the area. More samples were taken from area having high density of plants and each plant was assigned a name where, ARV abbreviation stands for Aravali. The experimental design was Completely Randomized Block Design (CRD). Observations were recorded on five normal appearing plants of 3 and 4 year age during 2007 and 2008 for 26 characters (Table 1). Phenotypic and genotypic coefficients of variation were estimated by the formulae suggested by Burton (1952). The phenotypic and genotypic correlation coefficients were calculated from the phenotypic and genotypic components of variances and covariances as described by Singh and Choudhary (1985). The principles and techniques suggested by Wright (1921), Li (1955) and Dewey and Lu (1959) were used to assess direct and indirect effects of variable on seed yield and oil content separately in both the years.

RESULT AND DISCUSSION

The mean squares due to genotypes were significant for all the traits at both the ages except for number of primary branches per plant. The Bartlet test showed homogeneity of the error variance for seven characters only *viz.* plant height, stem girth, number of primary branches per plant, number of fruiting branches per plant, area of fully matured leaf, seeds per fruit and acid value. All the seven characters had significant difference between genotypes over the years. The magnitude of phenotypic coefficient of variation (PCV) and genotypic coefficients of

variation (GCV) varied together, which suggest uniform response of different characters to different environmental conditions. Higher magnitude of PCV than GCV was indicating the role of environment in both the years for all the characters. Among the traits, magnitude of GCV and PCV was high for number of fruiting branches per plant, fruit yield per plant and seed yield per plant at both the ages. The number of fruits per fruiting branch showed high GCV and PCV at the 3 year age only. The magnitude of GCV and PCV was moderate for plant height, stem girth, number of primary branches per plant, number of flushes per fruiting branch, petiole length, area of fully matured leaf, diameter of fruiting branch, number of male flowers per secondary branch, number of female flowers per secondary branch, number of female flowers per inflorescence, ratio of male to female flowers, weight per fruit, 100-seed weight, seed content, kernel: shell ratio, oil content, acid value and iodine value at both the ages. It was also moderate for number of fruits per fruiting branch and number of secondary branches per inflorescence at the 4 year age. The moderate magnitude of GCV and PCV for area of fully matured leaf, number of fruits per fruiting branch, number of male and female flowers per primary has also been reported by Ranwah *et al.* (2009).

Correlation analysis (Table 2&3) revealed that the oil content was positively correlated with plant height, stem girth, number of fruits per fruiting branch, petiole length, number of secondary branches per inflorescence, weight per fruit, 100-seed weight, seed yield per plant, seed content and kernel: shell ratio in both the years and with number of flushes per fruiting branch in second year only. Acid value and iodine value did not show any relationship with the oil content correlated characters except iodine value with number of flushes per fruiting branch (0.27), which showed positive correlation in second year only. Significant positive correlation of oil content with plant height, collar diameter, seed weight and kernel weight has been also reported by Ginwal *et al.* (2004); with 100-seed weight by Kaushik *et al.* (2007) and Rao *et al.* (2008) and with 100-seed weight, kernel content, number of fruits per fruiting branch and number of female flowers per primary by Ranwah *et al.* (2009). The characters like plant height, stem girth, number of fruits per fruiting branch, 100-seed weight, seed content and kernel: shell ratio showed positive correlation with both seed yield per plant and oil content. Therefore, these characters could be used for improvement of both the economically important traits viz. seed yield and oil content simultaneously.

The path analysis was carried out to recommend reliable selection criteria. The value of residual effects 0.270 and 0.173 indicated that 73.0 and 87.5 per cent variability of oil content at 3 and 4 year age respectively was explained by these characters (Table 4&5). The positively correlated characters which exhibited positive direct effects on oil content were seed content, number of fruits per fruiting branch, weight per fruit and kernel: shell ratio in both the years and number of fruiting branches per plant, petiole length and 100-seed weight at 3 year age and plant height and number of secondary branches per inflorescence at 4 year age. These characters could be directly used for oil content improvement.

Based on these findings it is concluded that characters like seed content, number of fruits per fruiting branch, weight per fruit and kernel: shell ratio, number of fruiting branches per plant, petiole length, 100-seed weight, plant height and number of secondary branches per inflorescence should be included to form selection criteria for improvement of oil content. The characters like plant height, number of fruiting branches per plant, number of fruits per fruiting branch, seed content, 100-seed weight and kernel: shell ratio should be included to form selection criteria for improvement of both seed yield and oil content. Since most of these characters had moderate to high variability, heritability and genetic gain and substantial direct effect on the seed yield and oil content.

In conclusion, for development of high oil content clone genotypes ARV-079 and ARV-049 could be used as parents and can be crossed with ARV-020 or ARV-023 (having high *per se* performance for seed yield and for most of the positively correlated characters with seed yield). High seed yield and oil yield is expected from the above crosses. Individual plant may be tested for these characters and desired one may be multiplied through vegetative propagation to obtain the superior clones for high seed yield and oil content.

Table 1. Mean square for different characters in individual environment

SN	Characters	Environments	Genotype [55]	Error [224]	Bartlet [1]
1	Plant height (cm)	E1	1.71**	0.26	0.14
		E2	1.55**	0.25	
2	Stem grith (cm)	E1	111.64**	30.26	0.38
		E2	108.51**	32.89	
3	Number of primary branches per plant	E1	2.06	1.87	0.45
		E2	2.17	1.71	

4	Number of fruiting branches per plant	E1	239.55**	84.65	1.71
		E2	205.43**	71.07	
5	Number of flushes per fruiting branch	E1	0.16**	0.05	31.26**
		E2	0.10**	0.02	
6	Number of fruits per fruiting branch	E1	6.46**	1.11	4.04*
		E2	5.18**	0.85	
7	Petiole length (cm)	E1	26.47**	0.97	33.15**
		E2	27.38**	2.12	
8	Area of fully matured leaf (cm2)	E1	1033.43**	73.15	0.69
		E2	1040.72**	65.48	
9	Diameter of fruiting branch (cm)	E1	0.08**	0.02	11.72**
		E2	0.06**	0.01	
10	Number of primary branches per inflorescence	E1	0.10**	0.01	79.74**
		E2	0.03**	0.002	
11	Number of secondary branches per inflorescence	E1	1.04**	0.19	16.61**
		E2	2.23**	0.11	
12	Number of male flowers per secondary branch	E1	83.96**	0.99	28.33**
		E2	83.00**	2.02	
13	Number of female flowers per secondary branch	E1	0.86**	0.042	61.86**
		E2	0.38**	0.014	
14	Number of female flowers per inflorescence	E1	51.92**	0.65	8.44**
		E2	24.72**	0.44	
15	Ratio of male to female flowers	E1	84.72**	3.26	8.03**
		E2	65.13**	2.23	
16	Fruit diameter (cm)	E1	0.03**	0.01	171.42**
		E2	0.03**	0.002	
17	Weight per fruit (g)	E1	0.37**	0.003	97.68**
		E2	0.42**	0.01	
18	Seeds per fruit	E1	0.09**	0.01	1.19
		E2	0.08**	0.01	
19	100 Seed weight (g)	E1	440.13**	1.53	54.21**
		E2	433.09**	4.18	
20	Fruit yield per plant (g)	E1	8144.82**	751.00	132.66**
		E2	26051.46**	3780.00	
21	Seed yield per plant (g)	E1	3912.94**	314.00	143.28**
		E2	13222.37**	1695.00	
22	Seed content (%)	E1	184.79**	0.83	5.95*
		E2	178.56**	1.16	
23	Kernel : shell ratio	E1	0.37**	0.003	39.24**
		E2	0.36**	0.007	
24	Oil content (%)	E1	105.49**	0.67	27.85**
		E2	95.33**	1.36	
25	Acid value	E1	45.58**	1.31	0.16
		E2	68.47**	1.24	
26	Iodine value	E1	791.52**	11.29	37.21**
		E2	982.69**	25.79	

Table 2. Correlation coefficient matrix (P\G) for different characters at 3 year age of the plants

SN	Character	Plant height	Stem girth	Number of fruiting branches per plant	Number of flushes per fruiting branch	Number of fruits per fruiting branch	Petiole length	Area of fully matured leaf	Diameter of fruiting branch	Number of primary branches per inflorescence	Number of secondary branches per inflorescence	Number of male flowers per secondary branch	No. of female flowers per secondary branch	No. of female flowers per inflorescence
1	Plant height		1.00	0.80**	0.30*	0.86**	0.59**	0.34*	-0.50**	-0.25	0.14	0.47**	0.34**	0.38**
2	Stem girth	0.85**		0.79**	0.26	0.88**	0.54**	0.33*	-0.51**	-0.21	0.15	0.52**	0.31*	0.37**
3	Number of fruiting branches per plant	0.62**	0.65**		0.31*	0.83**	0.37**	0.34*	-0.50**	-0.24	0.22	0.39**	0.30*	0.49**
4	Number of flushes per fruiting branch	0.31*	0.31*	0.29*		0.43**	0.30*	0.25	0.09	-0.25	0.02	-0.05	0.50**	0.54**
5	Number of fruits per fruiting branch	0.65**	0.62**	0.54**	0.39**		0.53**	0.40**	-0.55**	-0.35**	0.29*	0.46**	0.32*	0.39**
6	Petiole length	0.42**	0.32*	0.21	0.15	0.38**		0.64**	-0.34**	-0.13	0.56**	0.20	0.43**	0.16
7	Area of fully matured leaf	0.24	0.19	0.18	0.13	0.25	0.51**		-0.22	-0.34*	0.33*	0.38**	0.36**	-0.02
8	Diameter of fruiting branch	-0.18	-0.20	-0.25	0.07	-0.21	-0.19	-0.11		0.06	-0.49**	-0.50**	-0.22	0.01
9	Number of primary branches per inflorescence	-0.16	-0.12	-0.11	-0.14	-0.22	-0.10	-0.26*	0.11		0.09	-0.27*	-0.14	-0.24
10	Number of secondary branches per inflorescence	0.15	0.13	0.12	0.09	0.23	0.36**	0.22	-0.10	0.08		0.14	0.16	-0.12

11	Number of male flowers per secondary branch	0.35**	0.32*	0.22	-0.01	0.34*	0.18	0.32*	-0.32*	-0.24	0.09	0.39**	0.13
12	Number of female flowers per secondary branch	0.24	0.16	0.14	0.26	0.26	0.35**	0.26	-0.11	-0.12	0.12	0.36**	0.51**
13	Number of female flowers per inflorescence	0.29*	0.23	0.26	0.31*	0.29*	0.16	-0.01	0.02	-0.20	-0.06	0.13	0.47**
14	Ratio of male to female flowers	0.07	0.11	0.05	-0.24	0.05	-0.10	0.08	-0.15	-0.09	-0.00	0.38**	-0.68**
15	Fruit diameter	-0.10	-0.11	-0.07	-0.15	-0.11	-0.04	-0.07	0.11	0.14	-0.07	-0.17	-0.24
16	Weight per fruit	0.20	0.11	0.06	-0.01	0.08	0.48**	0.24	-0.12	0.02	0.22	-0.03	0.07
17	Seeds per fruit	0.13	0.08	0.03	0.02	-0.01	0.08	-0.06	-0.15	0.09	0.08	0.14	0.10
18	100 Seed weight	0.18	0.12	-0.01	0.03	0.15	0.27*	0.09	-0.04	0.11	0.10	-0.06	-0.17
19	Fruit yield per plant	0.47**	0.44**	0.35**	0.08	0.49**	0.37**	0.19	-0.26	-0.20	0.13	0.32*	0.19
20	Seed yield per plant	0.49**	0.45**	0.35**	0.07	0.51**	0.34**	0.15	-0.26*	-0.19	0.11	0.32*	0.12
21	Seed content	0.15	0.10	0.04	-0.00	0.14	0.02	-0.16	-0.10	0.06	-0.05	-0.04	-0.30*
22	Kernel : shell ratio	0.28*	0.21	0.06	0.09	0.24	0.29*	0.08	-0.13	0.06	0.07	0.09	-0.01
23	Oil content	0.23	0.17	0.09	0.14	0.29*	0.33*	0.09	-0.08	-0.00	0.22	0.03	0.02
24	Acid value	-0.05	-0.08	-0.01	0.08	-0.02	-0.07	-0.24	0.02	0.01	0.08	-0.22	-0.10
25	Iodine value	0.05	0.04	-0.05	0.07	0.03	0.16	0.06	0.06	-0.12	-0.08	0.06	0.23

Cont….

Table 2. Continue

SN	Character	Ratio of male to female flowers	Fruit diameter	Weight per fruit	Seeds per fruit	100 Seed weight	Fruit yield per plant	Seed yield per plant	Seed content	Kernel : shell ratio	Oil content	Acid value	Iodine value
1	Plant height	0.11	-0.27*	0.26	0.24	0.25	0.76**	0.78**	0.20	0.38**	0.32*	-0.05	0.08
2	Stem girth	0.18	-0.31*	0.19	0.21	0.22	0.80**	0.80**	0.17	0.35**	0.30*	-0.12	0.07
3	Number of fruiting branches per plant	0.05	-0.26	0.11	0.15	-0.03	0.61**	0.60**	0.07	0.11	0.17	-0.04	-0.08
4	Number of flushes per fruiting branch	-0.50**	-0.40**	-0.02	0.02	0.07	0.03	0.04	0.02	0.16	0.27*	0.21	0.12
5	Number of fruits per fruiting branch	0.12	-0.27*	0.10	0.03	0.19	0.69**	0.70**	0.19	0.32*	0.40**	-0.01	0.05
6	Petiole length	-0.12	-0.15	0.53**	0.12	0.30*	0.50**	0.45**	0.02	0.33*	0.36**	-0.06	0.17
7	Area of fully matured leaf	0.08	-0.20	0.30*	-0.12	0.11	0.28*	0.21	-0.19	0.09	0.10	-0.33*	0.07
8	Diameter of fruiting branch	-0.25	0.12	-0.20	-0.27*	-0.07	-0.43**	-0.44**	-0.17	-0.22	-0.15	0.06	0.11
9	Number of primary branches per inflorescence	-0.11	0.12	0.03	0.14	0.12	-0.27*	-0.26	0.06	0.08	-0.01	0.03	-0.12
10	Number of secondary branches per inflorescence	0.02	-0.15	0.32*	0.08	0.15	0.17	0.14	-0.07	0.10	0.32*	0.11	-0.12
11	Number of male flowers per secondary branch	0.42**	-0.28*	-0.04	0.18	-0.06	0.40**	0.39**	-0.04	0.09	0.03	-0.23	0.06
12	Number of female flowers per secondary branch	-0.65**	-0.41**	0.07	0.13	-0.19	0.25	0.15	-0.34**	-0.03	0.01	-0.11	0.27*
13	Number of female flowers per inflorescence	-0.43**	-0.08	-0.01	0.17	-0.01	0.30*	0.32*	0.18	0.06	0.16	0.20	0.19
14	Ratio of male to female flowers		0.18	-0.01	0.05	0.18	0.14	0.22	0.32*	0.16	0.06	-0.10	-0.19
15	Fruit diameter	0.08		0.50**	0.19	0.42**	-0.11	-0.07	0.30*	-0.09	-0.11	-0.08	-0.17
16	Weight per fruit	-0.01	0.27*		0.40**	0.71**	0.18	0.19	0.21	0.34*	0.29*	-0.21	-0.04
17	Seeds per fruit	0.03	0.04	0.31*		0.30*	0.25	0.30*	0.44**	0.43**	0.15	-0.14	0.11
18	100 Seed weight	0.16	0.23	0.69**	0.23		0.18	0.27*	0.53**	0.61**	0.53**	-0.09	0.05
19	Fruit yield per plant	0.10	-0.06	0.13	0.17	0.14		0.98**	0.13	0.28*	0.18	-0.02	0.17
20	Seed yield per plant	0.16	-0.04	0.14	0.21	0.22	0.98**		0.32*	0.41**	0.29*	0.02	0.14
21	Seed content	0.29*	0.16	0.21	0.34*	0.52**	0.10	0.26		0.73**	0.64**	0.15	-0.09
22	Kernel : shell ratio	0.14	-0.04	0.33*	0.33*	0.60**	0.23	0.34*	0.73**		0.75**	-0.01	0.06
23	Oil content	0.05	-0.05	0.28*	0.12	0.52**	0.13	0.23	0.63**	0.74**		0.13	-0.02
24	Acid value	-0.08	-0.06	-0.19	-0.10	-0.08	-0.03	-0.00	0.15	-0.01	0.12		0.04
25	Iodine value	-0.17	-0.09	-0.04	0.09	0.04	0.14	0.11	-0.09	0.06	-0.02	0.04	

Table 3. Correlation coefficient matrix (P\G) for different characters at 4 year age of the plants

SN	Character	Plant height	Stem girth	Number of fruiting branches per plant	Number of flushes per fruiting branch	Number of fruits per fruiting branch	Petiole length	Area of fully matured leaf	Diameter of fruiting branch	Number of primary branches per inflorescence	Number of secondary branches per inflorescence	Number of male flowers per secondary branch	No. of female flowers per secondary branch	No. of female flowers per inflorescence
1	Plant height		0.96**	0.86**	0.37**	0.85**	0.60**	0.33*	-0.43**	-0.19	0.13	0.18	0.10	-0.06
2	Stem grith	0.80**		0.85**	0.33*	0.84**	0.62**	0.45**	-0.61**	-0.16	0.34*	0.27*	0.20	-0.13
3	Number of fruiting branches per plant	0.67**	0.71**		0.48**	0.91**	0.40**	0.37**	-0.44**	-0.21	0.09	0.23	0.17	0.11
4	Number of flushes per fruiting branch	0.38**	0.35**	0.40**		0.47**	0.34**	0.25	0.07	-0.12	0.05	-0.18	0.08	0.30*
5	Number of fruits per fruiting branch	0.68**	0.63**	0.60**	0.48**		0.50**	0.37**	-0.39**	-0.31*	0.24	0.28*	0.22	0.07
6	Petiole length	0.42**	0.32*	0.21	0.17	0.38**		0.68**	-0.32*	-0.11	0.51**	-0.06	0.36**	0.03
7	Area of fully matured leaf	0.27*	0.28*	0.22	0.16	0.25	0.57**		-0.12	-0.10	0.50**	0.17	0.44**	-0.02
8	Diameter of fruiting branch	-0.13	-0.20	-0.20	0.10	-0.18	-0.15	-0.08		0.08	-0.31*	-0.21	-0.19	0.23
9	Number of primary branches per inflorescence	-0.14	-0.13	-0.13	-0.11	-0.23	-0.09	-0.08	0.09		0.16	-0.27*	-0.25	-0.13
10	Number of secondary branches per inflorescence	0.10	0.15	0.06	0.04	0.18	0.39**	0.42**	-0.14	0.18		0.09	0.26	-0.15
11	Number of male flowers per secondary branch	0.12	0.10	0.11	-0.09	0.19	-0.05	0.17	-0.11	-0.23	0.11		0.28*	0.14
12	Number of female flowers per secondary branch	0.05	0.10	0.11	0.03	0.15	0.29*	0.35**	-0.09	-0.18	0.23	0.26		0.53**
13	Number of female flowers per inflorescence	-0.05	-0.07	0.06	0.19	0.04	0.03	0.00	0.14	-0.08	-0.11	0.12	0.51**	

14	Ratio of male to female flowers	0.10	0.04	0.02	-0.09	0.08	-0.23	-0.15	-0.03	-0.05	-0.08	0.55**	-0.64**	-0.37**
15	Fruit diameter	-0.09	-0.05	-0.04	0.00	-0.16	0.09	0.07	0.05	0.24	0.21	-0.09	-0.13	-0.04
16	Weight per fruit	0.19	0.13	0.05	0.00	0.09	0.44**	0.26	-0.15	0.08	0.36**	-0.00	0.16	-0.09
17	Seeds per fruit	0.15	0.15	0.11	0.08	0.09	0.14	0.01	-0.24	0.15	0.17	0.04	0.02	-0.01
18	100 Seed weight	0.18	0.09	0.00	-0.05	0.05	0.30*	0.16	-0.07	0.22	0.40**	-0.03	-0.01	-0.17
19	Fruit yield per plant	0.58**	0.55**	0.57**	0.21	0.57**	0.30*	0.12	-0.29*	-0.10	0.15	0.12	0.00	-0.00
20	Seed yield per plant	0.59**	0.54**	0.55**	0.20	0.57**	0.29*	0.09	-0.28*	-0.10	0.14	0.11	-0.04	-0.03
21	Seed content	0.18	0.07	0.04	-0.03	0.11	0.06	-0.17	-0.11	0.07	-0.03	0.06	-0.21	-0.09
22	Kernel : shell ratio	0.32*	0.19	0.09	0.07	0.19	0.30*	0.10	-0.14	0.07	0.13	0.04	-0.04	-0.18
23	Oil content	0.27*	0.18	0.10	0.10	0.28*	0.35**	0.13	-0.10	-0.05	0.23	0.00	0.12	-0.05
24	Acid value	0.01	-0.02	0.08	-0.07	0.01	-0.06	-0.11	-0.12	-0.03	-0.05	0.19	-0.12	0.04
25	Iodine value	0.06	0.01	0.00	0.18	0.04	0.13	0.08	0.00	-0.00	0.02	-0.04	0.05	0.14

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Table 3. Continue

SN	Character	Ratio of male to female flowers	Fruit diameter	Weight per fruit	Seeds per fruit	100 Seed weight	Fruit yield per plant	Seed yield per plant	Seed content	Kernel : shell ratio	Oil content	Acid value	Iodine value
1	Plant height	0.12	-0.17	0.28*	0.34*	0.25	0.92**	0.90**	0.24	0.45**	0.39**	-0.01	0.08
2	Stem grith	0.11	-0.16	0.30*	0.40**	0.20	0.90**	0.87**	0.13	0.37**	0.35**	-0.08	0.05
3	Number of fruiting branches per plant	0.07	-0.20	0.14	0.31*	-0.00	0.82**	0.78**	0.10	0.18	0.21	0.09	0.02
4	Number of flushes per fruiting branch	-0.19	-0.13	-0.01	0.18	-0.09	0.25	0.24	-0.05	0.11	0.22	-0.11	0.27*
5	Number of fruits per fruiting branch	0.11	-0.32*	0.10	0.15	0.09	0.80**	0.79**	0.16	0.29*	0.43**	0.01	0.03
6	Petiole length	-0.29*	0.09	0.57**	0.25	0.37**	0.47**	0.44**	0.07	0.40**	0.43**	-0.07	0.17
7	Area of fully matured leaf	-0.21	0.07	0.33*	0.00	0.20	0.18	0.11	-0.22	0.14	0.16	-0.15	0.10
8	Diameter of fruiting branch	-0.05	0.07	-0.25	-0.28*	-0.10	-0.42**	-0.41**	-0.19	-0.25	-0.15	-0.16	0.01
9	Number of primary branches per inflorescence	-0.04	0.30*	0.10	0.19	0.25	-0.14	-0.13	0.09	0.09	-0.06	-0.04	-0.01
10	Number of secondary branches per inflorescence	-0.12	0.22	0.43**	0.25	0.45**	0.18	0.16	-0.04	0.16	0.27*	-0.06	0.02
11	Number of male flowers per secondary branch	0.54**	-0.13	-0.02	0.09	-0.04	0.18	0.16	0.05	0.05	0.01	0.20	-0.05
12	Number of female flowers per	-0.64**	-0.17	0.19	0.04	-0.01	0.01	-0.06	-0.24	-0.04	0.13	-0.14	0.06

	secondary branch												
13	Number of female flowers per inflorescence	-0.39**	-0.04	-0.09	-0.00	-0.18	-0.02	-0.05	-0.09	-0.19	-0.05	0.04	0.16
14	Ratio of male to female flowers		0.03	-0.16	0.06	-0.00	0.22	0.27*	0.25	0.10	-0.07	0.27*	-0.08
15	Fruit diameter	0.03		0.53**	0.47**	0.45**	-0.08	-0.08	0.09	0.02	-0.10	0.05	0.07
16	Weight per fruit	-0.13	0.45**		0.49**	0.78**	0.23	0.23	0.21	0.36**	0.29*	-0.08	-0.04
17	Seeds per fruit	0.03	0.34**	0.34**		0.36**	0.33*	0.36**	0.46**	0.48**	0.12	-0.10	0.12
18	100 Seed weight	0.00	0.40**	0.73**	0.27*		0.23	0.30*	0.44**	0.58**	0.42**	0.03	-0.00
19	Fruit yield per plant	0.15	-0.03	0.14	0.17	0.17		0.98**	0.20	0.35**	0.25	0.16	-0.00
20	Seed yield per plant	0.18	-0.03	0.15	0.20	0.22	0.99**		0.36**	0.45**	0.33*	0.20	-0.02
21	Seed content	0.23	0.08	0.20	0.33*	0.42**	0.15	0.27*		0.71**	0.55**	0.26	-0.09
22	Kernel : shell ratio	0.09	0.02	0.32*	0.35**	0.55**	0.24	0.33*	0.67**		0.62**	-0.02	0.04
23	Oil content	-0.07	-0.11	0.26	0.11	0.40**	0.19	0.25	0.53**	0.58**		-0.03	-0.06
24	Acid value	0.25	0.05	-0.07	-0.05	0.03	0.13	0.17	0.24	-0.02	-0.03		-0.01
25	Iodine value	-0.07	0.07	-0.02	0.07	0.01	-0.01	-0.02	-0.09	0.04	-0.06	-0.02	

Table 4. Path analysis for oil content (%) at the 3 year age of the plants

SN	Character	Plant height	Stem girth	Number of fruiting branches per plant	Number of flushes per fruiting branch	Number of fruits per fruiting branch	Petiole length	Area of fully matured leaf	Fruiting branch diameter	Number of primary branches per inflorescence	Number of secondary branches per inflorescence	Number of male flowers per secondary branch	Number of female flowers per secondary branch	Number of female flowers per inflorescence
1	Plant height	**-1.04**	-0.36	0.47	-0.20	0.94	0.12	-0.22	-0.37	0.03	-0.02	-0.52	0.79	-0.12
2	Stem girth	-1.04	**-0.36**	0.47	-0.18	0.95	0.11	-0.21	-0.38	0.02	-0.02	-0.58	0.72	-0.11
3	Number of fruiting branches per plant	-0.83	-0.28	**0.59**	-0.21	0.91	0.08	-0.22	-0.37	0.03	-0.02	-0.44	0.69	-0.15
4	Number of flushes per fruiting branch	-0.31	-0.09	0.18	**-0.68**	0.47	0.06	-0.16	0.07	0.03	-0.00	0.06	1.14	-0.17
5	Number of fruits per fruiting branch	-0.89	-0.31	0.49	-0.29	**1.09**	0.11	-0.26	-0.41	0.04	-0.03	-0.51	0.73	-0.12
6	Petiole length	-0.61	-0.19	0.22	-0.21	0.58	**0.20**	-0.42	-0.25	0.02	-0.06	-0.22	0.99	-0.05
7	Area of fully matured leaf	-0.35	-0.12	0.20	-0.17	0.44	0.13	**-0.65**	-0.16	0.04	-0.04	-0.43	0.83	0.00
8	Diameter of fruiting branch	0.52	0.18	-0.30	-0.06	-0.60	-0.07	0.14	**0.74**	-0.01	0.05	0.56	-0.51	-0.00
9	Number of primary branches per inflorescence	0.26	0.07	-0.14	0.17	-0.38	-0.03	0.22	0.05	**-0.12**	-0.01	0.30	-0.32	0.07

10	Number of secondary branches per inflorescence	-0.14	-0.05	0.13	-0.02	0.31	0.12	-0.21	-0.36	-0.01	**-0.11**	-0.16	0.37	0.04
11	Number of male flowers per secondary branch	-0.48	-0.19	0.23	0.03	0.50	0.04	-0.25	-0.37	0.03	-0.02	**-1.11**	0.89	-0.04
12	Number of female flowers per secondary branch	-0.36	-0.11	0.18	-0.34	0.35	0.09	-0.23	-0.16	0.02	-0.02	-0.43	**2.31**	-0.16
13	Number of female flowers per inflorescence	-0.39	-0.13	0.29	-0.37	0.43	0.03	0.01	0.01	0.03	0.01	-0.14	1.18	**-0.31**
14	Ratio of male to female flowers	-0.12	-0.07	0.03	0.34	0.14	-0.03	-0.05	-0.18	0.01	-0.00	-0.46	-1.51	0.13
15	Fruit diameter	0.28	0.11	-0.16	0.27	-0.30	-0.03	0.13	0.09	-0.01	0.02	0.31	-0.94	0.02
16	Weight per fruit	-0.27	-0.07	0.06	0.02	0.11	0.11	-0.19	-0.15	-0.00	-0.04	0.04	0.15	0.00
17	Seeds per fruit	-0.25	-0.08	0.09	-0.01	0.03	0.03	0.07	-0.20	-0.02	-0.01	-0.21	0.31	-0.05
18	100 Seed weight	-0.26	-0.08	-0.02	-0.05	0.21	0.06	-0.07	-0.05	-0.01	-0.02	0.07	-0.44	0.00
19	Fruit yield per plant	-0.79	-0.29	0.36	-0.02	0.75	0.10	-0.18	-0.32	0.03	-0.02	-0.45	0.59	-0.09
20	Seed yield per plant	-0.81	-0.29	0.35	-0.02	0.77	0.09	-0.14	-0.32	0.03	-0.02	-0.43	0.36	-0.10
21	Seed content	-0.21	-0.06	0.04	-0.01	0.21	0.00	0.12	-0.13	-0.01	0.01	0.04	-0.79	-0.06
22	Kernel : shell ratio	-0.39	-0.13	0.07	-0.11	0.35	0.07	-0.06	-0.16	-0.01	-0.01	-0.10	-0.07	-0.02
23	Acid value	0.06	0.04	-0.02	-0.14	-0.01	-0.01	0.21	0.05	-0.00	-0.01	0.25	-0.25	-0.06
24	Iodine value	-0.08	-0.03	-0.05	-0.08	0.05	0.04	-0.05	0.08	0.01	0.01	-0.07	0.62	-0.06

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Table 4. Continue

SN	Character	Ratio of male to female flowers	Fruit diameter	Weight per fruit	Seeds per fruit	100 Seed weight	Fruit yield per plant	Seed yield per plant	Seed content	Kernel : shell ratio	Acid value	Iodine value	r
1	Plant height	0.18	0.36	0.11	-0.04	0.24	2.77	-2.97	0.41	-0.25	-0.00	-0.02	0.32*
2	Stem grith	0.30	0.42	0.08	-0.03	0.21	2.91	-3.08	0.34	-0.23	-0.01	-0.02	0.30*
3	Number of fruiting branches per plant	0.08	0.35	0.05	-0.02	-0.03	2.20	-2.29	0.14	-0.07	-0.00	0.02	0.17
4	Number of flushes per fruiting branch	-0.83	0.54	-0.01	-0.00	0.06	0.13	-0.14	0.04	-0.11	0.01	-0.03	0.27*
5	Number of fruits per fruiting branch	0.21	0.36	0.04	-0.00	0.18	2.50	-2.70	0.38	-0.21	-0.00	-0.01	0.40**
6	Petiole length	-0.21	0.21	0.23	-0.02	0.28	1.81	-1.74	0.05	-0.21	-0.00	-0.04	0.36**
7	Area of fully matured leaf	0.13	0.27	0.13	0.02	0.11	1.02	-0.82	-0.39	-0.06	-0.02	-0.02	0.10
8	Diameter of fruiting branch	-0.41	-0.16	-0.09	0.04	-0.07	-1.56	1.68	-0.35	0.15	0.00	-0.03	-0.15
9	Number of primary branches per	-0.18	-0.17	0.01	-0.02	0.11	-0.99	1.00	0.12	-0.05	0.00	0.03	-0.01

	inflorescence												
10	Number of secondary branches per inflorescence	0.03	0.20	0.14	-0.01	0.14	0.62	-0.53	-0.15	-0.06	0.01	0.03	0.32*
11	Number of male flowers per secondary branch	0.69	0.38	-0.02	-0.03	-0.06	1.46	-1.49	-0.08	-0.06	-0.01	-0.02	0.03
12	Number of female flowers per secondary branch	-1.08	0.55	0.03	-0.02	-0.18	0.92	-0.59	-0.70	0.02	-0.01	-0.07	0.01
13	Number of female flowers per inflorescence	-0.71	0.10	-0.00	-0.03	-0.01	1.10	-1.23	0.36	-0.04	0.01	-0.05	0.16
14	Ratio of male to female flowers	**1.65**	-0.24	-0.01	-0.01	0.17	0.50	-0.83	0.64	-0.11	-0.01	0.05	0.06
15	Fruit diameter	0.29	**-1.35**	0.22	-0.03	0.40	-0.41	0.28	0.61	0.06	-0.00	0.04	-0.11
16	Weight per fruit	-0.02	-0.67	**0.44**	-0.06	0.67	0.67	-0.71	0.44	-0.22	-0.01	0.01	0.29*
17	Seeds per fruit	0.08	-0.26	0.17	**-0.16**	0.28	0.90	-1.16	0.90	-0.28	-0.01	-0.03	0.15
18	100 Seed weight	0.29	-0.57	0.31	-0.05	**0.94**	0.64	-1.04	1.08	-0.40	-0.01	-0.01	0.53**
19	Fruit yield per plant	0.23	0.15	0.08	-0.04	0.17	**3.63**	-3.74	0.25	-0.19	-0.00	-0.04	0.18
20	Seed yield per plant	0.36	0.10	0.08	-0.05	0.26	3.55	**-3.82**	0.64	-0.27	0.00	-0.03	0.29*
21	Seed content	0.53	-0.40	0.09	-0.07	0.50	0.45	-1.21	**2.03**	-0.48	0.01	0.02	0.64**
22	Kernel : shell ratio	0.27	0.12	0.15	-0.07	0.58	1.03	-1.56	1.48	**-0.66**	-0.00	-0.02	0.75**
23	Acid value	-0.16	0.10	-0.09	0.02	-0.08	-0.07	-0.07	0.31	0.01	**0.06**	-0.01	0.13
24	Iodine value	-0.32	0.23	-0.02	-0.02	0.04	0.63	-0.52	-0.17	-0.04	0.00	**-0.24**	-0.02

Residual = 0.2700

Table 5. Path analysis for Oil content (%) at the 4 year age of the plants

SN	Character	Plant height	Stem girth	Number of fruiting branches per plant	Number of flushes per fruiting branch	Number of fruits per fruiting branch	Petiole length	Area of fully matured leaf	Fruiting branch diameter	Number of primary branches per inflorescence	Number of secondary branches per inflorescence	Number of male flowers per secondary branch	Number of female flowers per secondary branch	Number of female flowers per inflorescence
1	Plant height	**2.80**	-0.99	-0.83	0.25	0.07	-0.69	-0.17	-0.15	-0.00	0.18	-0.00	0.07	0.02
2	Stem girth	2.69	**-1.03**	-0.82	0.22	0.07	-0.71	-0.22	-0.22	-0.00	0.47	-0.01	0.14	0.06
3	Number of fruiting branches per plant	2.42	-0.87	**-0.97**	0.32	0.07	-0.46	-0.19	-0.16	-0.01	0.13	-0.01	0.11	-0.05
4	Number of flushes per	1.04	-0.34	-0.46	**0.68**	0.04	-0.39	-0.13	0.03	-0.00	0.07	0.00	0.05	-0.13

	fruiting branch													
5	Number of fruits per fruiting branch	2.38	-0.86	-0.88	0.32	**0.08**	-0.57	-0.19	-0.14	-0.01	0.34	-0.01	0.14	-0.03
6	Petiole length	1.68	-0.64	-0.39	0.23	0.04	**-1.15**	-0.34	-0.12	-0.00	0.71	0.00	0.24	-0.01
7	Area of fully matured leaf	0.93	-0.46	-0.36	0.17	0.03	-0.78	**-0.50**	-0.04	-0.00	0.70	-0.00	0.29	0.01
8	Diameter of fruiting branch	-1.21	0.62	0.42	0.05	-0.03	0.37	0.06	**0.36**	0.00	-0.43	0.00	-0.13	-0.10
9	Number of primary branches per inflorescence	-0.54	0.17	0.20	-0.08	-0.02	0.12	0.05	0.03	**0.02**	0.23	0.01	-0.17	0.06
10	Number of secondary branches per inflorescence	0.37	-0.35	-0.09	0.03	0.02	-0.58	-0.25	-0.11	0.00	**1.39**	-0.00	0.17	0.07
11	Number of male flowers per secondary branch	0.50	-0.28	-0.23	-0.12	0.02	0.07	-0.09	-0.08	-0.01	0.12	**-0.02**	0.18	-0.06
12	Number of female flowers per secondary branch	0.29	-0.21	-0.16	0.05	0.02	-0.42	-0.22	-0.07	-0.01	0.36	-0.01	**0.66**	-0.24
13	Number of female flowers per inflorescence	-0.16	0.14	-0.11	0.21	0.01	-0.04	0.01	0.08	-0.00	-0.21	-0.00	0.35	**-0.44**
14	Ratio of male to female flowers	0.33	-0.12	-0.07	-0.13	0.01	0.33	0.11	-0.02	-0.00	-0.17	-0.01	-0.42	0.17
15	Fruit diameter	-0.47	0.17	0.19	-0.09	-0.03	-0.10	-0.04	0.02	0.01	0.31	0.00	-0.11	0.02
16	Weight per fruit	0.79	-0.31	-0.14	-0.01	0.01	-0.65	-0.16	-0.09	0.00	0.60	0.00	0.12	0.04
17	Seeds per fruit	0.95	-0.41	-0.29	0.12	0.01	-0.29	-0.00	-0.10	0.00	0.35	-0.00	0.03	0.00
18	100 Seed weight	0.70	-0.20	0.00	-0.06	0.01	-0.43	-0.10	-0.04	0.01	0.63	0.00	-0.01	0.08
19	Fruit yield per plant	2.57	-0.93	-0.80	0.17	0.06	-0.54	-0.09	-0.15	-0.00	0.24	-0.00	0.01	0.01
20	Seed yield per plant	2.53	-0.90	-0.76	0.16	0.06	-0.50	-0.06	-0.15	-0.00	0.23	-0.00	-0.04	0.02
21	Seed content	0.68	-0.13	-0.09	-0.03	0.01	-0.08	0.11	-0.07	0.00	-0.06	-0.00	-0.16	0.04
22	Kernel : shell ratio	1.26	-0.38	-0.17	0.08	0.02	-0.46	-0.07	-0.09	0.00	0.22	-0.00	-0.03	0.09
23	Acid value	-0.02	0.08	-0.08	-0.07	0.00	0.08	0.07	-0.06	-0.00	-0.09	-0.00	-0.09	-0.02
24	Iodine value	0.23	-0.05	-0.02	0.18	0.00	-0.20	-0.05	0.00	-0.00	0.03	0.00	0.04	-0.07

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Table 5. Continue

SN	Character	Ratio of male to female flowers	Fruit diameter	Weight per fruit	Seeds per fruit	100 Seed weight	Fruit yield per plant	Seed yield per plant	Seed content	Kernel : shell ratio	Acid value	Iodine value	r
1	Plant height	-0.00	-0.12	0.26	-0.53	-0.36	8.41	-8.80	0.58	0.40	-0.00	0.00	0.39**
2	Stem girth	-0.00	-0.11	0.27	-0.63	-0.28	8.28	-8.44	0.31	0.33	-0.00	0.00	0.35**
3	Number of fruiting branches per plant	-0.00	-0.14	0.13	-0.48	0.01	7.56	-7.61	0.24	0.16	0.00	0.00	0.21
4	Number of flushes per fruiting branch	0.01	-0.09	-0.01	-0.28	0.12	2.31	-2.29	-0.11	0.10	-0.00	0.02	0.22
5	Number of fruits per fruiting branch	-0.00	-0.22	0.09	-0.24	-0.13	7.37	-7.65	0.39	0.26	0.00	0.00	0.43**
6	Petiole length	0.01	0.06	0.51	-0.40	-0.53	4.28	-4.28	0.16	0.35	-0.00	0.01	0.43**
7	Area of fully matured leaf	0.01	0.05	0.30	-0.01	-0.28	1.63	-1.12	-0.52	0.12	-0.00	0.01	0.16
8	Diameter of fruiting branch	0.00	0.05	-0.23	0.44	0.15	-3.86	3.98	-0.46	-0.23	-0.00	0.00	-0.15
9	Number of primary branches per inflorescence	0.00	0.21	0.09	-0.30	-0.36	-1.31	1.25	0.22	0.08	-0.00	-0.00	-0.06
10	Number of secondary branches per inflorescence	0.00	0.16	0.39	-0.39	-0.65	1.61	-1.57	-0.10	0.14	-0.00	0.00	0.27*
11	Number of male flowers per secondary branch	-0.02	-0.09	-0.02	-0.15	0.06	1.63	-1.58	0.12	0.04	0.00	-0.00	0.01
12	Number of female flowers per secondary branch	0.02	-0.12	0.17	-0.07	0.02	0.13	0.54	-0.57	-0.04	-0.00	0.00	0.13
13	Number of female flowers per inflorescence	0.01	-0.03	-0.08	0.01	0.25	-0.15	0.49	-0.22	-0.17	0.00	0.01	-0.05
14	Ratio of male to female flowers	**-0.03**	0.02	-0.14	-0.09	0.01	2.05	-2.60	0.60	0.09	0.00	-0.01	-0.07
15	Fruit diameter	-0.00	**0.70**	0.48	-0.74	-0.65	-0.76	0.74	0.22	0.02	0.00	0.00	-0.10
16	Weight per fruit	0.00	0.37	**0.90**	-0.77	-1.12	2.08	-2.21	0.51	0.32	-0.00	-0.00	0.29*
17	Seeds per fruit	-0.00	0.33	0.44	**-1.57**	-0.51	3.00	-3.48	1.11	0.42	-0.00	0.01	0.12
18	100 Seed weight	0.00	0.32	0.71	-0.56	**-1.43**	2.11	-2.90	1.06	0.51	0.00	-0.00	0.42**
19	Fruit yield per plant	-0.01	-0.06	0.20	-0.51	-0.33	**9.18**	-9.58	0.50	0.31	0.00	-0.00	0.25
20	Seed yield per plant	-0.01	-0.05	0.21	-0.56	-0.43	9.04	**-9.73**	0.87	0.40	0.00	-0.00	0.33*
21	Seed content	-0.01	0.06	0.19	-0.72	-0.63	1.88	-3.48	**2.42**	0.62	0.00	-0.01	0.55**
22	Kernel : shell ratio	-0.00	0.01	0.33	-0.75	-0.83	3.19	-4.39	1.70	**0.89**	-0.00	0.00	0.62**
23	Acid value	-0.01	0.03	-0.08	0.15	-0.04	1.46	-1.95	0.62	-0.02	**0.01**	-0.00	-0.03
24	Iodine value	0.00	0.05	-0.04	-0.19	0.00	-0.04	0.18	-0.21	0.03	-0.00	**0.06**	-0.06

Residual = 0.1737

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STUDY THE AREA, PRODUCTION, PRODUCTIVITY AND COST OF CULTIVATION OF TOMATO IN THE JASHPUR DISTRICT OF CHHATTISGARH

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Abstract: Tomato being a rich and cheap source of vitamins (A and C) and minerals, occupy an important place in food basket of Indian consumer. Tomato is an important cash crop. An attempt has been made in the study to examine the production and marketing aspects of tomato in Jashpur district.
The present study was conducted in the Jashpur districts of Chhattisgarh. Sixty farmers were selected randomly from three villages namely Ludeg, Saraitola and Katangjor and were categorized into marginal, small, medium and large farmers based on their holding size. The primary data were collected for the year 2010-11. The major findings of this study revealed that the average size of farm was worked out to be 1.93 hectares, overall on an average cropping intensity was observed to be 101.64 per cent. Out of total cropped area kharif, rabi, and zaid crops occupied about 88.38, 8.32 and 3.22 per cent of total cropped area respectively. On an average the cost of cultivation per hectare of tomato was found Rs. 26576.89. Overall on an average the cost of production per quintal of tomato was observed as Rs. 222.84. Cost of production per quintal of these vegetables shows decreasing trend with increase in farm size where as cost of cultivation increases with increase in the farm size. Overall on an average the input-output ratio and Benefit-Cost ratio of tomato came to 1:3.70 and 1:2.70, respectively on the sample farms. The cost and return on average cost-A, cost-B, and cost-C were 16026.99, 18526.99 and 29254.64 Rs/ha. More than ninety five per cent marketable surpluses were observed in the tomato crops in different size groups of farmers. Average marketable surplus in tomato was 117.06 qtl./ha.

Keywords: Area, Cost of cultivation, Production, Productivity

INTRODUCTION

Chhattisgarh is an agricultural chief land and due to large production of rice, Chhattisgarh is known as the rice bowl. Apart from paddy, vegetables are also grown. The immense diversity in agro-climatic condition in Chhattisgarh enables to produce large varieties of vegetable. Tomato are grown in an area about 42.9 thousand hectares with productivity 14640 kg/ha in Chhattisgarh. Jashpur District covers 14.17 per cent share in total tomato growing area in Chhattisgarh. High risk involves in the production of vegetables owing to its perishable nature. Keeping in view the economic important of tomato in the study area, the present enquiry related to its production and marketing was undertaken in Jashpur district of Chhattisgarh.

RESEARCH METHODOLOGY

Methodology of the study is at various stages. It has been applied particularly for selection of area, block, villages, and sample size, collection of information from farmers, traders and method of analysis.

Selection of study area

This study was conducted in the Jashpur district of Chhattisgarh State, since this district is famous for tomato production than that of other districts of the State. This district included eight blocks among these blocks Pathalgaon block, occupied more than 80 per cent area and production of tomato among all the blocks of Jashpur District. Therefore Pathalgaon block was selected for the present study.

Selection of Tomato Growers

Pathalgaon block of Jashpur district having 109 villages. Out of them 30 where tomatoes growing village among them 3 villages were selected proportionally. From each sampled village, 20 tomato growers were randomly selected and then categorized into marginal (below 1 ha), small (1-2 ha), medium (2-4 ha) and large (above 4 ha). Totally 60 farmers were selected for the study comprise of 25 marginal, 20 small, 5 medium and 10 large farmers.

Method of enquiry and data collection

Primary data from the farmers were collected through well prepared schedule designed for the study. The cost of different operations along with quantity of produce, were recorded on item wise included of fixed as well as variable costs of Tomato production. The relevant on cropped area, cropping pattern, irrigated area their sources inventory, etc. were recorded on the schedule designed for the study.
In order to compute the growth rate of area, production and productivity of Tomato in the Jashpur district of Chhattisgarh state. Time series secondary from 2000-2001 to 2009-2010 was collected.

Period of Inquiry

The detail inquiry was done for the year of 2010-11.

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Analytical tools

Compound growth rate

To compute the growth rate of area, production and productivity of Tomato of Jashpur district, the following mathematical model was used:-

$Y= aB^t$

Log Y= log a+ t log B

Where,

Y= Area/ production /productivity

a= Constant

B= Regression coefficient

t= time in year (from 2000-2001- to 2010-2011)

Compound growth rate (per cent) = (Antilog B-1)100

Cost and returns of tomato

To estimate the cost of production and their returns of tomato, whole cost structure is divided into three categories:

A. Variable cost-includes inputs material cost.

B. Fixed cost – includes land revenue and rental value of land.

C. Marketing cost – including marketing cost, like transportation, mandi fee, loading and unloading charges by the cultivator.

The data were analyzed and results were presented for all 60 farmers and separately for marginal farmers (below 1 ha), small farmers (1-2 ha), medium size farmers (2.1-4 ha) and large farmers (More than 4 ha).

RESULT AND DISCUSSION

Land use pattern

Cropped and irrigated area is worked out by incorporation of lease in land and discarded by lease out land and it reveals that total cropped area was observed to be 0.38, 1.57, 3.64 and 5.65 hectares of marginal, small, medium and large farms, respectively. Overall 1.93 hectare area was noted irrespectively to the farm size. It is clear from the Table that the leased-in area at sampled farms was decreasing with increase of farm size of holdings. It varied from 5 per cent at marginal to 1.26 per cent at small farmers. Overall, percentage of irrigated area was found to be 34.06 per cent to the total cropped area. The percentage of irrigation was varied from 22.50 per cent at marginal farms, to 41.63 per cent at large farms.

Cropped and irrigated area of sample farms

(ha/farm)

S. No.	Particulars	Marginal	Small	Medium	Large	Average
1	Owned land	0.38	1.57	3.64	5.65	1.93
2	Land	(95.00)	(98.74)	(97.33)	(99.12)	(98.30)
(i.)	Leased-in land	0.02	0.02	0.00	0.00	0.02
		(5.00)	(1.26)	(0.00)	(0.00)	(0.77)
(ii.)	Leased-out land	0.00	0.00	0.10	0.05	0.02
		(0.00)	(0.00)	(2.67)	(0.88)	(0.85
4	Total cropped area	0.40	1.59	3.74	5.70	1.96)
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
5	Irrigated area	0.09	0.39	1.27	2.37	0.67
		(22.50)	(24.24)	(34.06)	(41.63)	(34.06)
6	Un-irrigated area	0.31	1.20	2.47	3.33	1.29
		(77.50)	(75.76)	(65.94)	(58.37)	(65.85)

Note: Figures in the parenthesis indicate the percentages to the total cropped area.

Cropping pattern

It may be seen that the total cropped area was observed to be 0.38, 1.57, 3.64 and 5.65 hectares at marginal, small, medium and large farms, respectively.

The maximum cropped area was found to be during kharif among all the size holdings. The area under different crops in kharif was observed to be 90 per cent at marginal, 95 per cent at small, 85.50 per cent at medium and 85.50 per cent at large farms. So, rice was the main crop. The area under Rabi season was observed to be 10.53, 5.00, 9.50, and 9.50 per cent at marginal, small, medium and large farms, respectively. During summer, main of the crops grown by marginal and small farmers. While medium and large farmers were panted the crops in a

very small area and noted to be 0.50 per cent area each for medium and large farms.

It may be observed from analysis that most of the respondents in the study area were interested to grow tomato crop during kharif season. The cropping intensity was follow to be105.26, 101.27, 102.75 and 100.88 per cent at marginal, small, medium and large farms, respectively.

Demographical characteristics of sample household

S. No.	Particulars	Marginal	Small	Medium	Large	Total
1	**Total number of households**	25.00	20.00	5.00	10.00	60.00
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
2	**Social group**					
	a. Scheduled tribes	13.00	13.00	1.00	5.00	32.00
		(52.00)	(65.00)	(20.00)	(50.00)	(53.33)
	b. Scheduled castes	5.00	4.00	1.00	3.00	13.00
		(20.00)	(20.00)	(20.00)	(30.00)	(21.67)
	c. Other backward castes	7.00	3.00	3.00	2.00	15.00
		(28.00)	(15.00)	(60.00)	(20.00)	(25.00)
3	**Total family member**	**186.00**	**182.00**	**32.00**	**74.00**	**474.00**
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
	a. Male	84.00	82.00	15.00	33.00	214.00
		(45.16)	(45.05)	(46.88)	(44.59)	(45.15)
	b. Female	102.00	100.00	17.00	41.00	260.00
	Average of family member	(54.84)	(54.95)	(53.13)	(55.41)	(54.85)
		7.44	**9.10**	**6.40**	**7.40**	**7.90**
4	**Age group**					
	I. Below 18 years					
	a. Male	14.00	9.00	4.00	5.00	35.00
		(7.53)	(4.95)	(12.50)	(6.76)	(7.38)
	b. Female	15.00	15.00	2.00	4.00	25.00
		(8.06)	(8.24)	(6.25)	(5.41)	(5.27)
	II. 18-60 years					
	a. Male	65.00	68.00	10.00	26.00	169.00
		(34.95)	(37.36)	(31.25)	(35.14)	(35.65)
	b. Female	75.00	75.00	13.00	33.00	196.00
		(40.32)	(41.21)	(40.63)	(44.59)	(41.35)
	III. above 60 years					
	a. Male	5.00	5.00	1.00	2.00	13.00
		(2.69)	(2.75)	(3.13)	(2.70)	(2.74)
	b. Female	12.00	10.00	2.00	4.00	28.00
		(6.45)	(5.49)	(6.25)	(5.41)	(5.91)
5.	**Occupation working members**					

S. No.	Particulars	Marginal	Small	Medium	Large	Total
		134.00	135.00	21.00	56.00	346.00
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
	a. Agriculture	130.00	132.00	16.00	48.00	326.00
		(97.01)	(97.78)	(76.19)	(85.71)	(94.22)
	b. Business	0.00	0.00	2.00	4.00	6.00
		(0.00)	(0.00)	(9.52)	(7.14)	(1.73)
	c. Service	4.00	3.00	3.00	4.00	14.00
		(2.99)	(2.22)	(14.29)	(7.14)	(4.05)
6.	**Education**					
	a. Illiterate	28.00	35.00	8.00	18.00	89.00
		(15.05)	(19.23)	(25.00)	(24.32)	(18.78)
	b. Primary school	35.00	28.00	6.00	10.00	79.00
		(18.82)	(15.38)	(18.75)	(13.51)	(16.67)
	c. Middle school	70.00	82.00	2.00	14.00	168.00
		(37.63)	(45.05)	(6.25)	(18.92)	(35.44)
	d. Higher	35.00	22.00	8.00	17.00	82.00
	Secondary School	(18.82)	(12.09)	(25.00)	(22.97)	(17.30)
	e. Above higher	18.00	15.00	8.00	15.00	56.00
	secondary school	(9.68)	(8.24)	(25.00)	(20.27)	(11.81)
	Literacy (%)	84.95	80.77	75.00	75.68	**81.22**

Note: Figures in the parenthesis indicate the percentages to total number of family members.

Table. Cropping pattern followed by sample households.

(In ha)

S.No	Particular	Farm size				Over all
		Marginal	Small	Medium	Large	
A	**Kharif**					
	a. Paddy	0.27	1.06	1.82	2.68	1.07
		(67.50)	(66.50)	(51.30)	(47.03)	(54.67)
	b. **Tomato**	0.05	0.30	0.70	0.73	0.30
		(13.50)	(19.00)	(18.81)	(12.83)	(15.49)
	c. Vegetables	0.01	0.08	0.26	0.73	0.17
		(3.15)	(4.75)	(6.84)	(12.83)	(8.86)
	d. Other crops	0.02	0.08	0.32	0.73	0.18
		(5.85)	(4.75)	(8.55)	(12.83)	(9.36)
	Total Kharif	0.34	1.51	3.12	4.87	1.73
		(90.00)	(95.00)	(85.50)	(85.50)	(88.38)

B.	**Rabi**					
	a. **Tomato**	0.04	0.08	0.29	0.47	0.14
		(10.00)	(4.85)	(7.89)	(8.17)	(7.33)
	b. paddy	0.00	0.00	0.03	0.05	0.01
		(0.00)	(0.00)	(0.76)	(0.86)	(0.54)
	c. other crops	0.00	0.00	0.02	0.03	0.01
		(0.53)	(0.15)	(0.48)	(0.48)	(0.39)
	Total Rabi	0.04	0.07	0.36	0.44	0.16
		(10.53)	(5.00)	(9.50)	(9.50)	(8.32)
C	**Zaid**					
	a. **Tomato**	0.00	0.00	0.09	0.10	0.02
		(0.00)	(0.00)	(2.41)	(1.75)	(1.23)
	b. other crops	0.00	0.00	0.18	0.24	0.06
		(0.00)	(0.00)	(4.91)	(4.25)	(2.84)
	Total Zaid	0.00	0.00	0.19	0.29	0.06
		(0.00)	(0.00)	(5.00)	(5.00)	(3.22)
D.	**Total cropped area** (A+B+C)	0.38 (100.00)	1.57 (100.00)	3.64 (100.00)	5.65 (100.00)	1.93 (100.00)
E.	Area under tomato	0.09	0.38	1.09	1.30	0.47
F.	Net cultivated area	0.40	1.59	3.74	5.70	1.96
G.	Cropping intensity (%)	105.26	101.27	102.75	100.88	101.64

Note: Figures in the parenthesis indicate the percentages to total cropped area.

Growth in Area, Production and Productivity of Tomato

The significant growth of area and production of tomato was observed in Chhattisgarh state as well as in sample district Jashpur during the period of study 2001-02 to 2010-11. It was found to be 7.27 and 9.03 per cent growth in area of tomato in the State and Jashpur district in 2001-02 to 2010-11, which was significant 5 per cent probability level. However, significant growth in production of tomato was 34.54 and 10.94 per cent for the state and Jashpur district, respectively. Growth rate of productivity of tomato was significant in the district and found to be 25.43 and state 1.75 per cent, respectively. It is interesting to note that production was increased significantly due to significant growth in area and it was due to efforts of extension personnel for aware to cultivate the tomato in more area. The important point was come into notice that farmers were not adopting the full package of practices for tomato cultivation due to lack of resources and have poor base of available resources.

Compound growth rate of area, production, and productivity of tomato crop in Jashpur district and Chhattisgarh State.

	Compound Growth Rate (%)		
Particulars	**Area**	**Production**	**Productivity**
Jashpur District	7.27*	34.54*	25.43*
Chhattisgarh State	9.03*	10.94*	1.75

Note: * Denotes the significant level at 5% of probability level at t distribution.

These figures clearly show that farmers switched on tomato cultivation from paddy crop as a result of diversification in the state. Consequently, the area under cultivation of this crop increased drastically but growth in productivity of tomato in Chhattisgarh state could not be increased during the period- of 2001-02 and 2010-2011.

Cost of cultivation of Tomato

The cost of cultivation of tomato under different sample farms was estimated in Rs/ha,. It reveals that over all, cost of cultivation of tomato was found to be Rs/ha 26576.89. The maximum cost of cultivation of tomato was noticed to be in medium farms (Rs/ha 27867.19) followed by large farms (Rs/ha 27425.56), small farms (Rs/ha 26461.87) and marginal farms (Rs/ha 26071.37), respectively. The cost of cultivation of tomato showed a rising trend with the farm size holdings. It was due to the fact that the large farmers could be incurred more expenditure on modern farm inputs like quality seed, fertilizer, plant protection material, hired labour etc. The higher expenditure can seed to higher yield and provide more to returns large farms as compare to other farms.

Overall, input/ material costs was accounted Rs/ha 4295.84 and shared 16.16 per cent to the total cost of cultivation of tomato. The share of input/material cost was increasing with increase the farm size of holdings and noticed to be the maximum under large farms (18.83%) and the minimum under marginal farms (15.32%).

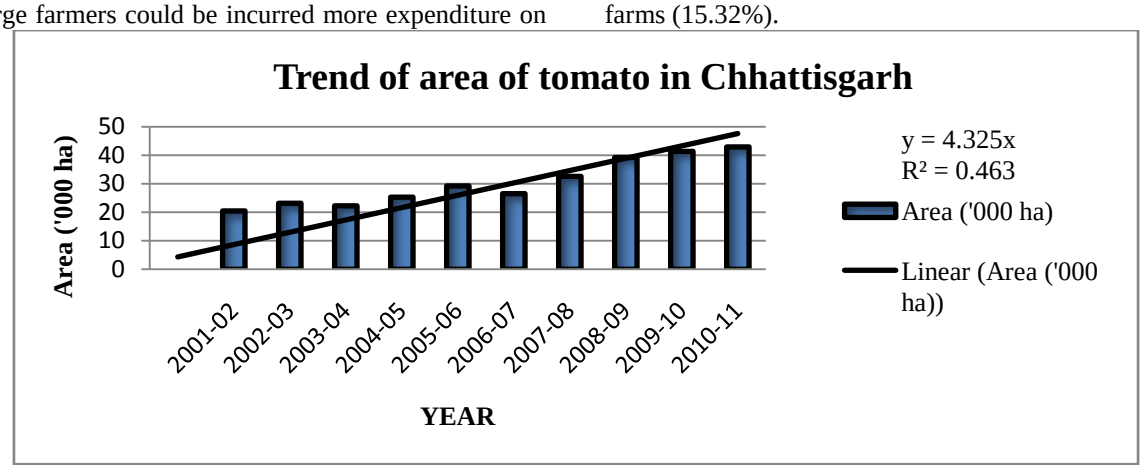

Fig. Trend of area of tomato in Chhattisgarh

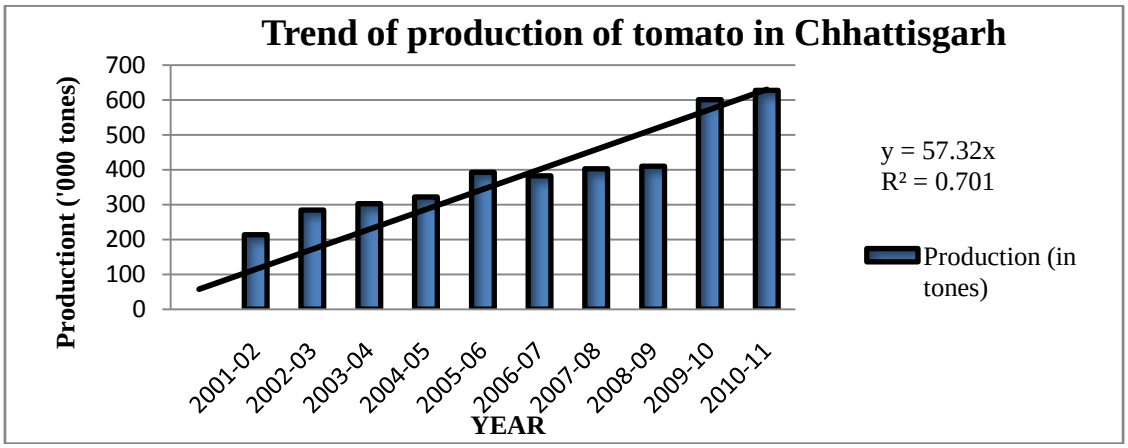

Fig. Trend of production of tomato in Chhattisgarh

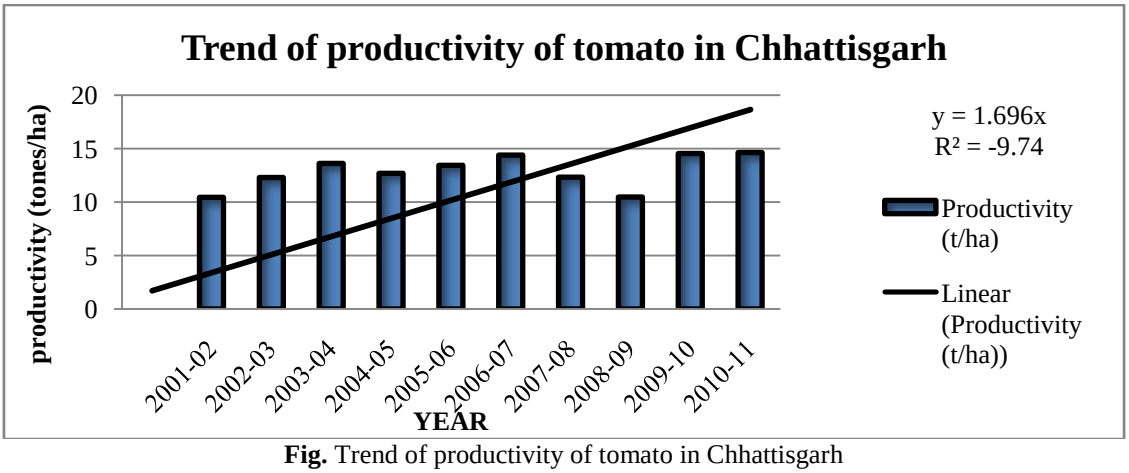

Fig. Trend of productivity of tomato in Chhattisgarh

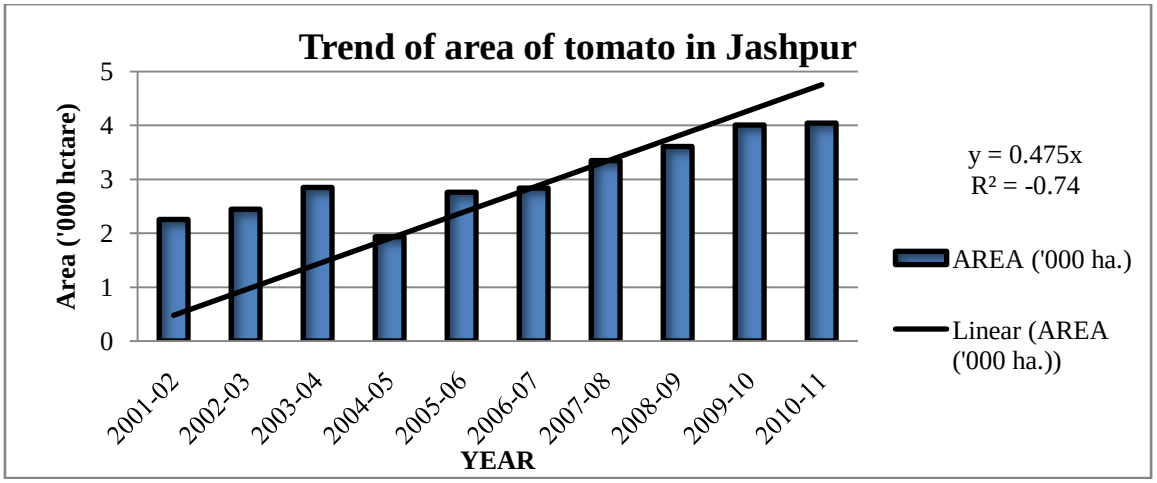

Fig. Trend of area of tomato in Jashpur

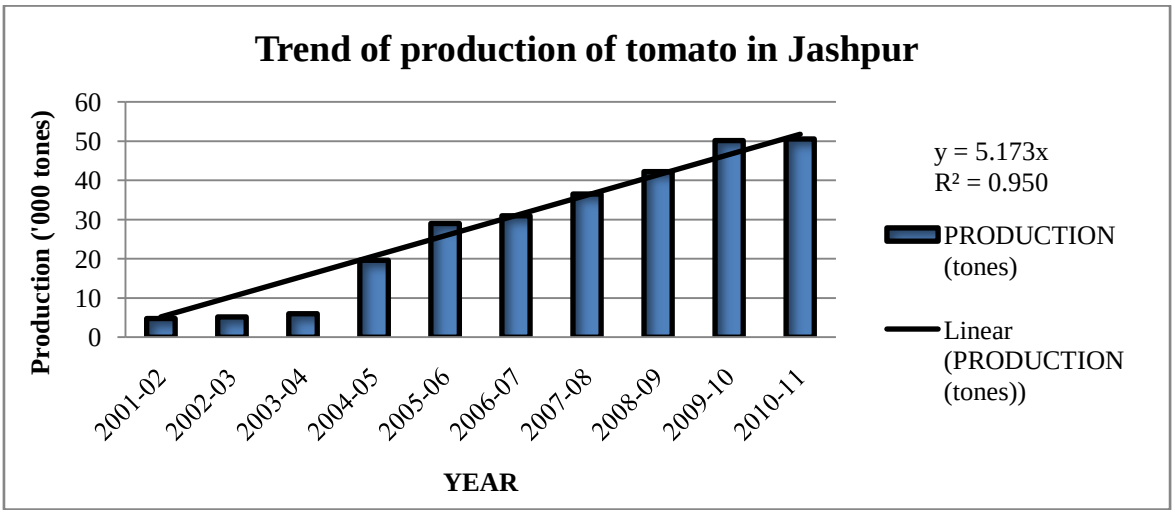

Fig. Trend of production of tomato in Jashpur

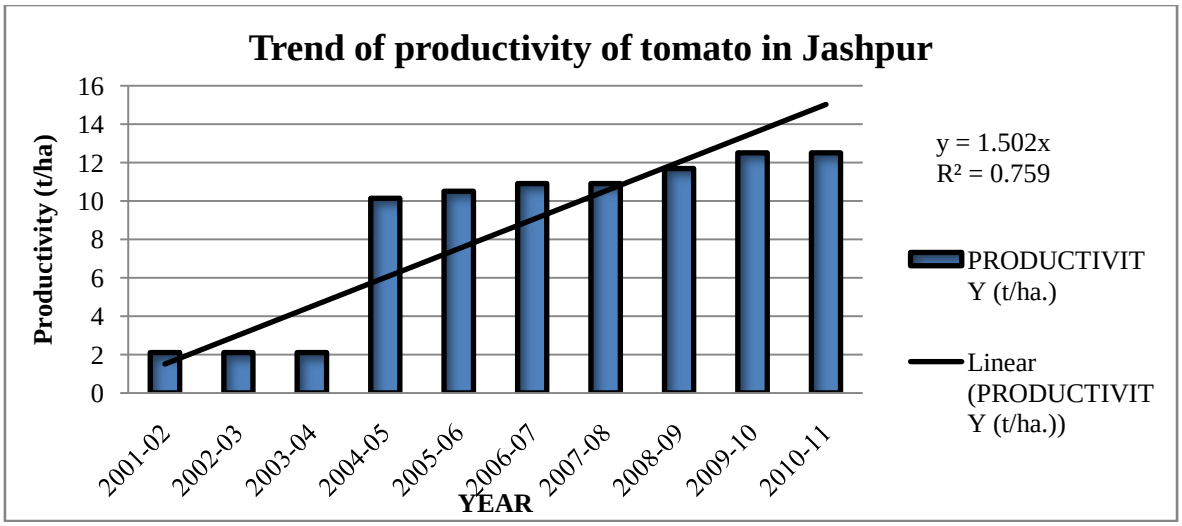

Fig. Trend of productivity of tomato in Jashpur

The Share of human labour cost was noticed to be the maximum under large farms (58.55%) followed by marginal farms (57.63), small farms (57.61%) and medium farms (55.78%). The overall expenditure on human labour cost was found to be 57.62 per cent.

The cost on power use was accounted Rs/ha 6.36, which was shared only 6.36 per cent and bullock power use cost was noticed to be 5.93 per cent. It indicates that sample farms have used very small proportion of machine power for cultivation of

tomato. The share of power use was varying from 4.67 to 7.06 per cent of large to medium farms.

The fixed cost is comprised of land revenue, rental value of land and interest on working capital. It indicated that share of fixed cost was 19.86 per cent to the total cost of cultivation of tomato and the rental value of land itself contributed 13.73 per cent to the total fixed, irrespective to the farm size of holding. The fixed cost was ranging from 17.94 to 20.41 per cent of large to marginal farms.

Thus, it could be concluded that share of human labour was the maximum (57.62%) to the total cost of cultivation of tomato followed by fixed cost (19.86%) and inputs/materials cost (16.16%), respectively.

Economics of tomato production

Yield, value of output and cost of production per quintal

The yield, value of output per hectare and cost of production per quintal of tomato on the sample farms have been worked out in This indicates that the average yield per hectare of tomato was 123.22 quintals of the sample farms.

Cost of cultivation of tomato under different sample farms

(Rs./ha)

S.No.	Particulars	Farm size				Overall
		Marginal	Small	Medium	Large	
A	**Inputs/Material Cost**					
a.	Seed cost	2250.25	2250.75	2533.33	2742.37	2356.03
		(8.63)	(8.51)	(9.09)	(10.00)	(8.86)
b.	Manure & Fertilizer	1323.20	1256.00	1525.00	1535.00	1352.92
		(5.08)	(4.75)	(5.47)	(5.60)	(5.09)
c.	Plant protection	420.00	592.50	750.25	761.28	561.90
		(1.61)	(2.24)	(2.69)	(2.78)	(2.11)
d.	Irrigation charges	0.00	0.00	50.00	125.00	25.00
		(0.00)	(0.00)	(0.18)	(0.46)	(0.09)
	Total	3993.45	4099.25	4858.58	5163.65	4295.84
		(15.32)	(15.49)	(17.43)	(18.83)	(16.16)
B	**Human Labour Cost**					
a.	Family human labour	12979.58	12979.58	3886.39	4014.58	10727.65
		(49.78)	(49.05)	(13.95)	(14.64)	(40.36)
b.	Hired human labour	2231.33	2263.88	11659.16	12043.75	4663.24
		(8.56)	(8.56)	(41.84)	(43.91)	(17.55)
	Total	15024.31	15243.47	15545.54	16058.33	15313.13
		(57.63)	(57.61)	(55.78)	(58.55)	(57.62)
C	**Power Use Cost**					
a.	Bullock labour	1642.98	1674.50	1808.00	1094.50	1575.83
		(6.30)	(6.33)	(6.49)	(3.99)	(5.93)
b.	Machine power	89.59	95.50	160.71	186.40	113.62
		(0.34)	(0.36)	(0.58)	(0.68)	(0.43)
	Total	1732.57	1770.00	1968.71	1280.90	1689.45
		(6.65)	(6.69)	(7.06)	(4.67)	(6.36)
D	**Fixed cost**					
a.	Land revenue	30.00	30.00	30.00	30.00	30.00
		(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
b.	rental value of land	3750.00	3750.00	3750.00	3750.00	3750.00
		(14.38)	(14.17)	(13.46)	(11.49)	(13.73)
c.	Interest on working	1541.04	1569.15	1714.36	1742.68	1598.46
	Capital (@7%)	(5.91)	(5.93)	(6.15)	(6.35)	(6.01)

Total	5321.04 (20.41)	5349.15 (20.21)	5494.36 (19.72)	5522.68 (17.95)	5378.46 (19.86)
Total Input cost	26071.37 (100.00)	26461.87 (100.00)	27867.19 (100.00)	27425.56 (100.00)	26576.89 (100.00)

Note: Figures in parenthesis indicate per cent of total input cost.

Average cost of production of tomato was worked out in Rs/q and found to be Rs. 222.84 irrespective to the farm size. While it was the maximum under marginal farms (Rs. 226.34) followed by medium farms (Rs. 224.43), small farms (Rs. 224.08) and large farms (Rs. 210.83). It investing to note that marginal and small farms earned more on per rupee investment. It was due to better management of farm and crop by marginal and small farms than that of large farms. The average value of output per hectare came to Rs. 98576.08. The higher value of output on large farms was associated with the higher expenditure incurred on modern farm inputs.

Per hectare yield, value of output and cost of production per quintal of tomato.

		Farm Size				(Rs./ha)
S.No.	**Particulars**	**Marginal**	**Small**	**Medium**	**Large**	**Average**
1.	Input cost (Rs.)	26071.37	26461.87	27867.19	27425.56	26576.89
2.	Production (q/ha)	118.19	122.09	129.17	135.08	123.22
3.	value of production (Rs.)	94550.62	97672.73	103333.33	108067.80	98576.08
4.	Cost of production (Rs./q)	226.34	224.08	224.43	210.83	222.84

Note: Price of tomato charged as per the market rates prevailing in the study area was Rs/q 800/-

Profitability in tomato cultivation

The net income, input-output ratio and benefit: cost ratio was worked out in Rs/ha by farm size of holding and presented in Table. It reveal that irrespective to the farms size, the net income earned by farmers was Rs/ha 71999.19. The input-output ratio was found to be 1:3.70 and benefit of Rs 2.70 in per rupee investment on tomato cultivation. The net income earned by farmers was found to be increasing with farm size of holding and ranging from Rs. 68479.25 to Rs. 80642.24 of marginal to large farm size of holdings. The similar pattern of input-output and B:C ratio had also been noticed with respect to farm size of holding.

Table. Cost and return of tomato under different sample farms.

(Rs./ha)

		Farm size				
S.No.	**Particulars**	**Marginal**	**Small**	**Medium**	**Large**	**Average**
1.	Input cost	26071.37	26461.87	27867.19	27425.56	26576.89
2.	Output value	94550.62	97672.73	103333.33	108067.80	98576.08
3.	Net income	68479.25	71210.86	75466.15	80642.24	71999.19
4.	Input-Output ratio	1:3.63	1:3.69	1:3.71	1:3.94	1:3.70
5.	B:C ratio	1:2.63	1:2.69	1:2.70	1:2.94	1:2.70

Cost and returns on the basis of cost concept

The Cost and returns on the basis of cost concept in the production of tomato have been presented in the Table 4.11. Portrays that, on an average cost-A, cost-B and cost-C were worked out to Rs. 16026.99, 18526.99 and Rs. 29254.64. Rs. 29254.64 per hectare, respectively on the sample farms. It is noted that rupees 5000 were considered as imputed rental value of owned land for each crop season. The incomes over different costs were also worked out. The average income over cost-A, cost-B and cost-C were calculated as Rs. 79482.42, Rs. 76982.42 and Rs. 66254.77 per hectare, respectively.

Table. Break-up of total cost, cost concept wise income over different cost in tomato.

(Rs./ha)

S.No.	Particulars	Farm size				
		Marginal	**Small**	**Medium**	**Large**	**Average**
A.	Break-up of cost					
	a. Cost A	13278.40	13482.28	23980.80	24010.97	16026.99
	b. Cost A1	13278.40	13482.28	23980.80	24010.97	16026.99
	c. Cost B	15778.40	15982.28	26480.80	26510.97	18526.99
	d. Cost C	28757.98	28961.87	30367.19	30525.56	29254.64
B.	Income over different cost					
	a. Income over cost A	81272.22	84190.44	79352.53	84056.82	79482.42
	b. Income over cost A1	81272.22	84190.44	79352.53	84056.82	79482.42
	c. Income over cost B	78772.22	81690.44	76852.53	81556.82	76982.42
	d. Income over cost C	65792.64	68710.86	72966.15	77542.24	66254.77

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EFFECT OF DIFFERENT RATE OF SULPHUR SOURCES ON GROWTH, YIELD AND QUALITY OF SESAME (*SESAMUM INDICUM* L.) GROWN IN THE ALLEY SPACE OF GUAVA (*PSIDIUM GUAJAVA* L.)

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Abstract: A field experiment was conducted in a sandy loam soil during *kharif* season, 2012-2013 at Rajiv Gandhi South Campus, Barkachha, BHU, Mirzapur, Uttar Pradesh, India to find out the effect of different rate of sulphur sources on growth, yield and quality of sesame (*Sesamum indicum* L.) grown in the alley space of guava (*Psidium guajava* L.). The experiment was laid out in a randomized block design with 3 replications and three sources of sulphur *viz*. single super phosphate, gypsum and elemental sulphur and three levels of sulphur *viz* 15, 30 and 45 kg ha^{-1} with control. The total treatment combination for all the levels were ten (T_1-Control, T_2-15 kg Sulphur ha^{-1} through SSP, T_3-15 kg Sulphur ha^{-1} through ES, T_4-15 kg Sulphur ha^{-1} through gypsum, T_5-30 kg Sulphur ha^{-1} through SSP, T_6-30 kg Sulphur ha^{-1} through ES, T_7-30 kg Sulphur ha-1 through gypsum, T_8-45 kg Sulphur ha-1 through SSP, T_9-45 kg Sulphur ha-1 through ES, T_{10}-45 kg Sulphur ha-1 through gypsum). The crop was fertilized with recommended dose of NPK of 60:30:30 kg ha^{-1}. Results revealed that application of 45 kg S ha^{-1} through elemental sulphur recorded the highest plant height, number of branch $plant^{-1}$, dry matter accumulation, capsules $plant^{-1}$, seeds $capsule^{-1}$, seed weight $plant^{-1}$ and test weight, seed yield, stover yield, biological yield, harvest index, protein content per cent, oil content per cent, carbohydrate per cent, total nutrient uptake and available nutrient in soil. It was significantly superior over 45 kg S ha^{-1} through gypsum over rest of the treatment. The highest net monetary return (Rs. 24921.27 ha^{-1}) and Benefit: Cost (B: C) ratio (1.52) was obtained when 45 kg sulphur was applied through elemental sulphur this was also found to be best treatment for sesame.

Keywords: Sesame, Agroforestry, Sulphur, Alley space, Oil content, Benefit

INTRODUCTION

Sesame (Sesamum indicum L.) is one of the important oilseed crops. It is one of the crop under cultivation from ancient times (Joshi, 1961; Weiss, 1983; Bist et al., 1998). It is used for its seed which contains about 50% oil and 25% protein. For human nutrition, a balanced diet should consist of carbohydrate, protein, fats, minerals and vitamins in adequate amount and in suitable proportion. The bulk of this fat is supplied in the form of digestible vegetable oil and comes through oilseed crops. In India, sesame occupies third position in area and production, being preceded by groundnut and rapeseed sesame. Extension of acreage being ruled out and new cropping patterns emerging to cater to increase should be brought about in productivity. It is well-known that satisfactory yield of crops can only be obtained under adequate nutrient combinations. There has been a consciousness among the farmers on fertilizer use N, P and K fertilizers are extensively used to meet the nutrient rsequirement of the sesame crop. Even with the application of recommended doses of NPK fertilizers, the high potential of yield could not be achieved with presently available high yielding varieties due to the inadequacy of the micronutrients. Among secondary nutrients sulphur (S) is vital for protein synthesis in oil seeds. Jones et al., 1970 reported that when sulphur in the soil was below critical limits both plant growth and quality was adversely affected. Several other workers have documented that oil seeds respond remarkably to sulphur depending on the soil type. Besides, sulphur influences the uptake of major and micro nutrients to a large extent, which results in quantitative changes in seed yield and oil percent (Wasmatkar et al., 2002). Since there is a lack of information on the needs of micronutrient for efficient use of crop nutrition, the present study was undertaken.

MATERIAL AND METHOD

A field experiment was conducted at the Rajiv Gandhi South Campus, Barkachha, BHU, Mirzapur which is situated in *Vindhyan* region of district Mirzapur (25º 10' latitude, 82º 37' longitude and altitude of 427 metres above mean sea level during *kharif* season, 2012 on sandy loam soil containing 0.58 % organic carbon, available nitrogen (177.2 kg ha^{-1}), low in available phosphorus (10 kg ha^{-1}) and potassium (115.7 kg ha^{-1}) having slightly acidic soil pH (5.84). The treatments consisted of 3 sources of sulphur viz. single super phosphate, gypsum and elemental sulphur and 3 levels of sulphur *viz* 15, 30 and 45 kg ha^{-1} and one control. These fertilizers are applied in the field one month before the date of sowing. The nitrogen was supplied through Di-Ammonium phosphate (@ 60 kg N ha^{-1}) in three splits half at basal and remaining half in two split at vegetative stage and at flower initiation stage; phosphorous (@ 30 kg P_2O_5 ha^{-1}) was supplied through Di-Ammonium phosphate as based;

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potassium (@ 30 kg K_2O ha^{-1}) through murate of potash as based.The experiment was laid out in R.B.D with three replicates with a gross plot size 4.95 x 4 m and net plot size 4 x 3 m with spacing of 45 x 15 cm by using sesame variety Gujarat Til-2. Thinning was done twice at 15 and 30 days after sowing. The plant height, number of branch $plant^{-1}$, dry matter accumulation , capsules $plant^{-1}$, seeds $capsule^{-1}$, seed weight $plant^{-1}$ and test weight, seed yield, stover yield, biological yield, harvest index, protein content per cent, oil content per cent, carbohydrate per cent , total nutrient uptake and available nutrients in soil was recorded at harvest stage of crop. The nitrogen content of seed was estimated by kjeldahl's method and protein content of seed was derived by multiplying there seed nitrogen content with the factor 6.25(Humphries,1956) .The oil content was estimated by Soxhelet apparatus method following the procedure of Singh *et al*., 1960 .

RESULT AND DISCUSSION

The data presented in Table-1 shows that effect of different rate of sulphur sources had significant influence on plant height, dry matter accumulation, capsule $plant^{-1}$, seeds $capsule^{-1}$, seed weight $plant^{-1}$, test weight, seed yield kg ha^{-1}, stover yield kg ha^{-1}, harvest index per cent, protein content per cent, oil content per cent and carbohydrate per cent of the sesame.

Among the sulphur levels, application of 45 kg S ha-1through elemental sulphur recorded the highest plant height, dry matter accumulation, capsule $plant^{-1}$, seeds $capsule^{-1}$, seed weight $plant^{-1}$, test weight, seed yield kg ha^{-1}, stover yield kg ha^{-1}, harvest index per cent, protein content per cent, oil content per cent and carbohydrate per cent . It was significantly superior over 45 kg S ha^{-1} through gypsum over all the treatment. The crop receiving 45 kg S ha^{-1} through elemental sulphur might have been helped in terms of vigorous root growth, formation of chlorophyll, , play a vital role in the formation of amino acids. It had favourable effect on dry matter and yield components due to proper partitioning of photosynthates from source to sink. The results of investigation are in consonance with the findings of Raja *et al*. (2007) and Hussain *et al*. (2011) Uptake of nitrogen, phosphorus and potassium by seed and Stover showed a significant variation with the application of different level of sulphur (Table-2). The highest nitrogen, phosphorus and potassium uptake and available nutrient in soil found when sulphur was applied @45 kg S ha^{-1}through elemental sulphur (T_9) and superior over 45 kg S ha^{-1} through gypsum (T_{10}) over rest of the treatment. These results are in conformity with the findings of Lal *et al*. (1995) and Prajapat *et al*. (2012)

Economics

Data presented in Table-2 shows that effect of different rate of sulphur sources caused the maximum net return (Rs .24921.27 ha^{-1}) by 45 kg S ha^{-1} through elemental sulphur (T_9) and it was significantly superior over rest of the treatments. The treatment 45 kg S ha^{-1} through gypsum is at par with 45 kg S ha^{-1} through elemental sulphur (T_9). The minimum net return (Rs. 14721.44 ha^{-1}) was recorded in control (T_1). These results are in conformity with the findings of Deshmukh *et al*. (2010)

Data presented in Table-2 shows that effect of different rate of sulphur sources caused the maximum B: C ratio (1.52) by 45 kg S ha^{-1} through elemental sulphur and it was significantly superior over rest of the treatments. The treatment 45 kg S ha^{-1} through gypsum (T_{10}) is at par with 45 kg S ha^{-1} through elemental sulphur. The minimum B:C ratio (1.10) was recorded in control (T_1). These results are in conformity with the findings of Deshmukh *et al*. (2010).

CONCLUSION

Results revealed that application of 45 kg S ha^{-1} through elemental sulphur recorded the highest plant height, number of branch $plant^{-1}$, dry matter accumulation, capsules $plant^{-1}$, seeds $capsule^{-1}$, seed weight $plant^{-1}$ and test weight, seed yield, stover yield, biological yield, harvest index, protein content per cent, oil content per cent, carbohydrate per cent, total nutrient uptake and available nutrient in soil. It was significantly superior over 45 kg S ha^{-1} through gypsum over rest of the treatment. The highest net monetary return (Rs. 24921.27 ha^{-1}) and Benefit: Cost (B: C) ratio (1.52) was obtained when 45 kg sulphur was applied through elemental sulphur this was also found to be best treatment for sesame.

Table 1. Effect of different rate of sulphur sources on growth, yield and quality of sesame grown in the alley space of guava.

Treatment	plant height (cm)	dry matter (g $plant^{-1}$)	Capsules $plant^{-1}$ (No.)	Seeds $capsule^{-1}$ (No.)	Seed weight $plant^{-1}$ (g)	Test weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Protein content (%) in seed	Oil content (%)	Carbo-hydrate (%)
T_1	106.27	39.0	18.83	55.67	3.31	3.16	397.0	2278.00	22.63	36.5	11.20
T_2	106.57	39.2	20.67	56.47	3.75	3.22	402.6	2304.00	22.75	36.7	11.50
T_3	107.60	41.3	22.17	58.57	4.36	3.36	456.0	2400.67	23.10	37.2	12.30

T_4	107.27	40.3	21.19	57.33	4.04	3.33	427.0	2338.33	23.02	36.5	11.70
T_5	108.40	40.8	22.50	59.07	4.50	3.38	467.6	2418.33	23.50	38.4	12.27
T_6	109.70	42.5	24.00	59.83	4.88	3.40	523.0	2506.12	23.90	41.4	12.37
T_7	109.60	42.3	23.50	59.25	4.72	3.39	507.6	2458.90	23.69	40.2	12.30
T_8	110.17	43.5	27.00	60.50	5.60	3.43	530.3	2581.62	24.15	42.3	12.43
T_9	110.83	44.5	32.33	62.27	7.47	3.53	574.6	3433.33	25.54	46.2	13.47
T_{10}	110.53	43.8	31.33	61.96	7.14	3.45	564.6	3360.00	25.38	45.5	13.37
SEm±	0.21	0.62	0.58	0.51	0.12	0.08	6.25	76.40	0.15	0.25	0.33
C.D(P=0.05)	0.61	1.84	1.73	1.50	0.36	0.24	18.56	226.99	0.46	0.74	0.99

T_1-Control, **T_2**-15 kg Sulphur ha^{-1} through SSP, **T_3**-15 kg Sulphur ha^{-1} through ES, **T_4**-15 kg Sulphur ha^{-1} through gypsum, **T_5**-30 kg Sulphur ha^{-1} through SSP, **T_6**-30 kg Sulphur ha^{-1} through ES, **T_7**-30 kg Sulphur ha^{-1} through gypsum, **T_8**-45 kg Sulphur ha^{-1} through SSP, **T_9**-45 kg Sulphur ha^{-1} through ES, **T_{10}**-45 kg Sulphur ha^{-1} through gypsum

Table 2. Effect of different rate of sulphur sources on total nutrient uptake in seed, stover and available nutrient in soil and economics

Treatment	Total nutrient uptake in (seed + stover) in kg ha^{-1}			Available nutrient in soil			Cost of cultivation (Rs.ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
	N	N	P	K	P	K				
T_1	56.21	168.95	15.37	190.43	5.29	20.02	13342.56	28064	14721.44	1.10
T_2	58.82	169.25	15.53	191.20	5.68	20.70	14107.56	28432	14324.44	1.02
T_3	66.71	171.14	17.33	194.33	6.52	25.57	14448.84	31155.33	16706.49	1.16
T_4	61.79	171.73	16.27	193.40	6.02	24.63	14364.86	29625.67	15260.81	1.06
T_5	68.85	177.62	17.77	195.50	7.11	26.73	14732.56	31733.67	17001.11	1.15
T_6	76.03	182.74	18.67	196.67	7.96	28.67	15415.7	34496.6	19080.9	1.24
T_7	72.69	179.55	18.20	196.23	7.58	27.56	15247.16	33616.48	18369.32	1.20
T_8	82.45	181.14	19.40	197.27	8.59	29.67	15357.56	35182.12	19824.56	1.29
T_9	113.84	185.03	21.64	199.77	14.22	42.25	16381.4	41302.67	24921.27	1.52
T_{10}	108.06	183.98	20.83	199.20	12.78	41.21	16129.46	40516	24386.54	1.51
SEm±	2.45	20.69	0.33	0.23	0.68	0.71				
C.D (P=0.05)	7.29	61.47	0.97	0.69	2.01	2.11				

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ROLE OF SOIL FLORA IN SOIL PHYSICAL CONDITION IMPROVEMENT AND THEIR IMPACT ON PLANT GROWTH

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Abstracts: Soil physically supports plants, and acts as a reservoir for storing the water and nutrients required for the plants. Good physical condition facilitates oxygen and water infiltration and can improve water storage, increasing fertilizer use efficiency in plants, ultimately, improves productivity of soil. The soil is teeming with millions of living organisms which make it a living and a dynamic system. These organisms not only help in the improvement of soil physical condition but also carry out a number of transformations, facilitating the availability of nutrients to the plants.

Keywords: Soil, Plant growth, Nutrient

INTRODUCTION

Soil physically supports plant and acts as a reservoir for storing the water and nutrients required by the plants. Soils are complex mixtures of mineral particles of various shape and size; living and dead organic materials including microorganisms, roots, plant and animal residues; air and water (Fig. 1). The physical condition of the soil plays a large role in influencing the nature of biological and chemical reactions. Physical, chemical, and biological reactions occur in the soil continuously and are closely interrelated. The physical form of the soil plays a large role in influencing the nature of biological and chemical reactions. The discussion of soil physical environment begins with the sizes (texture) and arrangements (structure) of individual soil particles. These two characteristics intimately affect the pore space between the particles. The pore space is important as the conveyor of water, dissolved mineral nutrients, and air, as well as for providing space in which rots can grow. Finally, it is important to consider the whole soil mass, and how it changes with depth below the surface. The soil is teeming with millions of living organisms which make it a living and a dynamic system. These organisms not only help in the improvement of soil physical condition but also carry out a number of transformations, facilitating the availability of nutrients to the plants. The rationale for the use of microbial and biochemical characteristics as soil quality indicators is their central role in cycling of C and N and their sensitivity to change (Nannipieri et al., 1990).

Soil macroflora (plant roots) create voids and macropores in the soil so that air and water can move through the soil. They roots supply food for microorganisms and burrowing soil fauna that also keep the soil from compaction. Bulk density can be increased from 12 to 35% compared with that of the bulk soil due to compressing action of growing root. However, organic residues left behind by the decaying plants are lighter and less dense than clay, silt, and sand particles decreasing the average soil density. Soil microflora plays an important role in improving soil physical condition which can be manifested by aggregate stability, because the size, arrangement and stability of aggregates have a wide influence on soil physical properties and plant growth.

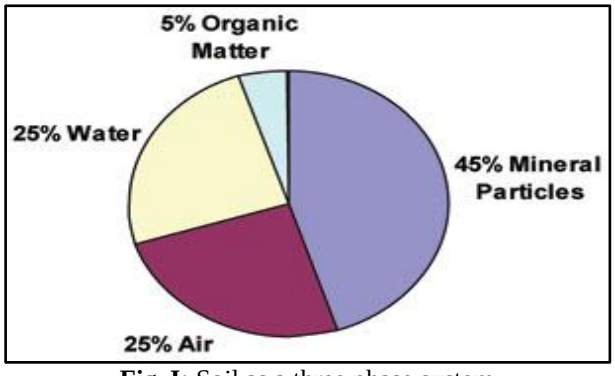

Fig. I: Soil as a three phase system

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Bacteria are involved in micro aggregate stabilization of soil particles, while fungi are involved in binding together larger soil particles and aggregate stabilization.
Therefore, soil organisms play very important role in soil physical condition improvement which affects plant growth by influencing root distribution and the ability to take up water and nutrients. Good physical condition facilitates oxygen and water infiltration and can improve water storage, increasing fertilizer use efficiency in plants, ultimately, improves productivity of soil.

Impact of soil organisms on soil physical conditions

A. Soil physical conditions as influenced by soil macroflora
B. Soil physical conditions as influenced by soil microflora

A. Soil physical conditions as influenced by soil macroflora

Root rhizosphere related processes affecting soil physical condition can be grouped into five categories:
a) Root penetration
b) Changed soil-water regimes
c) Root exudation
d) Dead root decomposition
e) Root entanglement

a) Root penetration

The compressing action of growing roots decreases soil porosity in the zone between roots and reorientates clay particles along the root surface. Near the root surfaces, bulk density can be increased from 12 to 35% compared with that of the bulk soil. According to Dorioz these modifications occur mostly within a 50—200 pm zone around the roots, inducing the formation of micro aggregates. In contrast, a decrease in macro aggregation after plant growth is partially due to the penetrating effect of roots into macrospores'. Also found that, even at constant water potentials, roots decreased the proportions of already formed large water stable aggregates by 20—50%.

b) Changed soil-water regimes

Plant roots also influence aggregation through modifying the soil water status in several ways. First, water uptake by plant causes a localized drying of the soil, which promotes the binding of root exudates on clay particles. Second, root exudation reduces the wetting rate by occluding pores or increasing pore tortuosity, thereby reducing slaking of aggregates. Third, water flows preferentially along living roots due to the presence of a saturated film of water along the roots.

c) Root exudation

As plant roots release organic material within the rhizosphere (rhizodeposition), they directly and indirectly affect soil physical condition. Mucilages produced by roots may stick soil particles directly together. Root mucilage such as polygalacturonic acid may stabilize aggregates by increasing bond strength. Roots can also alter the ionic and osmotic balance in the rhizosphere through nutrient uptake and rhizodeposition, which can affect aggregation. The degree of influence by roots on soil structure through root exudation is very variable as production and composition of mucilage's depend on various factors such as water regime, plant species, soil depth and time.

d) Dead root decomposition

During the decomposition of dead roots, soil structure will be promoted, resulting in improvement of soil physical condition, by increasing organic matter soil microbial activity, then decreasing bulk density, compaction thereby increasing soil porosity, water holding capacity or its availability and ultimately, increasing crop productivity.

e) Root entanglement

The entanglement of particles by roots to form and stabilize macro aggregates. However, it is difficult to separate the influence of entanglement versus exudation by roots. In addition, arbuscular mycorrhizal (AM) fungi are often associated with root systems, further complicating the separation of the effects of roots versus AM fungi and their exudates.

B. Soil Physical Conditions as Influenced By Soil Microflora

Soil microflora plays an important role in improving soil physical condition which can be manifested by aggregate stability, because the size, arrangement and stability of aggregates have a wide influence on soil physical properties and plant growth. Microbial and biochemical characteristics are used as potential indicators of soil quality, even if soil quality depends on a complex of physical, chemical and biological properties.

What is aggregate?

A soil aggregate can be defined as "a naturally occurring cluster or group of soil particles in which the forces holding the particles together are much stronger than the forces between adjacent aggregates".

Why is stable aggregate necessary?

The importance of soil aggregation in crop production lies in its effect on water and air relationships in soil. The size, shape, and stability of soil aggregates control the pore size distribution, which in turn affects many soil physical properties.

How is microflora involved in soil aggregation two major ways?
1. Mechanical binding of soil particles.
2. Influence of microbial product.

Mechanical binding of soil particles

Some organisms may be able to mechanically bind soil particles together. The improvement of soil physical conditions brought about by the addition of organic matter, but organic matter additions have no effect unless soil organisms are present. Bacteria are involved in microaggregate stabilization of soil particles, while fungi are involved in binding together larger soil particles i.e., macroaggregate. The role of fungi may be considered as both aggregate forming and aggregate stabilizing. By ramifying through the fungal hypae may bring soil particle together and force their contact with binding agents. Lichens and algae also formed surface crusts in sand through mucilaginous sheaths. In low rainfall areas, it was observed that the crust of sand were interwoven with algal filaments that had bacteria and fungi associates with them. Jastrow and Miller suggested that the soil micro flora involved if soil aggregation in several ways (Fig.2). They reported that Microaggregates are 20—250 pm in size and are composed of clay microstructures, silt-size microaggregates, particulate organic matter, plant and fungus debris, and mycorrhizal fungus hyphae: these particles are stable in size. Roots and microbes combine microaggregates in the soil to form macro aggregates.

Influence of microbial product

Others may produce effective binding agents either by synthesis or through the decomposition of organic materials. These products may remain in close contact with the cell or becomes part of the pool of soil organic matter and subjected to decomposition. Microbial product may be freshly synthesized by soil microorganisms or may be produced after the decomposition of plant residues and other tissues. The end product of decomposition is humus, a dark coloured, heterogeneous colloidal mixture. The humic colloids include polysaccharides, proteins having a large numbers of aromatic rings. Among the various product, polysaccharides were the main factor responsible for aggregate stabilization. Microflora in a soil form part of the biomass and contributes to the reserve of soil nutrients and is generally referred to as the microbial biomass.

Mechanisms involved in binding processes

Soil micro flora involved in aggregate formation mainly through the following three mechanisms.
Polysaccharides produced by microorganisms may absorb to soil surfaces:
By themselves absorbing to soil particles, microorganisms may bind soil particles.
Groups of microorganisms may interact with each other or with root to stabilize aggregate.

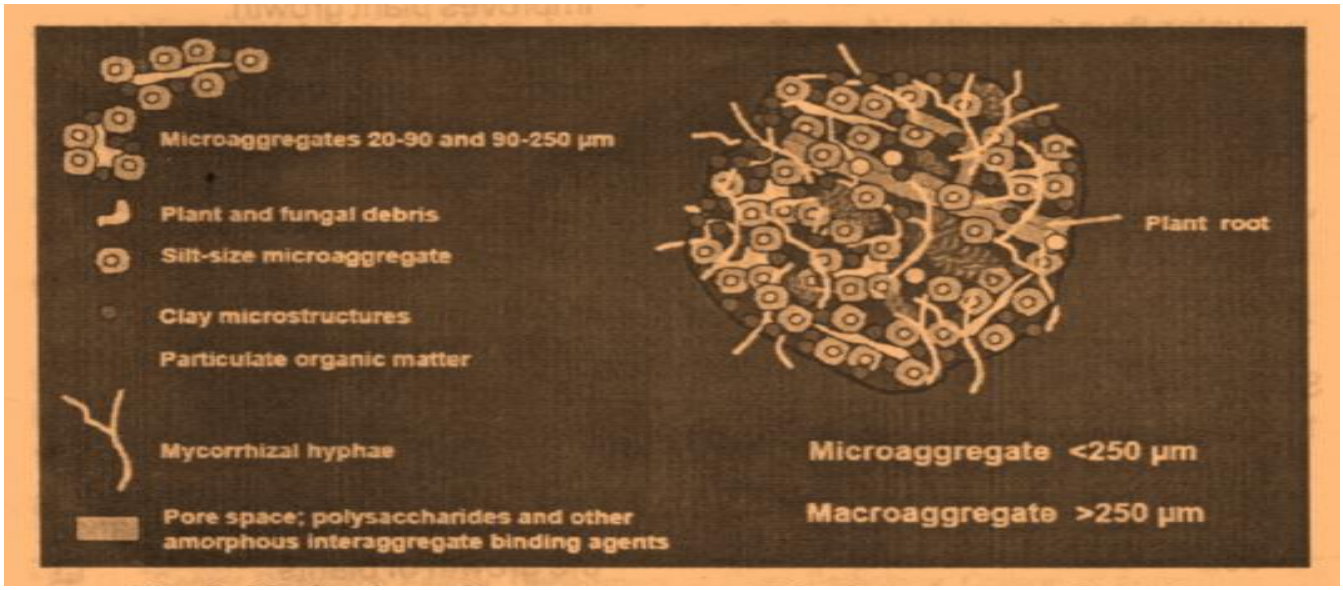

Fig. 2: Mechanism of macroaggregale and micro aggregate form atioli

The first two are leading to formation of microaggregates and the third leading to a higher level of organization.

a) Binding activity of polysaccharides:
Martin (1971) summarized the binding activity of polysaccharides as being due to —

The length and linear structure ‘or polysaccharides allow them to bridge spaces between soil particles.
Their flexibility, allowing many points of contact so that van der Waals forces can be more effective.
The number of acid groups present, allowing ionic bonding through di- and trivalent ions.

b) Adsorption of cells to soil surfaces

There are three interactions between microorganisms and soil particles:

1. Sorption between microorganisms and surfaces of large soil particles.
2. Sportive interactions between cells and soil particles of smaller size.
3. Sorption of very small particles to surfaces of microorganisms.

c) Interactions between groups of microorganisms with roots

The stability of aggregates produced by bacteria increased in the presence of fungi and actinomycetes. The presence of fungi, possibly arbuscular mycorrhiza and saprophytic fungi are the most important microorganism which could mechanically bind soil particles together, with stabilization being enhanced by polymers produced by bacteria associated with the hyphae. Bacteria at the root surface would be in an ideal position to utilize root residues to produce effective soil binding agents. These microorganisms help combine soil practice into stable aggregates around plant roots.

Soil physical conditions as influenced by soil mycorrhizal fungi

The contribution of mycorrhizal fungi to aggregation is a simultaneous process involving four steps (Fig.3):

1. The fungus hyphae form an entanglement with primary soil particles, organizing and bringing them together.

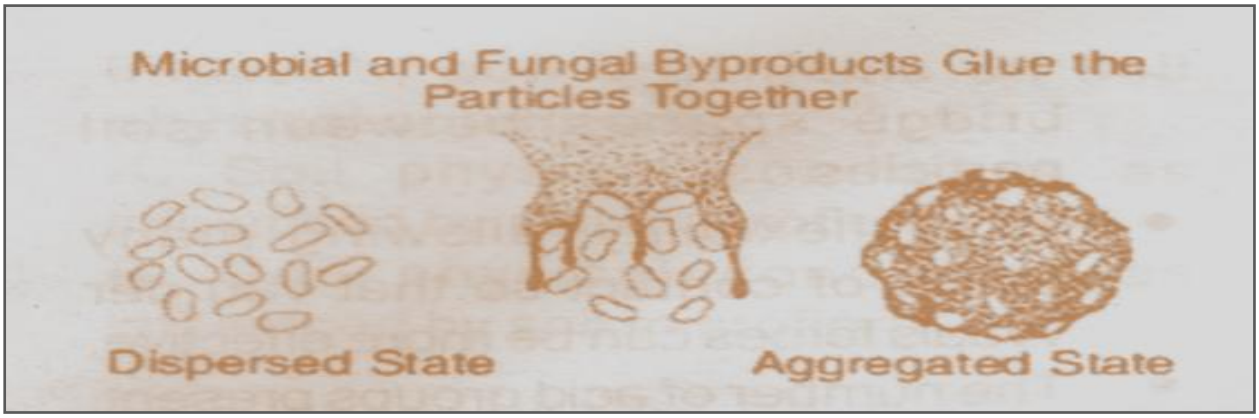

Fig. 3: how are aggregates formed?’

2. Fungi physically protect the clay particles and the organic debris that form micro aggregates.
3. The plant root and glomalin formed by fungal hyphae glue micro aggregates and some
Smaller macro aggregates together to form larger macro aggregates.
4. The fungal “root-hyphae-net” holds the aggregates intact and clay particles protect the roots and hyphae from attack by microorganisms. Roots also create other Polysaccharide. Exudates to coat soil particles.

Role of Glomalin

Glomalin is an amino polysaccharide or glycoprotein created by combining a protein from the mycorrhizal fungus.

It is present in soils at high concentrations and is an important factor in stabilizing aggregates, possibly due to its recalcitrant nature and high concentration in some soils and may protect other aggregating agents.
Glomalin initially coats the plant roots and then coats soil particles.
Glomalin acts like a glue to cement micro aggregates together to form macro aggregates and improve soil structure.

Management for improving soil microbial activity

Microbial activity can be increased by-

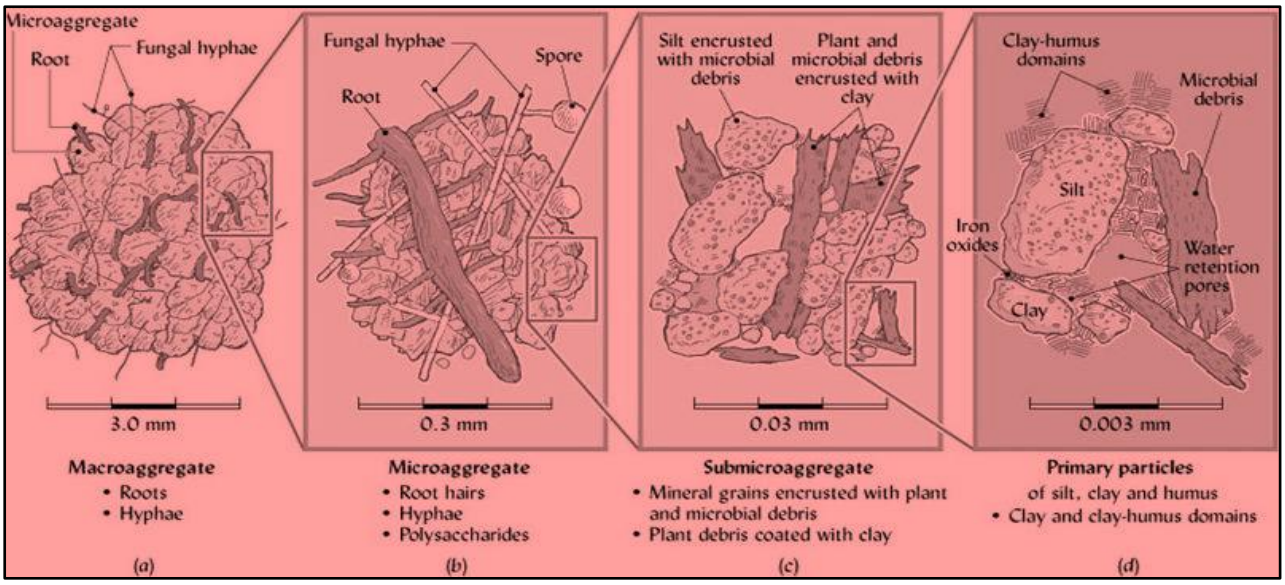

Fig. 4: Macroaggregale model and hierarchy

Application of farm yard manure (FYM), because it causes

The application of FYM increases the percentages of organic matter nutrient levels (providing a slow fertilization action over a long period of time), microbial biomass and improves the soils' physical properties (aeration, water holding capacity, etc.) Bertran *et al.* 2004.

Improvement of soil structure Improvement of water holding capacity.

Improvement of in soil aeration buffering of soil surface temperature.

Reduction of soil losses due to erosion.

Green manuring (GM)

Should be included in cultural practices as it enhances

It adds organic matter to soil. This simulates the activity of soil microorganisms.

It improves the structure of the soil.

It facilitates the penetration of rain water thus decreasing run-off and erosion.

It holds plant nutrients that would otherwise be lost by leaching.

It increases the availability of certain nutrients, like P, Ca, Mg and Fe.

The soil microbial population is closely associated with organic matter of soil. Immediately after incorporation into soil, plant materials are subjected to the transformation and decomposition process of heterotrophic microflora (Negi et al., 1986, 1987; Rauhe, 1987; Singh and Singh, 1993; Tilak et al., 1995).

Summary

Plant roots create voids and microspores in the soil so that air and water can move through the soil.

Plant roots supply food for microorganisms (especially fungus) and burrowing soil fauna that also keep the soil from compaction.

Organic residues left behind by the decaying plants are lighter and less dense than clay, silt, and sand particles which ultimately, decrease the average soil density.

Soil microflora improves the soil physical condition through contributing to the aggregation of soil particles thereby enhancing cycling of nutrients and their availability to plants and finally improves plant growth.

Soil fauna improve aeration, porosity, infiltration, aggregate stability, litter mixing, improved N and C stabilization, C turnover and carbonate reduction and N mineralization, nutrient availability and metal mobility.

Thus, soil physical condition can be improved through proper management of soil organism through addition of organic manures which ultimately enhance the growth of plants.

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DETERIORATIVE EFFECT OF ASSOCIATED FUNGI ON STORED SEEDS OF FENNEL (*FOENICULUM VULGARE* MILL.)

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Abstrcts: Toxic metabolites of all the pathogenic fungi had reduced seed germination, root and shoot elongation and seedling vigour. The per cent volatile oil content in seeds inoculated with *Aspergullus flavus* increased while it decreased in seeds inoculated with *Alternaria alternata, Rhizopus oryzae and Fusarium oxysporum* remain equal to control in *Rhizopus oryzae*.

Keywords: Fungi, Seed, Fennel

INTRODUCTION

Fennel (*Foeniculum vulgare* Mill.) also known as Saunf in Hindi is one of the major seed spices crop belongs to family apiacecae (Umbeliferae) and believed to have originate from Southern Europe and the Mediterranean area, especially in the vicinity of seas (Vanangamudi and Natrajan, 2008). In India, fennel is mostly grown in north India and the important producing states are Gujarat, Rajasthan, Madhya Pradesh, Haryana and Uttar Pradesh (Sastry *et al.*, 2009). In fennel volatile oils the major compounds are t-anethole, estragole, fenchone and limonene. The essential oil of fennel fruits showed a characteristic chemical profile from year to year. The essential oil content and its monoterpenes components were the most susceptible features to be affected by climatic conditions viz., temperature and rainfall (Aprotosoaie *et al.,* 2010). Among several factors which reduced the productivity of fennel seeds quantatively and qualitatively the use of self stored saved seeds invaded by different field and storage fungi during their course of development on the plants, handling and processing and also during their storage, respectively. This is one of the major factor which take heavy toll of the crop at all stages, right from seedling to harvest, also during transit and storage by causing reduction in germination of seed, deteriorating the seeds qualitative and quantitatively. Hence, present investigations were carried out on deteriorative effect of associted fungi on stored of fennel (*Foeniculum vulgare Mill*.)

MATERIAL AND METHOD

(A) Effect of toxic metabolites of seed borne fungi on seed germination and shoot and elongation of fennel

Effect of toxic metabolites on seed germination

One hundred surface sterilized seeds were soaked in 10 ml culture filtrate for 12 hours. The soaked seeds were then placed on top of 3 blotters moistened with the same filtrate. The blotters were fixed in the bottom of a Petri dish. Ten seeds were accommodated in one Petri dish. Seeds in un-inoculated sterile medium and sterile water served as control. The Petri dishes were incubated at 25 ± 2^0C for 15 days after which observations on seed germination were recorded.

Effect of toxic metabolites on root elongation

The surface sterilized seeds of sample A were first germinated on blotters moistened with sterile water and fixed in Petri dishes held at 25 ± 2^0C. One hundred germinated seeds with 5 mm root length were separately used to assay each of the different culture, filtrates. Then germinated seeds were placed on top of 3 blotters moistened with the culture filtrate. The blotters were fixed in bottom of each Petri dish. Blotters moistened with uninoculated sterile medium and sterile water served as control. After 5 days of incubation, the root elongation over the initial 5 mm length was measured.

Effect of toxic metabolites on shoot elongation

Procedure described above was followed except that seed selected for assay had initial shoot length of 5 mm irrespective of root length. Appropriate numbers of replications wasfour in all above these experiments.

Seedling vigour was also calculated by formula suggested by Abdul-Buki and Anderson (1973) as described as follows:

$$\text{Spore load / seed} = \frac{N \times V}{X \times n}$$

N = Total number of spores counted / numbers of squares.

X =Value of mounting solution between the cover glass and above the square covered (area of squares x depth of chamber)

V = Value of the mounting fluid added to the sediment and

n = Number of seeds washed.

(B) Effect of pathogenic storage mycoflora on volatile oil content of seed

One hundred gram inoculated seed with each fungus under test were ground finely with electrical grinder. The seed powder was transferred in assembly flask

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(one litre) and 540 ml water was added to fill the flask upto half of its capacity and placed on heating mantle. Heating was done for 5 to 6 hrs continusly. The volatile oils were collected in the graduated side arm of the assemly. Two consecutive reading reading were taken at 30 minutes until there was no change in oil content. The volume of volatile oil obtained in terms of milliliter/100 g seed sample directly reveals per cent oil content in the seeds.

RESULT AND DISCUSSION

Effect of toxic metabolites of seed borne fungi on seed germination and shoot and elongation of fennel

Toxic metabolites of all the fungi caused reduction in per cent seed germination (38.00 to 60.00%) and shoot (18.00 to 26.00 mm) / root elongation (8.50 to 13.00 mm) and seedling vigour (1225.00 to 2145.00) in comparison to control *i.e.* sterilized medium and sterilized water where they were observed to be 78-81%, shoot 32.00 mm and 16.00 mm and 3744 to 3888, respectively. Maximum reduction in seed germination, shoot and root elongation and seedling vigour was observed in toxic metabolites of *Alternaria alternata* followed by *Rhizopus oryzae* and they were least affected in toxic metabolites of *Aspergillus niger* and *Fusarium oxysporum* followed by *Aspergillus flavus* (Table-1). The similar results were observed by Manjari *et. al.,* (1996) and Sharma and Sharma (2006).

Effect of pathogenic storage mycoflora on volatile oil content of seed

The per cent volatile oil content of the fennel seed inoculated with five mycoflora *viz.*, *Aspergillus niger*, *A. flavus*, *Alternaria alternata*, *Rhizopus oryzae* and *Fusarium oxysporum* were assessed and expressed as per cent of dry weight of seeds. Out of five species of mycoflora tested for mycoflora *i.e. Aspergillus niger* (2.10%) increased no significantly oil content of seed in compared to control (2.50%). Oil content was observed to be reduced in seed inoculated with rest of the mycoflora*i.e.Aspergillus flavus* (2.00%), *Fusarium oxysporum* (1.90%), *Rhizopus oryzae* (1.80%) and *Alternaria alternata* (1.75%). However, significant difference was observed between *Aspergillus niger* and *A. flavus* as compared to control (Table-2). Similar resuls have also been reported by Shivpuri *et al*., (1990), Lalita kumari *et al.,* (1971) and Anonymous (2005).

Table 1. Effect of toxic metabolites of seed borne fungi on seed germination and shoot and root elongation of fennel.

S. no.	Fungi	Per cent seed germination	Root elongation (mm)	Shoot elongation (mm)	Seedling vigour
1.	*Aspergillus niger*	38.00 (38.06)	12.00 (20.27)	24.00 (29.33)	1368
2.	*Aspergillus flavus*	49.00 (44.43)	8.50 (16.95)	17.00 (24.35)	1225
3.	*Alternaria alternata*	60.00 (50.77)	11.50 (19.82)	25.00 (30.00)	2160
4.	*Fusariumo xysporum*	50.00 (45.00)	9.00 (17.46)	18.00 (25.10)	1350
5.	*Rhizophus oryzae*	55.00 (47.87)	13.00 (21.13)	26.00 (30.66)	2145
6.	Control				
	(i) Sterilized medium (SM)	78.00 (62.03)	16.00 (23.58)	32.00 (34.45)	3744
	(ii) Sterilized water (SW)	81.00 (64.16)	16.00 (23.58)	32.00 (34.45)	3888
	S.Em±	0.95	0.50	0.64	57.76
	C.D. at 5%	(2.92)	(1.53)	(1.97)	177.96

* Average of four replication
Figure in parentheses are angular values

Table 2. Effect of different seed mycoflora on the volatile oil content of seed.

S. no.	Storage fungi	Volatile oil content (%)
1.	*Aspergillus niger*	2.10 (8.33)
2.	*Aspergillus flavus*	2.00 (8.13)
3.	*Alternaria alternata*	1.75 (7.60)
4.	*Rhizopus oryzae*	1.80 (7.71)
5.	*Fusarium oxysporum*	1.90 (7.92)
6.	Control (uninoculated)	2.50 (9.10)
	S.Em+	0.37
	C.D.at 5%	(1.17)

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STUDY ON SEASONAL INCIDENCE OF MAJOR INSECT PESTS OTHER THAN RICE GALL MIDGE ON FINE SLENDER RICE GENOTYPES IN THE NORTHERN HILL REGION OF C.G

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Abstracts: Rice is consumed by more than half of the world's population. In Asia alone, more than 2 billion people obtain 60 to 70 percentage of their energy intake from rice and its derivatives. Only 4-5 percentage of world rice production enters the global market. A part from food, rice is intimately involved in the culture as well as economy of many societies. The cultivation of rice is done under more diverse conditions than any other food crop, ranging from irrigated to rainfed ecology and upland to deep water conditions. In world, rice has occupied an area of 154 million hectares, with a total production of 476 million tonnes and productivity 2949 kg ha^{-1} (Anonymous, 2012). India has largest area among rice growing countries and enjoys the second rank in production. India has 45.5 million hectares, total cultivated area under rice, with the production of 105.31 million tonnes and productivity 2393 kg ha^{-1} (Anonymous, 2013 a).

Keywords: Insect, Pest, Rice, Chhattisgarh

INTRODUCTION

Chhattisgarh state is popularly known as "rice bowl of India" because maximum area is covered under rice during *Kharif* and contribute major share in national rice production. It has geographical area of 13.51 million hectares of which 5.9 million hectares area is under cultivation. Rice occupies an area around 3.61 million hectares, with the production of 5.48 million tonnes and productivity 1517 kg ha^{-1} (Anonymous, 2013 b). The productivity of rice in Chhattisgarh is comparatively lower than the national average. This is due to several constraints which are responsible for such low productivity rice in the region. Among these, insect pests are one of the most important factors limiting the rice production. There are more than 100 species of insect pests of rice but only about 20 of them are of major economic importance (Pathak and Khush, 1979). The losses due to insect pests during vegetative phase (50 percentage) contributes more to yield reduction than the reproductive phase (30 percentage) or ripening phase (20 percentage) as reported by Gupta and Raghuraman (2003). In Chhattisgarh region various rice pests cause losses up to 20 percentages every year to rice crop. Which gall midge, *Orseolia oryzae* (Wood-Mason), The Asian rice gall midge, *Orseolia oryzae* (Wood-Mason), Diptera: Cecidomyidae, is the most important pest and causes extensive damage. (Jagadeesha Kumar *et al.*, 2009). It is an important pest from the seed bed to maximum tillering stages of the rice crop. Yield loss assessments in field with up to 30% tiller infestation suggest that for each 1% increase in tiller infestation, a farmer can expect to lose 2-3% grain yield, (Nacro *et al*., 1996). In Chhattisgarh rice gall midge is locally called "gangai". The extent of losses it cause has been recorded from as low as a few kilograms to as high as 25 q/ha (Kittur and Agrawal, 1983). The major active period of these insect is September to October. In rice gall midge, maggot is the destructive stage and the feeding maggot causes the conversion of leaf sheath to galls often referred as 'onion shoots' or 'silvershoots' (Hidaka, 1974 and Hill, 1987) and it also causes the production of secondary tillers which may themselves become infested. In India, gall midge is a serious pest of irrigated and shallow water rice ecosystem (Lai *et al*., 1984). In Chhattisgarh region gall midge caused 30 to 40 per cent losses in yield in susceptible varieties of paddy (Anonymous, 2010).

Therefore, **''**study the seasonal incidence of major insect pests other than rice gall midge on fine slender rice genotypes in the northern hill region of C.G.**"** is undertaken for the present investigation.

MATERIAL AND METHOD

Site and Climate

Ambikapur is an important rice growing tract of Chhattisgarh and comes under the northern hill region of Chhattishgarh in India. The general climate condition of Surguja is Eastern plateau and hilly region with average rainfall 1422.8 mm.

Experimental details

Place of experiment	: -	Ajirma Research Farm RMD CARS, Ambikapur.
Crop	: -	Rice
Date of sowing	: -	11-07-2013
Date of transplanting	: -	01-08-2013
Season	: -	Kharif, 2013

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Design	: -	Randomized Block Design
Replications	: -	03
No. of entries	: -	60
Plot size	: -	4.5m x 0.8m
Spacing	: -	20 x 15 cm
Fertilizer dose	: -	100:50:30 Kg/ha.

Sixty rice genotypes were screened against gall midge infestation based on the percentage of silver shoots. These varieties were sown on 11-07-2013 and were transplanted into the main field after 21 days. Regular crop practices were followed in the main field. When there was severe infestation of pests, observations like total number of plants, damaged plants, total number of tillers and total number of silver shoots were recorded.

Leaffolder

Number of entries: 60

Time of observation: Maximum tillering and heading stage of crop plant.

Target pests: leaffolder (*Cnaphalocrocis medinalis*)

The observations on incidence of leaffolder appearance were taken at 70 days by counting the total number of leaf and the number of damaged leaf by leaffolder. In each paddy genotype, 10 plants were observed.

Data processing

Data were proceeding by following calculation of the Damage leaf and standard evaluation system of leaffolder damage.

$$\text{Percentage Damage leaves} = \frac{\text{Damaged leaves}}{\text{Total number leaves}} \times 100$$

Observation of plants was taken on the basis of plant damage symptoms (0-9 scale) which are as follows:

Table 1. standard evaluation systems for evaluating rice for resistant to leaf folder (IRRI 2002)

Score*	Rating	Damage percentage range (%DL)
0	Highly resistant	No damage
1	Resistant	1 - 5 per cent
3	Moderately resistant	5 -10 per cent
5	Moderately susceptible	10 - 15 per cent
7	Susceptible	15 - 25 per cent
9	Highly susceptible	More than 25 per cent

*Mean score of plant damage was calculated.

Rice stem borer

Number of entries: 60

Time of observation: Maximum tillering and heading stage of crop plant.

Target pests: Yellow stem borer (*Scirpophaga incertulas*).

The observations on incidence of stem borer (white earheads) appearance were taken at maturity by counting the total number of tillers and the number of tillers damaged by stem borer (white earheads). In each paddy genotype, 10 plants were observed for white earheads.

Data processing

Data were proceeding by following calculation of the white earheads and standard evaluation system of gall midge damage.

$$\text{Percentage white earheads} = \frac{\text{Total number of white earheads}}{\text{Total number of tillers}} \times 100$$

Table 2: Standard evaluation systems for evaluating rice for resistant to stem borer (IRRI 2002)

Score*	Rating	Damage percentage range (% SS)
0	Highly resistant	No damage
1	Resistant	1-5 percent
3	Moderately resistant	5-10 percent
5	Moderately susceptible	10-15 percent
7	Susceptible	15-25 percent
9	Highly susceptible	More than 25 percent

*Mean score of plant damage was calculated.

RESULT AND DISCUSSION

Major insect pests other than rice gall midge on fine slender rice genotypes

Rice Leaf folder (*Cnaphalocrocis medinalis*)

On the basis of statistical analysis only two genotypes viz. IET 21053 (NDR9542) (Ch.) and R 1670-1151-1-119-1 were found with no infestation (zero percent damage) of leaffolder out of sixty genotypes. In second group four genotypes i.e. R 1730-501-3-250-1(0.32%), R 1757-540-3-286-1(0.36%), R 1667-1032-1-98-1(0.45%) and R 1938-620-1-163-1(0.63%) were found significantly superior over other genotype and at par with each other showed minimum percentage. In third group leaf damage four genotypes i.e. R 1819-473-1-139-1(3.04%), R 1656-3181-1-420-1(1.91%), R 1819-469-2-137-1(2.31%) and R 1656-2821-1-3245-1(2.58%) were found significantly superior over other genotypes and at par with each other. In fourth group five genotypes i.e. R 1804-399-1-134-1(3.40%), R 1738-504-3-255-1(3.52%), R 1656-3173-1-415-1(3.63%), R 1607-321-1-34-1(3.71%) and R 1750-937-1-530-1(3.83%) were found significantly superior over other genotypes and at par with each other. In fifth group three genotypes namely R 1595-14-1-6-1(4.56), R 1595-17-1-8-1(5.55) and IR 83376 B-B110-3 (ch) (5.71%). In sixth group four genotypes viz. R 1656-430-10-1965-1(5.87%), R 1553-1369-2-252-1(6.17%), R 1536-136-1-77-1(6.22%) and R 1747-4941-1-515-1(6.83%) were found significantly at par with each other, superior over other genotypes. In seventh group nine genotype were evaluated in this category i.e. Indira Sona(Ch) (7.60%), Chandrahasini(7.74%), R 1599-594-2-305-1(8.82%), Vishanu bhog(Ch) (7.83%), R1629-234-5-1882-2(8.86%), R 1661-1372-1-601-1(8.88%), R 1648-2663-2-2862-1(8.88%), Mahisugandha(Ch) (8.94%) and R 1629-112-2-67-1(9.00%) were found significantly superior over other genotypes and at par with each other. In eighth group six genotype were found significantly at par with each other i.e. R 1700-302-1-156-1(9.22%), Indira Sugandhit Dhan-1(Ch) (9.63%), R 1779-320-1-111-1(9.81%), R 1661-605-84-1(10.25%), R 1675-1844-2-1257-1(10.54%) and R 1630-32-1-21-1(10.60%). In ninth group four genotypes were found significantly at par with each other namely; R 1664-59-2-47-1(11.44%), R 1595-17-3-10-1(11.46%), R 1670-3975-1-485-1(11.70%) and R 1698-3644-3-4696-1(13.08%). In tenth group twelve genotypes were found significantly similar with each other viz. R 1545-184-3-22-1(13.45%), TN 1 (Check)(13.57%), R 1588-7-1-1-1(13.59%), R 1607-28-3-19-1(13.66%), R 1656-46-2-41-1(13.80%), IR 84887-B-15(13.89%), R1700-308-3-170-1(14.41%), R 1698-168-1-76-1(14.58%), IR 64(Ch.) (14.87%), R 1519-815-1-646-1(14.88%), R 1630-1237-2-827-1(14.95%) and R 1926-1013-2-595-1(15.06%). In eleventh group six genotypes were found significantly at par with each other i.e. R 1664-59-1-46-1(15.36%), R 1695-2155-1-270-1(15.55%), R 1521-950-6-843-1(15.92%), R 1688-2150-5-2060-1(16.06%), R 1700-2240-4-2295-1(16.33%) and R 1625-1211-2-765-1(16.59%). Whereas in twelfth group only one genotype was found significantly different from other genotypes i.e. R 1536-1170-5-140-1 which showed maximum leaf damage, against leaf folder (17.83%).

Rice Stem Borer (*Scirpophaga incertulas*) At Maturity (White earheads)

Result evaluated that among sixty genotypes seven were found free from stem borer damage i.e. IET 21053 (NDR9542) (Ch.), IR 83376 B-B110-3(Ch), R 1599-594-2-305-1, R 1656-2821-1-3245-1, R 1630-1237-2-827-1, R 1661-605-84-1 and R 1819-473-1-139-1 in fist group whereas rest genotype affected due to stem borer. In second group two genotype were found in this namely; R 1661-1372-1-601-1(1.02%), R 1607-28-3-19-1(1.73%), they are significantly at par and observed superior over genotypes.

In third group ten genotypes were found significantly at par with each other viz. R 1536-1170-5-140-1(1.80%), Vishanu bhog(Ch.) (1.83%), R 1804-399-1-134-1(1.89%), R 1536-136-1-77-1(1.94%), R 1750-937-1-530-1(2.29%), R 1545-184-3-22-1(2.38%), R 1656-46-2-41-1(2.48%), Mahisugandha (Ch.) (2.48%), Indira Sugandhit Dhan-1(Ch.) (2.73%) and R 1595-14-1-6-1(2.50%). In fourth group thirteen cultivar were found at par with each other i.e. R 1607-321-1-34-1(2.89%), TN 1(Ch.) (3.22%), Indira Sona(Ch.) (3.38%), R 1656-430-10-1965-1(3.39%), IR 64 (Check)(3.45%), R 1819-469-2-137-1(3.54%), Chandrahasini (Check)(3.60%), IR 84887-B-15(3.66%), R 1675-1844-2-1257-1(3.76%), R 1595-17-3-10-1(3.79%), R 1667-1032-1-98-1(3.84%), R 1519-815-1-646-1(3.88%) and R 1521-950-6-843-1(4.23%). In fifth group thirteen genotypes were found significantly at par with each other i.e. R 1747-4941-1-515-1(4.16%), R 1698-3644-3-4696-1(4.28%), R1700-308-3-170-1(4.46%), R 1625-1211-2-765-1(4.54%), R 1688-2150-5-2060-1(4.60%), R 1698-168-1-76-1(4.61%), R 1670-3975-1-485-1(4.74%), R1629-234-5-1882-2(4.76%), R 1700-302-1-156-1(5.00%), R 1588-7-1-1-1(5.14%), R 1630-32-1-21-1(5.38%), R 1938-620-1-163-1(5.44%) and R 1656-3173-1-415-1(5.47%). In sixth group five genotype were.

Table 1. Average percentage Leaf Damage at 70 days after transplanting.

NO.	Name of Entry/genotypes	Parentage	Percentage Leaf Damage	Scale (0-9)	Reaction Pattern
1	Chandrahasini	(Check)	7.74 (16.03)	5	MS
2	IET 21053 (NDR9542)	(Check)	0.00 (2.87)	0	HR

3	Indira Sona	(Check)	7.60 (15.86)	5	MS
4	Indira Sugandhit Dhan-1	(Check)	9.63 (18.04)	5	MS
5	IR 83376 B-B110-3	(Check)	5.71 (13.67)	5	MS
6	IR 64	(Check)	14.87 (22.58)	7	S
7	IR 84887-B-15	MLT 11-24	13.89 (21.82)	7	S
8	Mahisugandha	(Check)	8.94 (17.23)	5	MS
9	R 1519-815-1-646-1	Rastic Br 240-47 / Charder	14.88 (22.62)	7	S
10	R 1521-950-6-843-1	R 1521-950-6-843-1	15.92 (23.43)	7	S
11	R 1536-1170-5-140-1	R302-111 / Ganga Baru	17.83 (24.90)	7	S
12	R 1536-136-1-77-1	R 1536-136-1-77-1	6.22 (14.33)	5	MS
13	R 1545-184-3-22-1	Pusa Basmati x ChinniKapoor	13.45 (21.47)	7	S
14	R 1553-1369-2-252-1	Mahamya / Nidhee	6.17 (14.28)	5	MS
15	R 1588-7-1-1-1	R 1102-2795-3 x Nidhee	13.59 (21.54)	7	S
16	R 1595-14-1-6-1	Pusa Basmati x ChiniKapoor	4.56 (12.20)	3	MR
17	R 1595-17-1-8-1	Pusa Basmati x ChiniKapoor	5.55 (13.48)	5	MS
18	R 1595-17-3-10-1	Pusa Basmati x ChiniKapoor	11.46 (19.68)	7	S
19	R 1599-594-2-305-1	MTU 1010 x Mahamaya	8.82 (17.20)	5	MS
20	R 1607-28-3-19-1	IR 71703-221-1-5-2 x Jira Shankar	13.66 (21.64)	7	S
21	R 1607-321-1-34-1	SR 12 x ChinniKapoor	3.71 (11.01)	3	MR
22	R 1625-1211-2-765-1	Denteshwari / Tarori Basmati	16.59 (23.99)	7	S
23	R 1629-112-2-67-1	HMT x Jira Shankar	9.00 (17.39)	5	MS
24	R 1630-1237-2-827-1	SR 12 / LaxmiBhog	14.95 (22.68)	7	S
25	R 1630-32-1-21-1	IR 71703-221-1-5-2 x Laxmibhog	10.60 (18.89)	7	S
26	R 1648-2663-2-2862-1	R 1072-360-1-1 x Poornima	8.88 (17.18)	5	MS
27	R 1656-2821-1-3245-1	Swarna x Jira Shankar	2.58 (9.13)	3	MR
28	R 1656-3173-1-415-1	Danteshwari x Elaychi	3.63 (10.86)	3	MR
29	R 1656-430-10-1965-1	Swarna x Jira Shankar	5.87 (13.84)	5	MS
30	R 1656-46-2-41-1	Swarna x Jira Shankar	13.80 (21.77)	7	S
31	R 1661-1372-1-601-1	R 1004-5552-1-1 x NagriDubraj	8.88 (17.18)	5	MS
32	R 1661-605-84-1	R 1004-5552-1-1 x NagriDubraj	10.25 (18.59)	7	S
33	R 1664-59-1-46-1	R 1004-5552-1-1 x Swarna	15.36 (23.03)	7	S
34	R 1664-59-2-47-1	R 1004-5552-1-1 x Swarna	11.44 (19.70)	7	S
35	R 1667-1032-1-98-1	R 1060-1674-1-1 x Chandrahasini	0.45 (4.02)	1	R
36	R 1670-1151-1-119-1	Samleshwari x Poornima	0.00 (2.87)	0	HR
37	R 1670-3975-1-485-1	Samleshwari x Poornima	11.70 (19.93)	7	S
38	R 1675-1844-2-1257-1	R 1037-649-1-1 x Mahamaya	10.54 (18.85)	7	S
39	R 1688-2150-5-2060-1	R 975-897-1-1 x Tarori Basmati	16.06 (23.56)	7	S
40	R 1695-2155-1-270-1	Danteshwari x Poornima	15.55 (23.16)	7	S
41	R 1698-168-1-76-1	Danteshwari x Elaychi	14.58 (22.38)	7	S
42	R 1698-3644-3-4696-1	Danteshwari x Elaychi	13.08 (21.13)	7	S
43	R 1700-2240-4-2295-1	Danteshwari x AmritBhog	16.33 (23.81)	7	S
44	R 1700-302-1-156-1	Denteshwari x AmritBhog	9.22 (17.52)	5	MS
45	R 1730-501-3-250-1	Poornima x Indira Sugandhit Dhan-1	0.32 (3.73)	1	R
46	R 1738-504-3-255-1	IR 64x Pusa Basmati	3.52 (10.70)	3	MR
47	R 1747-4941-1-515-1	Rastic Br 240-47 x ShaymJira	6.83 (15.04)	5	MS
48	R 1750-937-1-530-1	BG380-2xAmrit Bhog	3.83 (11.18)	3	MR
49	R 1757-540-3-286-1	IR 64x BishanuBhog	0.36 (3.52)	1	R
50	R 1779-320-1-111-1	Danteshwari x WGL 320100	9.81 (18.14)	5	MS
51	R 1804-399-1-134-1	R 979-1528-2-1 x GopalBhog	3.40 (10.50)	3	MR
52	R 1819-469-2-137-1	Shyamla x MR 219	2.31 (8.57)	3	MR
53	R 1819-473-1-139-1	Shyamla x MR 219	3.04 (7.69)	3	MR
54	R 1926-1013-2-595-1	R1130-80-1-52-1xHURFG 4-6	15.06 (22.77)	7	S
55	R 1656-3181-1-420-1	SwarnaxJira Shankar	1.91 (7.72)	3	MR
56	R 1938-620-1-163-1	Abhaya x B 644-FMR-6-0-0	0.63 (4.53)	1	R
57	R1629-234-5-1882-2	HMTxJira Shankar	8.86 (17.10)	5	MS
58	R1700-308-3-170-1	Denteshwari x AmritBhog	14.41 (22.26)	7	S
59	TN 1	Susceptible (Check)	13.57 (21.56)	7	S
60	Vishanubhog	(Check)	7.83 (16.16)	5	MS
	SEm±		**0.55**		
	CD(5%)		**1.55**		

Figures in parentheses are Angular transformed values.
DAT- Days after transplanting, SS- Silver shoot (tiller basis), Score= 0-Highly resistant (0% SS),2- Resistant (<1% SS), 3- Moderately resistant (1-5% SS), 5- Moderately susceptible (5-10%SS),7-Susceptible (10-25% SS), 9- Highly susceptible (25% SS).

Table 2. AveragePercentLeaf damage at 70 day after transplanting (IRRI rating) (Based on the mean value)

Scale (0-9)	Score (Silver shoot)	Category	Number of entries	Name of entries
0	No damage	Highly Resistant	2	IET 21053 (NDR9542) (Check) and R 1670-1151-1-119-1.
1	Less than 1%	Resistant	4	R 1757-540-3-286-1,R 1730-501-3-250-1, R 1667-1032-1-98-1 and R 1938-620-1-163-1
3	1-5%	Moderately Resistant	10	R 1819-473-1-139-1 , R 1656-3181-1-420-1,R 1819-469-2-137-1,R 1656-2821-1-3245-1, R 1804-399-1-134-1 ,R 1738-504-3-255-1 ,R 1656-3173-1-415-1,R 1607-321-1-34-1 ,R 1750-937-1-530-1, R 1595-14-1-6-1 ,
5	5-10%	Moderately Susceptible	18	Indira Sugandhit Dhan-1(Check),R 1700-302-1-156-1,R 1779-320-1-111-1,R 1629-112-2-67-1,Mahisugandha(Check),R 1648-2663-2-2862-1,R 1661-1372-1-601-1,R1629-234-5-1882-2,R 1599594-2-305-1,Vishanu bhog(Check), Chandrahasini(Check), Indira Sona(Check),R 1747-4941-1-515-1,R 1536-136-1-77-1,R 1553-1369-2-252-1,R 1595-17-1-8-1,IR 83376 B-B110-3(Check)and R 1656-430-10-1965-1.
7	10-25%	Susceptible	26	R 1661-605-84-1,R 1675-1844-2-1257-1, R 1630-32-1-21-1, R 1595-17-3-10-1, R 1664-59-2-47-1, R 1670-3975-1-485-1, R 1698-3644-3-4696-1, R 1545-184-3-22-1,R 1588-7-1-1-1, TN 1 (Check), R 1607-28-3-19-1, R 1656-46-2-41-1, IR 84887-B-15, R 1700-308-3-170-1, R 1698-168-1-76-1, IR 64 (Check) ,R 1519-815-1-646-1,R 1630-1237-2-827-1,R 1926-1013-2-595-1, R 1664-59-1-46-1 ,R 1695-2155-1-270-1, R 1521-950-6-843-1 ,R 1688-2150-5-2060-1, R 1625-1211-2-765-1 and R 1536-1170-5-140-1.
9	More than 25%	Highly Susceptible	0	-Nil-

Table 3. Average percentage White earheads at Maturity

NO.	Name of Entry/genotypes	Parentage	Percentage White earheads	Scale (0-9)	Reaction Pattern
1	Chandrahasini	(Check)	3.60 (10.94)	3	MR
2	IET 21053 (NDR9542)	(Check)	0.00 (2.87)	0	HR
3	Indira Sona	(Check)	3.38 (10.47)	3	MR
4	Indira Sugandhit Dhan-1	(Check)	2.73 (9.46)	3	MR
5	IR 83376 B-B110-3	(Check)	0.00 (2.87)	0	HR
6	IR 64	(Check)	3.45 (10.63)	3	MR
7	IR 84887-B-15	MLT 11-24	3.66 (10.94)	3	MR
8	Mahisugandha	(Check)	2.48 (8.91)	3	MR
9	R 1519-815-1-646-1	Rastic Br 240-47 / Charder	3.88 (11.24)	3	MR
10	R 1521-950-6-843-1	R 1521-950-6-843-1	4.23 (11.83)	3	MR
11	R 1536-1170-5-140-1	R302-111 / Ganga Baru	1.80 (7.71)	3	MR
12	R 1536-136-1-77-1	R 1536-136-1-77-1	1.94 (7.92)	3	MR
13	R 1545-184-3-22-1	Pusa Basmati x Chinni Kapoor	2.38 (8.72)	3	MR
14	R 1553-1369-2-252-1	Mahamya / Nidhee	10.58 (18.91)	7	S
15	R 1588-7-1-1-1	R 1102-2795-3 x Nidhee	5.14 (13.05)	5	MS
16	R 1595-14-1-6-1	Pusa Basmati x Chini Kapoor	2.50 (9.10)	3	MR
17	R 1595-17-1-8-1	Pusa Basmati x Chini Kapoor	6.29 (14.42)	5	MS
18	R 1595-17-3-10-1	Pusa Basmati x Chini Kapoor	3.79 (11.09)	3	MR
19	R 1599-594-2-305-1	MTU 1010 x Mahamaya	0.00 (2.87)	0	HR
20	R 1607-28-3-19-1	IR 71703-221-1-5-2 x Jira Shankar	1.73 (7.49)	3	MR
21	R 1607-321-1-34-1	SR 12 x ChinniKapoor	2.89 (9.63)	3	MR
22	R 1625-1211-2-765-1	Denteshwari / Tarori Basmati	4.54 (12.25)	3	MR
23	R 1629-112-2-67-1	HMT x Jira Shankar	8.97 (17.36)	5	MS
24	R 1630-1237-2-827-1	SR 12 / LaxmiBhog	0.00 (2.87)	0	HR
25	R 1630-32-1-21-1	IR 71703-221-1-5-2 x Laxmibhog	5.38 (13.31)	5	MS
26	R 1648-2663-2-2862-1	R 1072-360-1-1 x Poornima	7.02 (15.34)	5	MS
27	R 1656-2821-1-3245-1	Swarna x Jira Shankar	0.00 (2.87)	0	HR
28	R 1656-3173-1-415-1	Danteshwari x Elaychi	5.47 (13.44)	5	MS
29	R 1656-430-10-1965-1	Swarna x Jira Shankar	3.39 (10.47)	3	MR
30	R 1656-46-2-41-1	Swarna x Jira Shankar	2.48 (8.91)	3	MR
31	R 1661-1372-1-601-1	R 1004-5552-1-1 x NagriDubraj	1.02 (5.74)	3	MR
32	R 1661-605-84-1	R 1004-5552-1-1 x NagriDubraj	0.00 (2.87)	0	HR

33	R 1664-59-1-46-1	R 1004-5552-1-1 x Swarna	10.74 (19.09)	7	S
34	R 1664-59-2-47-1	R 1004-5552-1-1 x Swarna	9.75 (18.15)	5	MS
35	R 1667-1032-1-98-1	R 1060-1674-1-1 x Chandrahasini	3.84 (11.24)	3	MR
36	R 1670-1151-1-119-1	Samleshwari x Poornima	8.54 (16.95)	5	MS
37	R 1670-3975-1-485-1	Samleshwari x Poornima	4.74 (12.52)	3	MR
38	R 1675-1844-2-1257-1	R 1037-649-1-1 x Mahamaya	3.76 (11.09)	3	MR
39	R 1688-2150-5-2060-1	R 975-897-1-1 x Tarori Basmati	4.60 (12.38)	3	MR
40	R 1695-2155-1-270-1	Danteshwari x Poornima	7.30 (15.68)	5	MS
41	R 1698-168-1-76-1	Danteshwari x Elaychi	4.61 (12.38)	3	MR
42	R 1698-3644-3-4696-1	Danteshwari x Elaychi	4.28 (11.83)	3	MR
43	R 1700-2240-4-2295-1	Danteshwari x AmritBhog	7.13 (15.45)	5	MS
44	R 1700-302-1-156-1	Denteshwari x AmritBhog	5.00 (12.92)	3	MR
45	R 1730-501-3-250-1	Poornima x Indira Sugandhit Dhan-1	7.25 (15.45)	5	MS
46	R 1738-504-3-255-1	IR 64x Pusa Basmati	9.89 (18.24)	5	MS
47	R 1747-4941-1-515-1	Rastic Br 240-47 x ShaymJira	4.16 (11.68)	3	MR
48	R 1750-937-1-530-1	BG380-2xAmrit Bhog	2.29 (8.53)	3	MR
49	R 1757-540-3-286-1	IR 64x BishanuBhog	9.70 (18.15)	5	MS
50	R 1779-320-1-111-1	Danteshwari x WGL 320100	5.60 (13.69)	5	MS
51	R 1804-399-1-134-1	R 979-1528-2-1 x GopalBhog	1.89 (7.71)	3	MR
52	R 1819-469-2-137-1	Shyamla x MR 219	3.54 (10.78)	3	MR
53	R 1819-473-1-139-1	Shyamla x MR 219	0.00 (2.87)	0	HR
54	R 1926-1013-2-595-1	R1130-80-1-52-1xHURFG 4-6	10.56 (18.91)	7	S
55	R 1656-3181-1-420-1	SwarnaxJira Shankar	8.12 (16.54)	5	MS
56	R 1938-620-1-163-1	Abhaya x B 644-FMR-6-0-0	5.44 (13.44)	5	MS
57	R1629-234-5-1882-2	HMTxJira Shankar	4.76 (12.52)	3	MR
58	R1700-308-3-170-1	Denteshwari x AmritBhog	4.46 (12.11)	3	MR
59	TN 1	(Check)	3.22 (10.30)	3	MR
60	Vishanubhog	(Check)	1.83 (7.71)	3	MR
	SEm±		**0.64**		
	CD(5%)		**1.82**		

Figures in parentheses are Angular transformed values.

DAT- Days after transplanting, SS- Silver shoot (tiller basis), Score= 0-Highly resistant (0% SS),2- Resistant (<1% SS), 3- Moderately resistant (1-5% SS), 5- Moderately susceptible (5-10%SS),7-Susceptible (10-25% SS), 9- Highly susceptible (25% SS).

Table 4. Average Percent White earheads at Maturity (IRRI rating) (Based on the mean value)

Scale (0-9)	Score (Silver shoot)	Category	Number of entries	Name of entries
0	No damage	Highly Resistant	7	IET 21053 (NDR9542) (Check), IR 83376 B-B110-3(Check), R 1599-594-2-305-1, R 1656-2821-1-3245-1, R 1630-1237-2-827-1, R 1661-605-84-1 and R 1819-473-1-139-1.
1	Less than 1%	Resistant	0	
3	1-5%	Moderately Resistant	34	R1661-1372-1-601-1, R 1607-28-3-19-1, R 1536-1170-5-140-1,Vishanubhog(Check), R 1804-399-1-134-1, R 1536-136-1-77-1, R 1750-937-1-530-1, R 1545-184-3-22-1, R 1656-46-2-41-1,Mahisugandha (Check), Indira Sugandhit Dhan-1(Check), R 1595-14-1-6-1, R 1607-321-1-34-1, TN 1(Check), Indira Sona(Check), R 1656-430-10-1965-1, IR 64 (Check), R 1819-469-2-137-1,Chandrahasini(Check), IR 84887-B-15, R 1675-1844-2-1257-1, R 1595-17-3-10-1, R 1667-1032-1-98-1, R 1519-815-1-646-1, R 1521-950-6-843-1, R 1747-4941-1-515-1, R 1698-3644-3-4696-1, R1700-308-3-170-1, R 1625-1211-2-765-1, R 1688-2150-5-2060-1, R 1698-168-1-76-1, R 1670-3975-1-485-1, R1629-234-5-1882-2, R 1700-302-1-156-1.
5	5-10%	Moderately Susceptible	16	R 1588-7-1-1-1, R 1630-32-1-21-1, R 1938-620-1-163-1, R 1656-3173-1-415-1, R 1779-320-1-111-1, R 1595-17-1-8-1, R 1648-2663-2-2862-1, R 1700-2240-4-2295-1, R 1730-501-3-250-1, R 1695-2155-1-270-1,R 1656-3181-1-420-1, R 1670-1151-1-119-1, R 1629-112-2-67-1,R 1757-540-3-286-1, R 1664-59-2-47-1, R 1738-504-3-255-1.
7	10-25%	Susceptible	3	R 1664-59-1-46-1, R 1926-1013-2-595-1, R 1553-1369-2-252-1.
9	More than 25%	Highly Susceptible	0	-Nil-

found significantly at par with each other i.e. R 1779-320-1-111-1(5.60%), R 1595-17-1-8-1(6.29%), R 1648-2663-2-2862-1(7.02%), R 1700-2240-4-2295-1(7.13%), R 1730-501-3-250-1(7.25%). In seven group four genotype were found significantly at par with each other i.e. R 1695-2155-1-270-1(7.30%), R 1656-3181-1-420-1 (8.12%) and R 1670-1151-1-119-1(8.54%), R 1629-112-2-67-1(8.97%). In present finding six genotypes were found highly susceptible against rice stem borer viz. R 1757-540-3-286-1(9.70%), R 1664-59-2-47-1(9.75%), R 1738-504-3-255-1(9.89%), R 1926-1013-2-595-1(10.56%), R 1553-1369-2-252-1(10.58%) and R 1664-59-1-46-1(10.74%), these genotype were found significantly similar with each other. During kharif 2013 rice stem borer damage was observed at maturity for total earheads and white earheads. Minimum average percent white earheads was recorded 1.02 in genotypes R 1661-1372-1-601-1 and maximum average percent was recorded 10.74 percentages in genotypes R 1664-59-1-46-1 given in table. From the study of 60 genotypes were found in the category of highly resistant and genotypes were found in the range of infestation up to 5% percent damage. These genotypes are suggested for further evaluation against rice stem borer below the threshold limit category remaining genotypes not considered for further evaluation against stem borer.

CONCLUSION

The finding indicate that according percentage damage in various category of resistant ,two genotypes are highly resistant ,four were resistant ,ten genotypes are moderately resistant eighteen were moderately susceptible and twenty six were in the category of susceptible in range of 10 to 25% leaf damage. The result are agree with other worker who reported earlier viz. Bandral and Sharma.,2007, Gupta et al.,2003, Hafeez et al.,2006, Kotwal and Makhmoor.,1991, Mandal et al.,1997, Mishra et al.,2002, Mishra et al.,2006, Ray et al.,1993 and Sudhakar et al.,1991. Rice stem borer infestation recorded at maturity in sixty varieties/genotypes result are discussed based on percent of infestation distributed in 0 - 9 scale for genotypes resistant from the sixty genotypes, seven were found in highly resistant category, non was found in resistant category, thirty four genotypes were in moderate resistant, sixteen genotypes were in moderate susceptible and three were in susceptible category highest infestation white earheads observed 10.74 percent.

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EFFECT OF DIFFERENT PLANTING SYSTEM AND SULPHUR LEVEL ON YIELD AND QUALITY OF CASTOR (*RICINUS COMMUNIS* L.) INTERCROPPED WITH CLUSTERBEAN [*CYAMOPSIS TETRAGONOLOBA* (L.) TAUB] UNDER BAEL BASED AGRI-HORTI SYSTEM

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Abstract: A field experiment was conducted during *kharif* season of 2013-14 at Agricultural Research Farm, Rajeev Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh, to investigate, "Effect of different planting system and sulphur level on yield and quality of castor (*Ricinus communis* L.) intercropped with clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] under bael based agri-horti system". The treatment comprised of 4 different planting systems (PS_1 =1:2), (PS_2 =1:4), (PS_3 =1:6), (PS_4 =1:8) as main plots and 3 levels of sulphur (S_1 =25 kg ha^{-1}), (S_2 =50 kg ha^{-1}), (S_3 =75 kg ha^{-1}) as sub plots replicated thrice in a split-plot design. Significantly improvement in the yield and yield attributes and quality of castor and clusterbean component crops was observed under PS_3, (1:6) treatment and application of (S_2), (50 kg ha^{-1}) recorded significantly higher, yield and yield attributes parameters and stalk yield of castor and clusterbean parameters. Similar effect of these treatments was observed on N, P, K, and Sulphur content and total uptake in grain and straw of castor and clusterbean treatments. And also recorded higher gross return (133955 Rs. ha^{-1}) with net returns (116285 Rs. ha^{-1}), and B: C ratio (6.58) under PS_3, (1:6) treatment.

Keywords: Planting system, Castor, Clusterbean, Sulphur, Intercropping, Bael, Agri-horti system

INTRODUCTION

Castor (*Ricinus communis* L.) is produced in more than 30 countries across the globe. However, India is the major producer and holds a giant share of around 83 per cent, of the total global production, followed by China 6 per cent, Brazil 5 per cent and Mozambique 4 per cent. India is the largest exporter and China is the net importer of castor oil. In India, Gujarat is the top producing state which contributes 63 per cent followed by Andhra Pradesh 19 per cent, Rajasthan 14 per cent and Maharashtra 2 per cent. India being the largest producer of castor in the world, area, production and productivity of castor in the country during 2011-12 was 11.50 lakh hectares, 16.19 lakh tonnes and 1417 kg ha^{-1} respectively. (Special Report on Castor Seed 3-4, 2011-12).

Castor (*Ricinus communis* L.) is most important oilseed crop of India due to the fact that its oil has diversified uses and has great value in foreign trade. Unfortunately, in India, castor along with other oilseed crops are raised under limited resource condition which leaving the crop thirsty and hungry by the resource poor farmers. However, as castor is a long duration, widely spaced crop with comparatively thin plant population as compared to other field crops, provide ample scope for growing intercrop in order to increase production from unit area of land.

The importance of sulphur in oilseeds, sulphur plays a significant role in the quality and development of seeds. Therefore, crops of oilseeds require a higher quantity of sulphur for proper growth and development for higher yields (Salwa *et al*., 2010). Sulphur is one of the essential elements required for plant growth and plays a major role in many plant processes. Sulphur plays an important role in enhancing the productivity and quality of oilseed crops by providing environment in the soil. Castor is an oilseed crop, so for the production of high oil content, sulphur is required. Today, sulphur is recognized as fourth major nutrient after nitrogen, phosphorus and potassium.

In agroforestry systems there are both ecological and economical interactions between the different components. In agroforestry, tree and agriculture crops are combined together and they compete with each other for growth resource such as light, water and nutrients. The resource sharing in component crop may result in complementary or competitive effect depending upon nature of species involved in the system. The incorporation of woody species into crop production system is one option that has received significant attention in recent years.

A field experiment was conducted at Agricultural Research Farm, Rajeev Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh (India). Which is situated in vindhyan region of district Mirzapur (25º 10' latitude, 82º 37' longitude and altitude of 147 meters above mean sea level) during *kharif* season, of 2013-14 on sandy loam soils containing 0.58 % organic carbon, bulk

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density 1.44 and particle density 2.65 g/cc, available nitrogen (177.2 kg ha^{-1}), low in available phosphorus (10 kg ha^{-1}), and potassium (115.7 kg ha^{-1}), having slightly acidic soil Ph (5.84). The experiment laid out in split-plot design with three replications. The treatments combination comprised 4 different planting system *viz.*, (PS_1 =1:2, 45 × 15 cm), (PS_2 =1:4, 22.5 × 15cm), (PS_3 =1:6, 15 × 15cm), (PS_4 =1:8, 11.25 × 15cm) in main plots and 3 sulphur levels (S_1 =25 kg ha^{-1}), (S_2 =50 kg ha^{-1}), (S_3 =75 kg ha^{-1}), in sub plots. Fertilizers were placed in planting system rows 8-10 cm below the surface. Full dose of sulphur as per treatments through elemental sulphur were applied just before sowing of crops. Castor "GCH – 4" and Clusterbean "RGC-1003" varieties of castor and clusterbean, respectively were used for experimental purpose. Sowing of the crops was done on 15 August in 2013. The spacing between row to row in castor was maintained 90 cm and plant to plant was maintained 45 cm. and for intercropping as well as clusterbean (PS_1 =1:2, 45 × 15 cm), (PS_2 =1:4, 22.5 × 15cm), (PS_3 =1:6, 15 × 15cm), (PS_4 =1:8, 11.25 × 15cm). The plants from net plots were harvested from the ground level and were left for sun drying *in- situ.* The castor and clusterbean were threshed manually. Grains were cleaned and weighed for expressing yield in kg ha^{-1}. The weight of the stalk was recorded separately and used for estimating stover yield. The observed data were analysed statistically using analysis of variance at 5 per cent level of significance.

Planting system brought a significantly variation in yield, yield attributes and quality of castor, *viz.*, except (days to 50% flowering, seed index (g), straw yield (q ha^{-1}), harvest index (%),oil content in seed (%),) no. of racemes $plant^{-1}$, no. of capsules $racemes^{-1}$, no. of seeds $plant^{-1}$, length of main spike (cm), seed yield $plant^{-1}$(g), , grain yield (q ha^{-1}), oil yield (q ha^{-1}), planting system (PS_3) recorded significantly higher value of yield and yield attributes of castor, remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments in (Table 1 & 2) and also planting system brought a significantly variation in yield and yield attributes of clusterbean. *viz.*, except [Harvest index (%)], no. of pods $plant^{-1}$, no. of seeds pod^{-1}, length of pod (cm), test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}), gum content (%),gum yield (q ha^{-1}) planting system (PS_3) recorded significantly higher value of yield and yield attributes of clusterbean remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments. in (Table 1 & 2). This might be due to the absence of competition between the main crop (castor) and intercropped (clusterbean) for growth resources such as nutrients, moisture, solar radiation because of shorter duration and non spreading nature of clusterbean. This can be attributed to the increase in plant height, dry matter accumulation $plant^{-1}$ under the different planting system. Short duration, short plant nature, non- bushiness and also neither complementary non competitive nature of intercrops did not influence the growth parameters. Because of the harvested of intercropped as well as clusterbean. PS_3 treatment recorded the higher yield attributes and yield due better availability of resources. The results of the present investigation are in close proximity with the finding of Kumar *et al* (2002) and reported that a wide spacing 90 cm × 60 cm increased all the growth parameters like plant height, dry matter $plant^{-1}$. This result is in close proximity with the findings of Patel and Patel (2004).

Application of sulphur with 50 (kg ha^{-1}) (S_2) treatment significantly recorded higher values of yield and yield attributes of castor except [days to 50% flowering, harvest index (%)] and clusterbean [Harvest index (%)] remained at par with (S_3) 75 (kg ha^{-1}) treatments. The results are also in close proximity with the finding of Fyzee and Raju (1991).It may be attributed to the fact that application of sulphur improved not only availability of S but other nutrient to which are considered vitally important for growth and development of plants. Being an essential constituent of several biologically active compounds like amino acids (cystine, cysteine and methionine), vitamins (thiamine and biotin), lipoic acid and S play multiple role in the plant metabolism might have been helped in terms of vigorous root growth, formation of chlorophyll, resulting in higher photosynthesis. The increase in yield attributes might be due to the fact that increment in supply of S the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased, resulting in more flower and capsules. When supply of sulphur optimum, grater translocation of photosynthesis occurs from leave to the site *i.e.* capsules and seed yield.

Different planting system had significant effect on total N_2, P_2O_5, K_2O and Sulphur uptake by castor and clusterbean during the year of study in (Table: - 3) planting system (PS_3) recorded significantly except (K_2O in clusterbean) higher value of total N_2, P_2O_5, K_2O and Sulphur uptake and remained at par with (PS_2) when compared with (PS_4) and (PS_1) treatments in (Table 3).

Sulphur levels showed remarkable recorded maximum improvement in N_2, P_2O_5, K_2O and Sulphur uptake by castor and clusterbean under application of sulphur with 50 (kg ha^{-1}) (S_2) treatments remained at par with (S_3) 75 (kg ha^{-1}) treatments and minimum was observed under the treatments (S_2) 50 (kg ha^{-1}). This may be attributed to less competition among the crop plants for all the available resources.

Intercropping system remains significantly superior in enhancing the gross return as compared to other treatment. Among the different planting system (table: - 3) treatment recorded the highest gross returns (`133955 Rs.ha^{-1}), net return (116285 Rs. ha^{-}

^{1}), and as well as B: C ratio (6.58), was recorded the highest in PS_3 (1:6) treatment. Closely followed by PS_2 treatments. The higher gross returns realized with intercropping systems was attributed to better performance of component crops castor + clusterbean witch have produced higher equivalent yield compared to their respective sole crops. The higher net returns with castor + clusterbean was due to higher complimentarily between these two component crops which produced higher yield and their by higher net returns. Though, intercrops yields were lower than their respective sole crops yield, but they produced higher equivalent yield and income in combination. The higher B : C ratio with these treatment combination crops, which gave higher productivity and net returns helping in getting higher benefit : cost ratio. The results are also in close proximity with the finding of Neginhal*et al*. (2011).

Among the sulphur levels, the highest gross return with (125925 Rs. hs^{-1}) net return (108405 Rs. hs^{-1}), and B : C ratio (6.19) was obtained with S_2 (50 kg ha^{-1}) treatment. The application of 50 kg ha^{-1} provided favorable environment for the production and economics value of castor and clusterbean.

Table 1. Effect of different planting system and sulphur level on yield and yield attributes of castor and clusterbean.

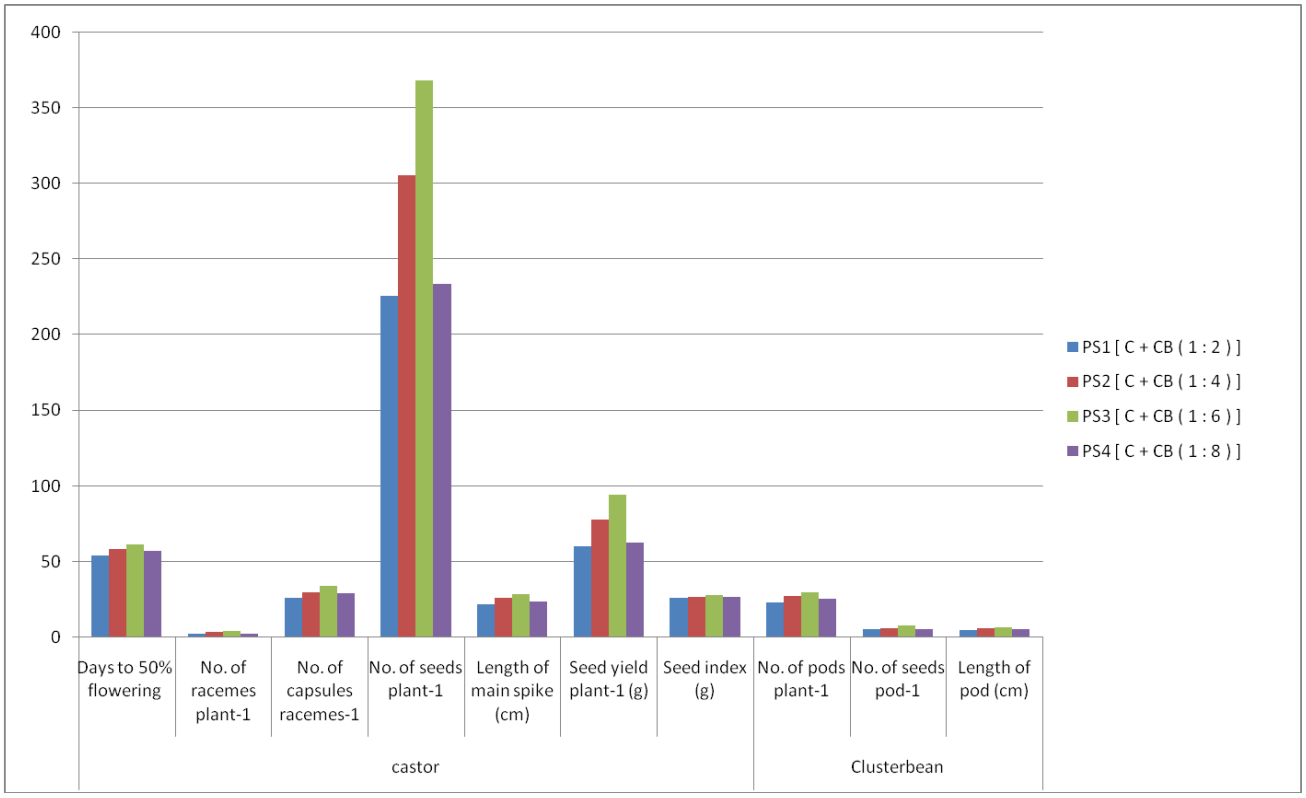
Treatments	Castor							Clusterbean		
	Days to 50% flowering	**No. of racemes plant^{-1}**	**No. of capsules racemes^{-1}**	**No. of seeds plant^{-1}**	**Length of main spike (cm)**	**Seed yield plant^{-1} (g)**	**Seed index (g)**	**No. of pods plant^{-1}**	**No. of seeds pod^{-1}**	**Length of pod (cm)**
A) Different Planting System										
PS_1 [C + CB (1 : 2)]	54.3	2.5	25.9	225.8	22.1	60.0	26.4	22.8	5.3	5.0
PS_2 [C + CB (1 : 4)]	58.5	3.4	30.0	305.2	26.4	77.7	26.8	27.3	6.3	5.8
PS_3 [C + CB (1 : 6)]	61.3	4.0	34.1	367.5	28.4	94.0	28.1	29.5	7.7	6.4
PS_4 [C + CB (1 : 8)]	57.0	2.7	29.1	233.6	23.8	62.9	26.5	25.3	5.6	5.3
SEm±	2.13	0.06	1.12	9.60	0.39	2.94	0.48	0.22	0.07	0.08
C.D. (P=0.05)	NS	0.21	3.89	33.23	1.34	10.16	NS	0.75	0.24	0.29
B) Sulphur Level (kg ha^{-1})										
S_1 (25)	54.8	2.9	27.7	247.1	23.3	64.0	25.8	25.2	5.8	5.1
S_2 (50)	59.6	3.3	31.8	319.3	27.2	80.8	28.2	27.2	6.6	6.1
S_3 (75)	58.9	3.2	29.8	282.7	25.0	76.2	27.0	26.3	6.3	5.6
SEm±	1.84	0.09	0.26	9.62	0.27	2.23	0.47	0.10	0.05	0.01
C.D. (P=0.05)	NS	0.27	0.77	28.83	0.82	6.69	1.40	0.31	0.15	0.02

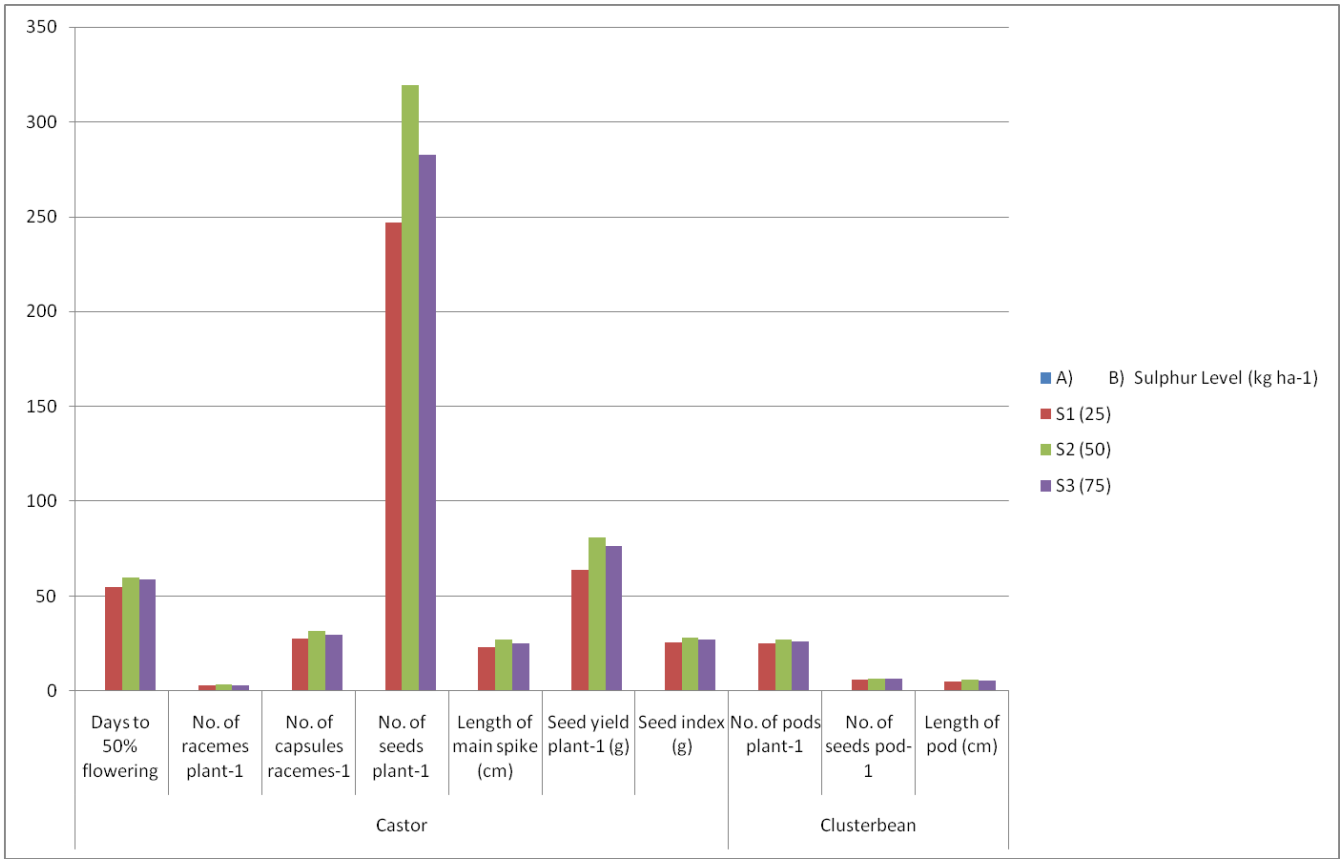
Table 2. Effect of different planting system and sulphur level on yield and quality of castor and clusterbean.

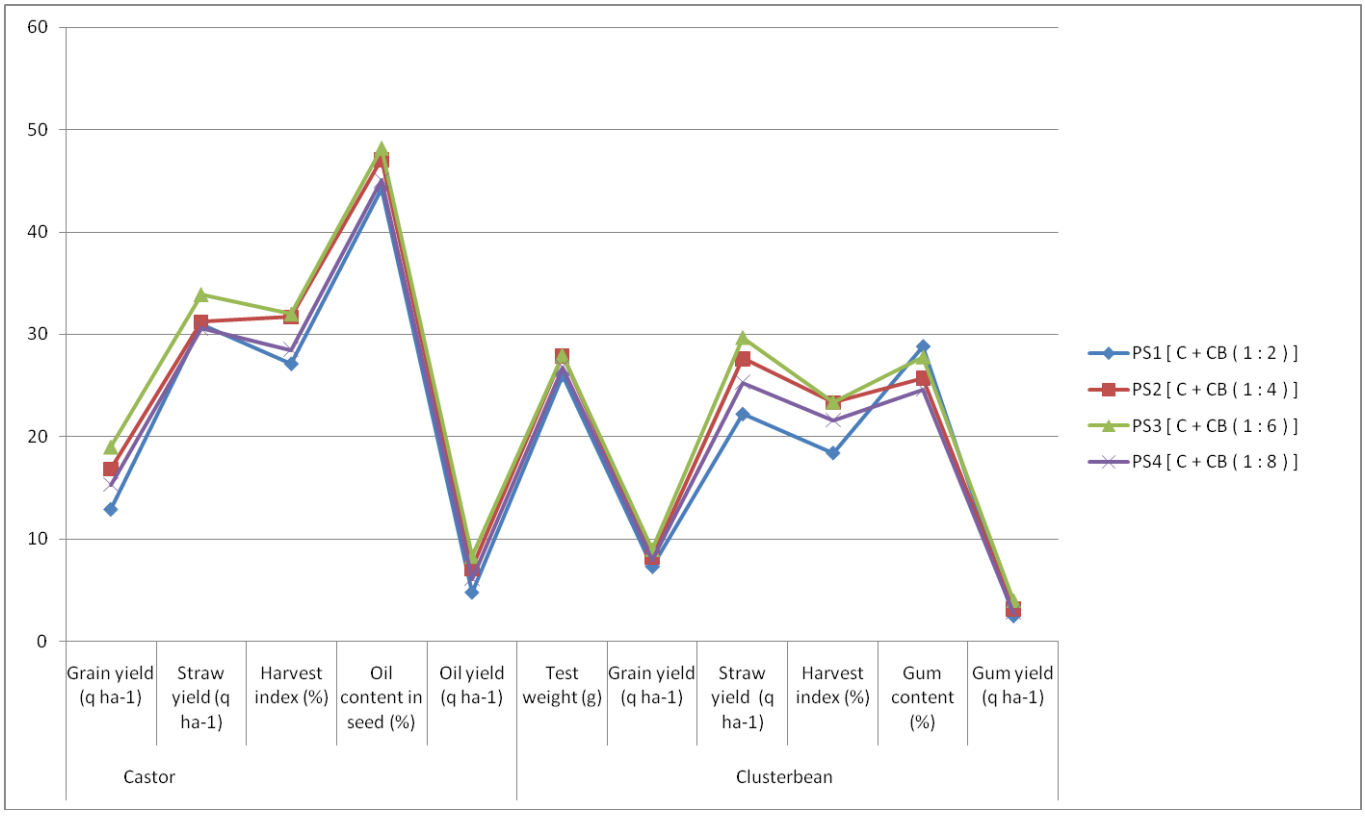
Treatment	Castor					Clusterbean					
	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Oil content in seed (%)	Oil yield (q ha^{-1})	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Gum content (%)	Gum yield (q ha^{-1})
A) Different Planting System											
PS_1 [C + CB (1 : 2)]	12.9	31.0	27.1	44.2	4.8	26.0	7.3	22.2	18.4	28.8	2.5
PS_2 [C + CB (1 : 4)]	16.8	31.2	31.7	47.1	7.1	27.9	8.2	27.6	23.3	25.7	3.1
PS_3 [C + CB (1 : 6)]	19.0	33.9	32.0	48.2	8.3	28.0	9.0	29.7	23.4	27.8	4.0
PS_4 [C + CB (1 : 8)]	15.3	30.6	28.5	45.1	6.1	26.8	8.0	25.3	21.6	24.6	2.8
SEm±	0.90	1.38	1.34	1.74	0.30	0.11	0.07	0.23	0.59	0.19	0.06
C.D. (P=0.05)	3.10	NS	NS	NS	1.03	0.38	0.24	0.79	NS	0.67	0.20
B) Sulphur Level (kg ha^{-1})											
S_1 (25)	14.4	27.2	28.5	41.1	4.8	26.9	7.7	25.8	21.2	23.5	2.9
S_2 (50)	17.6	35.4	30.8	50.9	8.4	27.8	8.5	26.7	22.0	26.9	3.3
S_3 (75)	16.0	32.4	30.2	46.5	6.6	27.4	8.1	26.2	21.9	25.2	3.1
SEm±	0.84	1.02	0.88	0.84	0.62	0.05	0.01	0.04	0.54	0.11	0.01
C.D. (P=0.05)	2.52	3.06	NS	2.51	1.85	0.15	0.03	0.11	NS	0.32	0.03

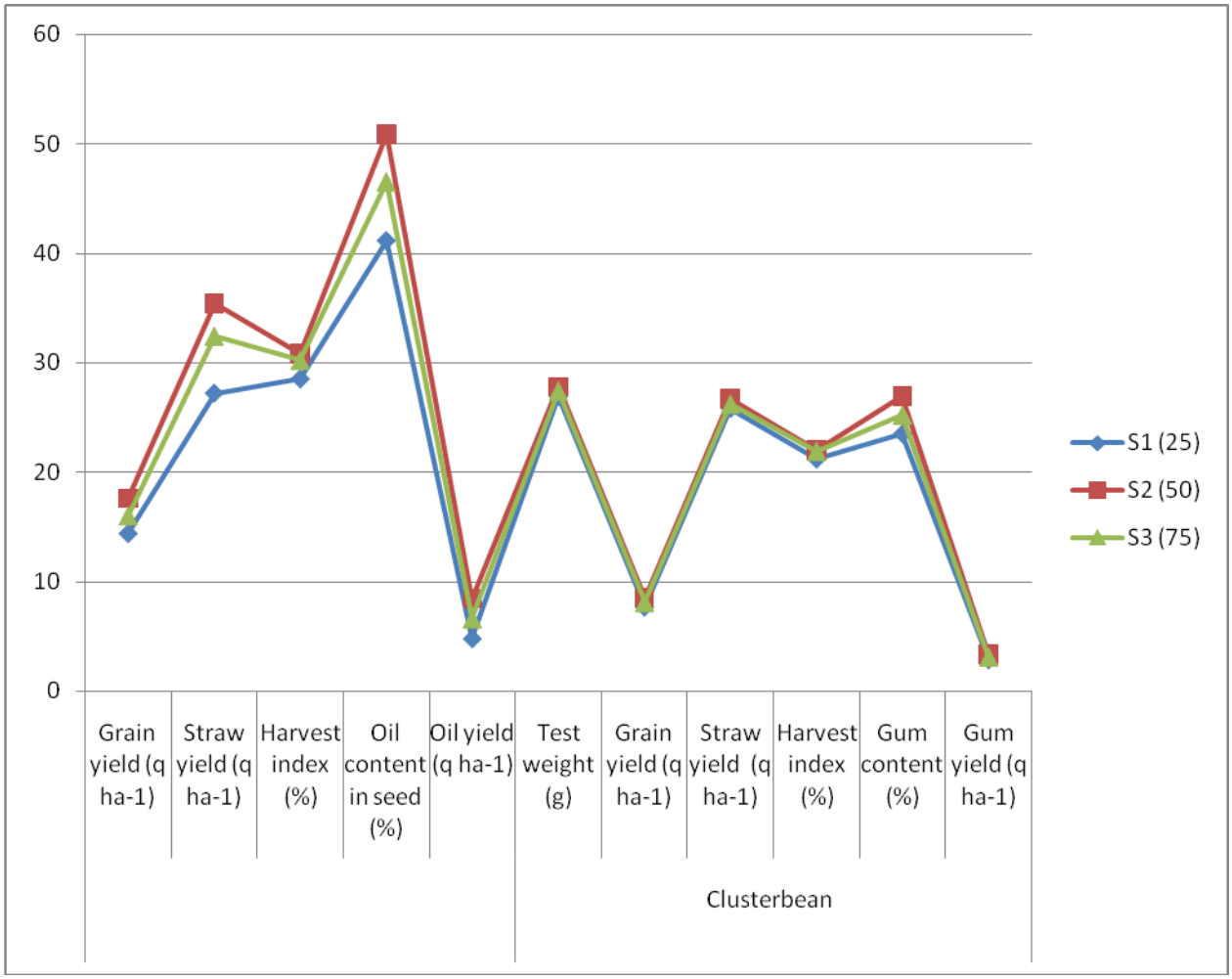
Table 3. Effect of different planting system and sulphur level on N, P_2O_5, K_2O and S total uptake [(kg ha^{-1}) Grain + Straw] and Economics of castor and clusterbean

Treatment	Castor		Clusterbean				Economics (ha^{-1})		
	N	S	N	P	K	S	Gross return	Net return	B : C Ratio
A) Different Planting System									
PS_1 [C + CB (1 : 2)]	40.5	6.2	42.9	6.5	26.8	5.9	102100	84964	4.96
PS_2 [C + CB (1 : 4)]	56.5	8.1	57.6	8.8	30.8	9.6	121660	104290	6.00
PS_3 [C + CB (1 : 6)]	67.7	9.2	74.2	10.3	36.6	11.8	133955	116285	6.58
PS_4 [C + CB (1 : 8)]	48.6	7.2	50.1	8.0	29.6	7.8	114805	96835	5.39
SEm±	1.55	0.23	0.68	0.08	1.63	0.14			
C.D. (P=0.05)	5.38	0.81	2.36	0.29	5.65	0.49			
B) Sulphur Level (kg ha^{-1})									
S_1 (25)	43.8	6.5	50.6	7.8	30.5	7.6	110110	94840	6.21
S_2 (50)	61.9	8.7	62.0	9.0	31.3	10.0	125925	108405	6.19
S_3 (75)	54.4	7.8	55.9	8.5	31.0	8.7	118010	98190	4.95
SEm±	1.94	0.25	0.48	0.05	1.35	0.04			
C.D. (P=0.05)	5.82	0.74	1.45	0.16	NS	0.11			




350
300
250
200
150
100
50
0
Days to 50% flowering
No. of racemes plant-1
No. of capsules racemes-1
No. of seeds plant-1
Length of main spike (cm)
Seed yield plant-1 (g)
Seed index (g)
No. of pods plant-1
No. of seeds pod-1
Length of pod (cm)
Castor
Clusterbean
A) B) Sulphur Level (kg ha-1)
S1 (25)
S2 (50)
S3 (75)


60
50
40
30
20
10
0
Grain yield (q ha-1)
Straw yield (q ha-1)
Harvest index (%)
Oil content in seed (%)
Oil yield (q ha-1)
Test weight (g)
Grain yield (q ha-1)
Straw yield (q ha-1)
Harvest index (%)
Gum content (%)
Gum yield (q ha-1)
Castor
Clusterbean
PS1 [C + CB (1 : 2)]
PS2 [C + CB (1 : 4)]
PS3 [C + CB (1 : 6)]
PS4 [C + CB (1 : 8)]



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PHENOLOGICAL EFFICIENCY AND YIELD TRAITS OF RICE (*ORYZA SATIVA* L.) UNDER DIFFERENT MOISTURE REGIMES

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Abstract: Among the breeding lines R-RF-90, Mahamaya and MTU-1010 ranked relatively superior regarding there morpho- physiological and yield traits. Least reduction in yield was noticed in R-RF-89 and Vandana in rainfed and transplanted (TSD) condition. Mahamaya (57.88) exhibited maximum time to initiates the panicle followed by IR-64 (56.63). The maximum days taken to anthesis was recorded under rainfed condition (65.40) followed by irrigated (57.79) and transplanted (57.45). Mahamaya (68) exhibited maximum time to anthesis. Days to 50 % flowering was noticed maximum in rainfed condition (70.11) followed by irrigated (62.42) and transplanted (62.08). Direct sown (60.51) recorded minimum time to attain 50% flowering. Mahamaya (72.75) exhibited maximum time to days to 50 % flowering followed by IR-64 (71.38). Genotypes in direct sown condition (112.97) recorded more time to mature under different moisture regimes followed by irrigated (101.05) and rainfed condition (90.8). Rice genotypes in transplanted condition (88.25) exhibited minimum time to mature as compared to other moisture regimes. Mahamaya (110.13) exhibited maximum time to days to maturity followed by IR-64 (109.63). Among the breeding lines R-RF-90, Mahamaya and MTU-1010 ranked relatively superior regarding there morpho- physiological and yield traits. Least reduction in yield was noticed in R-RF-89 and Vandana in rainfed and transplanted (TSD) condition.

Keywords: Rice, Moisture regimes, Traits, *Oryza sativa*

INTRODUCTION

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planet's human population. Rice is an integral part of creation myth and remains today as leading crop and most preferred food (Huke and Huke, 1997). Rice a member of the family Poaceae originated from South-East Asia and in the Asia, where more than 90% of world's rice is produced and consumed (Li and Xu, 2007) thus rice is immensely important to food security of Asia. About 23 million hectare of Asian rice area experienced present yield loss due to drought (Widawsky and O'Toole, 1990). More than 70 % of the rice area of Eastern India is rainfed even when the total rainfed is adequate, shortage at critical period reduced the yield . Since the rainfed ecosystem of Eastern India is highly variable and unpredictable, which can range from normal situation to severe drought condition, therefore identification of a stable genotype performing well under all the expected conditions under target population of environment is required. Pandey *et al.* (2005) observed that in Eastern India terminal drought is the most frequent type and severly affects the yield.

MATERIAL AND METHOD

The experimental site was located at Instructional cum-Research Farm, College of Agriculture, IGKV, Raipur (C.G.) during *kharif*, 2010. Raipur is situated in central part of Chhattisgarh and lies at latitude, longitude of 21°16' N, 81°26' E, respectively and 290.20 meters above mean sea level. It receives an average annual rainfall of 1326 mm (based on 80 years mean). The experiment was conducted in four different environment (Direct sown, transplanted (TSD), rainfed and irrigated) using SPD with two replications. The experimental details are as follows.

Experiment I	**Direct sown**	**Experiment II**	**Transplanted condition (TSD)**
Design	**: SPD**	Design	**: SPD**
Replications	**: 2**	Replications	**: 2**
Replication to replication distance	**: 1 m**	Replication to replication distance	**: 1 m**
Crop	**: Rice (*Oryza sativa* L.)**	Crop	**: Rice (*Oryza sativa* L.)**
Plot size	**: 3x1 mtr.**	Plot size	**: 3.80x0.60 mtr.**
Spacing (row to row)	**: 20 cm.**	Spacing	**: 20x20 cm.**

*Corresponding Author

Treatments	**: 48 genotypes**	Treatments	**: 48 genotypes**
Date of Sowing	**: 25th June, 2010**	Date of Sowing	**: 15th July, 2010**
Experiment III	**Rainfed condition**	**Experiment IV**	**Irrigated condition**
Design	**: SPD**	Design	**: SPD**
Replications	**: 2**	Replications	**: 2**
Replication to replication distance	**: 1 m**	Replication to replication distance	**: 1 m**
Crop	**: Rice (Oryza sativa L.)**	Crop	**: Rice (Oryza sativa L.)**
Plot size	**: 2.20x1.60 mtr.**	Plot size	**: 3x2 mtr.**
Spacing	**: 20x20 cm.**	Spacing	**: 20x20 cm.**
Treatments	**: 48 genotypes**	Treatments	**: 48 genotypes**
Date of Sowing	**: 24th June, 2010**	Date of Sowing	**: 18th June, 2010**

Experimental materials used for the study:

S. No.	Genotypes	S. No	Genotypes
1.	R-1838-RF-41	**25.**	R-RF-88
2.	R-1839-RF-42	**26.**	R-RF-80
3.	R-1837-RF-40	**27.**	R-RF-89
4.	R-RF-69	**28.**	R-RF-90
5.	IR70215-70-CPA	**29.**	R-RF-81
6.	Annnada	**30.**	R-RF-82
7.	MTU 1010	**31.**	R-RF-91
8.	IR-64	**32.**	R-RF-83
9.	Mahamaya	**33.**	R-RF-92
10.	Poornima	**34.**	R-RF-93
11.	Samleshwari	**35.**	R-RF-94
12.	Vandana	**36.**	R-RF-95
13.	Dagad deshi	**37.**	IR 84899-B-183-C
14.	Danteshwari	**38.**	IR 84899-B-185-C
15.	R-RF-84	**39.**	IR 72667-16-1-B-P
16.	R-RF-74	**40.**	R-RF-96
17.	R-RF-75	**41.**	R-RF-97
18.	R-RF-76	**42.**	R-RF-98
19.	R-RF-85	**43.**	R-RF-99
20.	R-RF-77	**44.**	R-RF-100
21.	R-RF-78	**45.**	R-RF-101
22.	R-RF-79	**46.**	R-RF-102
23.	R-RF-86	**47.**	R-RF-103
24.	R-RF-87	**48.**	R-RF-104

The size of each nursery beds were 1 x 25 cm drainage channel of 30 cm width was provided between the beds. The basal dose of fertilizers was given at the time of nursery bed preparation @ 80 kg N_2, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. The fertilizers were applied as per the requirement of crop. 80:60:60 kg ha^{-1} N: P: K were applied in the form of urea, DAP and MOP, respectively. After transplanting the soil was kept saturated until seedlings were get established in four sites *i.e.* direct sown, transplanted (TSD), rainfed and irrigated. In direct sown condition irrigation was not provided, in transplanted (TSD) condition water was not provided after 50% flowering, in rainfed site the irrigation was not provided until maturity and in irrigated site after establishment of seedling 5$\pm$2cm standing water was maintained throughout the growing period. Phenological parameters were days to panicle

initiation, days to anthesis, days to flowering, days to maturity. Experimental data were analyzed statistically adopting the technique of analysis of variance (ANOVA) for Split Plot Design (SPD). The level of significance was observed at 5 percent probability (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Phenological Parameters

Days to panicle initiation

In rainfed condition (55.13) rice genotypes took more time to initiate the panicle under different moisture regimes followed by direct sown (53.88) and transplanted condition (50.99) while in irrigated condition (40.58) rice genotypes took minimum time to initiates panicle. On the basis of average performance in four environments Mahamaya (57.88) exhibited maximum time to initiates the panicle followed by IR-64 (56.63). In all the genotypes variability in panicle initiation ranged between 45.50 to 57.88 days. However R-RF-91 (45.50) exhibited minimum period for panicle initiation. In few breeding lines delay in days to panicle initiation was observed in rainfed condition as compared to irrigated one. Similar findings were also reported by Anugus *et al.* (1993). Lilley and Fukai, (1994) have also correlated water deficit condition with phenological development and suggested that water deficit can only delay or advance the phenological phases.

Days to anthesis

The maximum days taken to anthesis was recorded under rainfed condition (65.40) followed by irrigated (57.79) and transplanted (57.45). The minimum was recorded under direct sown condition (55.92).On the basis of average performance in four environments Mahamaya (68) exhibited maximum time to anthesis. Genotype IR-64 (66.38) also showed comparable results with Mahamaya. In all the genotypes variability in anthesis ranged between 54.37 to 68 days. However R-RF-103 (54.37) exhibited minimum period for anthesis.

Days to 50 % flowering

The results clearly showed that days to 50 % flowering varied significantly due to different moisture regimes. Days to 50 % flowering was noticed maximum in rainfed condition (70.11) followed by irrigated (62.42) and transplanted (62.08). Direct sown (60.51) recorded minimum time to attain 50% flowering. On the basis of average performance in four environments Mahamaya (72.75) exhibited maximum time to days to 50 % flowering followed by IR-64 (71.38). In all the genotypes variability in days to 50 % flowering ranged between 58.38 to 72.75 days. However Vandana (58.38) exhibited minimum period for days to 50 % flowering.

Days to maturity

Genotypes in direct sown condition (112.97) recorded more time to mature under different moisture regimes followed by irrigated (101.05) and rainfed condition (90.8). Rice genotypes in transplanted condition (88.25) exhibited minimum time to mature as compared to other moisture regimes. On the basis of average performance in four environments Mahamaya (110.13) exhibited maximum time to days to maturity followed by IR-64 (109.63). In all the genotypes variability in days to maturity ranged between 98.50 to 110.13 days. However R-RF-69 (93.5) exhibited minimum period for days to maturity.

Table 1. Effect of different moisture regimes on phenological parameters of different rice genotypes

Treatments	Days to Panicle Initiation	Days to Anthesis	Days to 50% Flowering	Days to Maturity
Different Moisture Regimes				
M_1 – Direct Sown	53.88	55.92	60.51	112.97
M_2-Transplantad(TSD) Condition	50.99	57.45	62.08	88.25
M_3 –Rainfed Condition	55.13	65.40	70.11	90.80
M_4 – Irrigated Condition	40.58	57.79	62.42	101.05
SEm +	**0.11**	**0.56**	**0.63**	**0.09**
CD at 5%	**0.51**	**2.56**	**2.86**	**0.40**
Genotypes	**Mean**	**Mean**	**Mean**	**Mean**
V_1- R-1838-RF-41	49.63	55.75	60.88	98.38
V_2- R-1839-RF-42	50.75	59.75	63.38	95.75
V_3- R-1837-RF-40	51.00	60.63	65.00	96.63
V_4- R-RF-69	49.50	58.88	63.13	93.50
V_5- IR70215-70-CPA	50.75	59.75	63.75	96.38
V_6- Annnada	50.25	58.75	63.50	95.88

V_7- MTU 1010	53.13	64.88	69.25	102.50
V_8- IR-64	56.63	66.38	71.38	109.63
V_9- Mahamaya	57.88	68.00	72.75	110.13
V_{10}- Poornima	50.38	59.88	64.13	96.88
V_{11}- Samleshwari	53.13	61.63	65.88	102.63
V_{12}- Vandana	46.13	53.88	58.38	91.00
V_{13}- Dagad deshi	49.75	57.25	60.88	98.38
V_{14}- Danteshwari	52.88	58.50	63.38	97.75
V_{15}- R-RF-84	48.38	56.25	61.13	97.38
V_{16}- R-RF-74	49.75	57.50	62.50	97.13
V_{17}- R-RF-75	47.88	56.50	61.38	94.63
V_{18}- R-RF-76	48.50	58.63	63.13	93.75
V_{19}- R-RF-85	49.00	60.63	64.88	95.75
V_{20}- R-RF-77	51.25	58.88	63.00	96.13
V_{21}- R-RF-78	52.75	60.38	65.00	95.75
V_{22}R-RF-79	50.00	59.88	64.50	99.00
V_{23}- R-RF-86	48.88	60.50	65.00	100.13
V_{24}- R-RF-87	51.00	61.63	66.88	101.13
V_{25}- R-RF-88	48.63	56.50	61.88	96.88
V_{26}- R-RF-80	49.88	57.25	62.25	97.75
V_{27}- R-RF-89	49.88	58.13	63.38	98.00
V_{28}- R-RF-90	52.13	57.25	62.25	97.13
V_{29}- R-RF-81	49.50	58.50	63.13	98.75
V_{30}- R-RF-82	48.88	57.63	63.00	96.38
V_{31}- R-RF-91	45.50	58.50	63.38	96.88
V_{32}- R-RF-83	49.00	57.25	62.38	97.00
V_{33}- R-RF-92	47.50	60.25	64.25	97.75
V_{34}- R-RF-93	51.50	59.75	64.25	100.75
V_{35}- R-RF-94	53.38	60.38	65.13	101.13
V_{36}- R-RF-95	48.13	58.50	63.25	102.38
V_{37}- IR 84899-B-183-C	53.00	61.75	67.13	102.88
V_{38}- IR 84899-B-185-C	50.25	60.88	65.13	98.88
V_{39}- IR 72667-16-1-B-P	53.50	62.75	67.00	96.75
V_{40}- R-RF-96	46.13	58.63	63.38	95.38
V_{41}- R-RF-97	50.00	58.88	63.25	101.13
V_{42}- R-RF-98	52.50	60.50	64.25	97.00
V_{43}- R-RF-99	52.75	60.75	64.50	99.25
V_{44}- R-RF-100	47.25	56.375	60.63	96.75
V_{45}- R-RF-101	47.63	56.25	61.63	97.13
V_{46}- R-RF-102	47.75	57.875	62.75	99.50
V_{47}- R-RF-103	46.38	54.375	60.25	97.25
V_{48}- R-RF-104	46.75	55.12	60.12	98.12
SEm ±	**0.44**	**0.78**	**0.62**	**0.31**
CD at 5%	**1.24**	**2.19**	**1.75**	**0.87**
I (M x V)	**S**	**S**	**S**	**S**

Yield Determinants

The maximum number of panicle plant^{-1} was recorded in irrigated condition (14.41) which was significantly highest among different moisture regimes. In the same way transplanted condition (12.75) followed by rainfed condition (11.10) stands after irrigated ones. The lowest number of panicle plant^{-1} was recorded under direct sown condition (2.93). On the basis of mean value of number of panicle plant^{-1} (four environments) MTU-1010 (12.30) exhibited highest value of number of panicle plant^{-1}. However R-RF-82 (7.84) exhibited minimum value of number of panicle plant^{-1}.Highest test weight of rice seeds was obtained with rainfed condition (16.08 g) however it was statistically at par with irrigated condition (15.97 g). Lowest test weight was recorded under direct sown condition (14.65 g). R-RF-84 (19.33 g) followed by Mahamaya (18.01 g) exhibited highest value of test weight. However R-RF-102 (12.19 g) exhibited minimum value of test weight. The maximum number of grains panicle^{-1} was found under irrigated condition (131.43),

however it was statistically similar with direct sown condition (124.37). Under transplanted condition (84.06), it results lower number of grains panicle^{-1}. R-RF-95 (189.94) exhibited highest value of number of grains panicle^{-1}. However R-RF-83 (86.91) exhibited minimum value of number of grains panicle^{-1}. Among different moisture regimes, significantly maximum grain yield was recorded under irrigated condition (54.74 q ha^{-1}) which was statistically at par with rainfed condition (50.22), while minimum grain yield was obtained under direct sown condition (42.25).On the basis of mean value of grain yield (four environments) R-RF-69 (63.74 q ha^{-1}) similar with other six genotypes namely R-RF-78 (60.91 q ha^{-1}), R-RF-85 (35.44q ha^{-1}), R-1839-RF-42 (58.77 q ha^{-1}), R-1838-RF-41 (58.389 q ha^{-1}), IR-70215-70-CPA (57.34 q ha^{-1}) and R-RF-104 (56.28 q ha^{-1}) produced highest grain yield. However R-RF-86 (35.44 q ha^{-1}) exhibited minimum value of grain yield. Drought is a major cause of yield loss in rainfed rice. Stress caused mean yield reduction of 64 % across populations (Venuprasad *et al.*, 2007). Wide range of variability for yield attributing traits has been reported by other workers (Chauhan and Tandon, 1984; Singh *et al.*, 1984; Gomathinayagam *et al.*, 1990; Patil *et al.*, 1993). Maintenance of leaf water potential just prior to flowering is associated with higher panicle water potential, reduced delay in flowering time and reduced spikelet sterility and hence contributes to higher yield (Fukai *et al.*, 1999). Among different moisture regimes, significantly maximum biological yield of rice genotypes was recorded under irrigated condition (158.25 q ha^{-1}) followed by direct sown (124.51 q ha^{-1}) and rainfed condition (114.49 q ha^{-1}) whereas, minimum was obtained under transplanted conditions (97.43 q ha^{-1}). Samleshwari (153.82 q ha^{-1}) attained maximum value of biological yield followed by MTU-1010 (147.69 q ha^{-1}), IR-64 (146.47 q ha^{-1}), Mahamaya (146.35 q ha^{-1}) and IR-70215-70-CPA (145.77 q ha^{-1}). However R-RF-86 (100.66 q ha^{-1}) exhibited minimum value of biological yield. Amongst different moisture regimes genotypes in transplanted condition gave significantly maximum harvest index (47.18 %) of rice. The lowest harvest index was recorded in direct sown condition (34.72 %). R-RF-78 (51.68 %) and similar with R-RF-69 (49.32 %), R-1838-RF-41 (48.22 %), R-RF-85 (47.35 %), R-1839-RF-42 (46.90 %) and Vandana (44.35 %) exhibited highest value of harvest index. However R-1837-RF-40 (23.31 %) exhibited minimum value of harvest index.

Table 2. Effect of different moisture regimes on yield attributes of different rice genotypes

Treatments **Different Moisture Regimes**	**No. of Panicle plant^{-1}**	**No. of Grain Panicle^{-1}**	**Biological yield (q ha^{-1})**	**Grain yield (q ha^{-1})**	**Harvest Index (%)**	**Test Weight**
M_1 – Direct sown	2.93	124.37	124.51	42.25	34.72	14.65
M_2-Transplantad(TSD) Condition	12.75	84.06	97.43	46.03	47.18	15.58
M_3 –Rainfed Condition	11.10	98.86	114.49	50.22	43.92	16.08
M_4 – Irrigated Condition	14.41	131.43	158.25	54.74	34.75	15.97
SEm ±	**0.21**	**3.59**	**5.21**	**1.69**	**0.54**	**0.09**
CD at 5%	**0.94**	**16.15**	**23.46**	**7.61**	**2.43**	**0.41**
Genotypes	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
V_1- R-1838-RF-41	11.33	104.69	121.76	58.39	48.22	15.45
V_2- R-1839-RF-42	10.31	109.20	127.86	58.78	46.90	16.99
V_3- R-1837-RF-40	11.14	119.88	127.81	52.74	41.80	14.90
V_4- R-RF-69	11.61	107.31	130.50	63.74	49.32	16.44
V_5- IR70215-70-CPA	11.33	114.64	145.77	57.34	40.19	15.79
V_6- Annnada	10.96	98.69	128.73	54.59	43.27	15.60
V_7- MTU 1010	12.30	104.58	147.69	52.66	37.57	16.23
V_8- IR-64	11.06	98.23	146.47	43.65	31.16	16.28
V_9- Mahamaya	11.16	140.03	146.35	51.51	35.74	18.01
V_{10}- Poornima	10.34	115.69	104.37	40.74	40.11	14.59
V_{11}- Samleshwari	8.86	144.24	153.82	51.55	34.38	12.91
V_{12}- Vandana	9.88	110.44	102.95	42.79	44.35	15.18
V_{13}- Dagad deshi	9.18	98.29	117.13	42.19	32.78	13.49
V_{14}- Danteshwari	10.36	99.44	114.79	40.50	37.75	15.14
V_{15}- R-RF-84	9.68	88.65	124.44	52.77	42.66	19.33
V_{16}- R-RF-74	9.49	94.44	133.56	45.43	34.82	14.43
V_{17}- R-RF-75	9.89	110.33	124.88	49.27	40.20	16.00
V_{18}- R-RF-76	10.61	115.65	125.55	49.64	40.12	17.69

V_{19}- R-RF-85	10.90	103.15	130.76	59.33	47.35	13.83
V_{20}- R-RF-77	10.09	120.06	121.58	50.37	41.85	16.74
V_{21}- R-RF-78	11.51	98.55	122.36	60.91	51.68	17.95
V_{22}R-RF-79	10.34	117.48	104.12	38.32	37.52	16.56
V_{23}- R-RF-86	10.34	101.69	100.66	35.44	36.37	12.79
V_{24}- R-RF-87	9.41	89.65	130.36	40.52	32.35	14.38
V_{25}- R-RF-88	11.54	110.53	122.95	50.81	41.90	15.89
V_{26}- R-RF-80	9.33	108.46	113.36	46.69	41.63	16.26
V_{27}- R-RF-89	10.34	120.13	103.08	39.24	38.00	15.78
V_{28}- R-RF-90	10.08	106.09	122.23	48.62	40.62	13.93
V_{29}- R-RF-81	9.58	128.79	118.11	43.82	38.00	14.85
V_{30}- R-RF-82	7.84	110.85	122.16	50.29	42.08	15.98
V_{31}- R-RF-91	8.74	125.66	118.24	41.30	36.99	16.18
V_{32}- R-RF-83	8.84	86.91	123.24	51.04	42.56	15.80
V_{33}- R-RF-92	9.26	100.21	125.19	50.82	41.71	14.61
V_{34}- R-RF-93	11.15	116.04	110.99	48.26	44.96	16.36
V_{35}- R-RF-94	10.65	96.66	123.32	48.60	40.26	17.15
V_{36}- R-RF-95	10.65	189.94	114.10	54.98	49.18	15.84
V_{37}- IR 84899-B-183-C	9.75	124.60	112.69	48.40	44.47	16.41
V_{38}- IR 84899-B-185-C	11.30	108.88	131.44	44.57	33.96	16.36
V_{39}- IR 72667-16-1-B-P	11.23	108.71	136.44	45.33	33.76	15.64
V_{40}- R-RF-96	11.56	91.20	111.62	45.73	41.60	16.69
V_{41}- R-RF-97	9.48	110.16	127.83	51.58	40.38	15.71
V_{42}- R-RF-98	10.07	99.18	137.82	43.22	34.52	13.89
V_{43}- R-RF-99	9.84	101.19	134.80	45.44	35.20	13.50
V_{44}- R-RF-100	10.38	91.93	103.85	41.22	40.17	15.51
V_{45}- R-RF-101	10.69	101.74	120.78	43.60	37.34	16.20
V_{46}- R-RF-102	9.14	113.79	124.23	41.02	33.30	12.19
V_{47}- R-RF-103	10.16	135.99	104.33	44.91	44.12	13.19
V_{48}- R-RF-104	10.54	99.03	139.10	56.29	41.65	16.88
SEm ±	**0.21**	**13.09**	**4.33**	**2.69**	**2.26**	**0.24**
CD at 5%	**0.60**	**36.53**	**12.08**	**7.52**	**6.31**	**0.67**
I (M x V)	**S**	**S**	**S**	**S**	**S**	**S**

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MORPHOLOGICAL AND BIOCHEMICAL STUDIES IN HEALTHY AND INFECTED PLANT PARTS OF *ORYZA SATIVA*

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Abstract: Pollen morphology is a very minute structure encloses in it the entire body of plant. It contains all genetic information for a complete plant. It has great significance particularly in plant taxonomy. Results of present investigation revealed the effect of infection on the uptake rates of total N and P and its distribution in selected plant parts clearly define the nutritional aspects and role of macronutrients and pigments in growth and development. Our observation indicates that non-acetolysed pollen grains of *Oryza sativa* show reduction in size as compared than that of acetolysed pollen grains. Likewise total N, P and chlorophyll content uptake and its distribution in plant parts decline in infected plant parts as compared to healthy plant parts as in stem, leaf, anther & pollen grains.

Keywords: Acetolysis, Fungal infection, Pollen grain, Rice, Total N .P., Chlorophyll development

INTRODUCTION

Oryza sativa (Rice), of family Poaceae is cultivated during the month of July to August as kharif crop and flowering appear at 80th days. Pollen morphology is of great significance particularly in plant taxonomy. Man has been always interested to find out air quality, microorganism, pollen grains and fungal spores in air. Pollen is a very minute structure encloses in it the entire body of plant. It contains all genetic information for a complete plant. The ultimate aim of pollen grains is pollination leading to fertilization and seed production. Some contribution to study of pollen grains has been done in the past (Nagy, 1962, Bamzai and Randhawa, 1965). Sharma (1967) worked on pollen morphology of Indian monocot plant. Vishnu Mitra and Gupta (1966) worked on maize pollen morphology. Nair (1963) did several studies on pollen morphology and pollen analysis of certain socio-economical important families of Angiosperms such as Liliaceae (1965), Fabaceae (Nair & Sharma, 1962). Information regarding to pollen flora of Hospital, Medical colleges and nursing home areas are not sufficiently available, therefore, present investigation was carried on morphological and biochemical studies of cultivated rice plant in and around the Maharaj Singh degree college, Saharanpur (UP).

MATERIAL AND METHOD

For study of pollen morphology, anther and pollen grains of *Oryza sativa* were collected on glycerine jelly coated microslides during flowering season at 80th days from the experimental crop field just before anthesis. The collected anthers were fixed in 70% FAA (Formaline acetic acid) for 24 hours (Nair, 1960). The pollen preparation were made through acetolysis method proposed by Erdmaan (1952) and modified by Nair (1960) was employed. Certain parameters related to pollen shape and size was determined on the basis of studies done with technique micrometery by using ocular micrometer and stage micrometer. Apart from this, pore diameter, annulus diameter and exine thickness was also studied.

Biochemical analysis was carried in healthy and infected plant parts of *Oryza sativa*. Nitrogen and Phosphate are universally occurring element in all living being and major component of protein. For investigations on total N and P uptake and distribution in the dried samples of healthy and infected vegetative and floral parts particularly anther & pollen grains collected from the crop field at Saharanpur (UP). The plants were dissected into different plant parts (stem, leaf, anthers & pollen grains), dried samples were subjected to total N and total P analysis. Side by side soil samples from healthy and infected experimental plant sites were also analysed for total N and total P. Chlorophyll development studies was also carried in the leaf disc in healthy and infected plant.

For investigation of total N and P uptake and its distribution in healthy and fungal infected plant, samples (Stem, leaf, anther and pollen grains) were taken at 40th days and 80th days of seeding emergence. Soil samples from healthy and infected experimental plant sites were also analysed for total N and total P content.

Total N content of Stem, leaf, anther and pollen grains was done according to Snell and Snell method (1954). While the total P content was done according to Allen (1960) method. For estimation of chlorophyll development in healthy and infected leaf

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disc of rice plant the amount of chlorophyll- a and chlorophyll-b was estimated according to Arnon (1949) formulae which are shown below-

Chl-a mg / l =12.83 A_{645} – 2.58 A_{665}

Chl-b mg / l = 22.87 A_{645} – 4.67 A_{665}

Chl-a + chl-b mg / l = 8.05A_{665} + 20.29 A_{645}

OBSERVATIONS

Result of all different parameters are given in table-1,2,3,4 and figure 1-9.

Table 1. Size of pollen grains in (µm).

Acetolysed Diameter (µm)	Non-Acetolysed Diameter (µm)	Pore diameter (µm)	Annulus diameter (µm)	Exine thickness (µm)
38.50 ±2.48	35.10 ±1.26	4.20 ±0.38	10.50 ±0.30	1.80 ±0.32

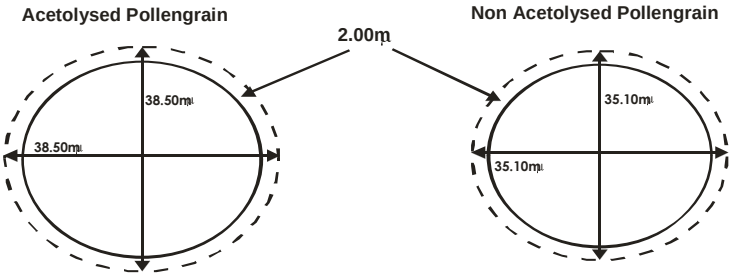

Fig.1 : Size of pollengrains in (µm)

Table 2. Total nitrogen (per gram dry weight) uptake and distribution in healthy and infected plant parts in *Oryza sativa*

Days from emergence	Soil with plant (Blank) mg/kg	Soil with plant mg/kg	Total nitrogen level in			
			Stem	Leaf	Anther	Pollen grains
			mg/gm dry wt.			
Plant without infection (Control)						
0	575.0	575.0	.....	.....	.....	.....
40	565.0	560.0	30.50	22.80	…..	…..
80	550.0	550.0	28.90	20.30	14.50	18.50
Plant with infection						
0	575.0	575.0	.....	.....	.....	.....
40	570.0	560.0	28.80	20.00	.....	.....
80	562.0	560.0	26.50	18.00	11.80	13.60

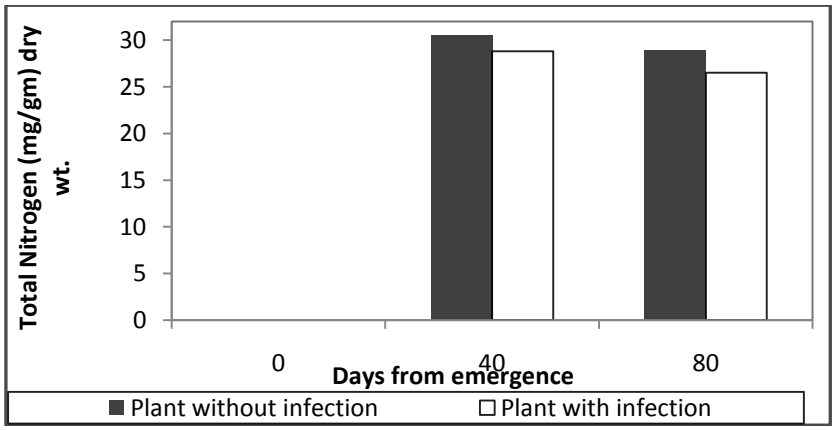

Figure 2. Total nitrogen (mg/gm) dry wt. of stem in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

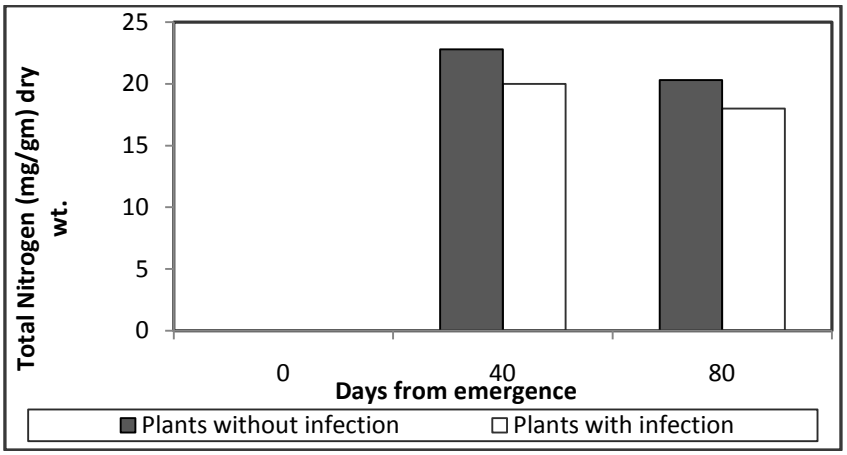

Figure 3. Total nitrogen (mg/gm) dry wt. of leaf in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

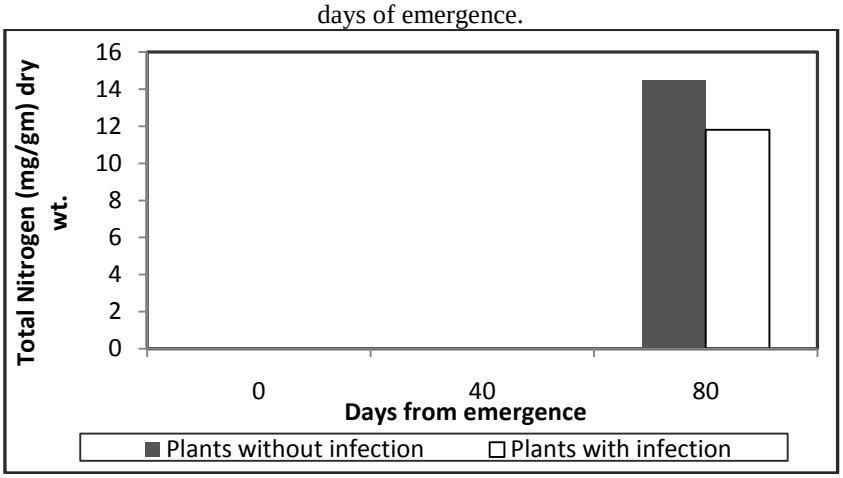

Figure 4. Total nitrogen (mg/gm) dry wt. of anthers in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

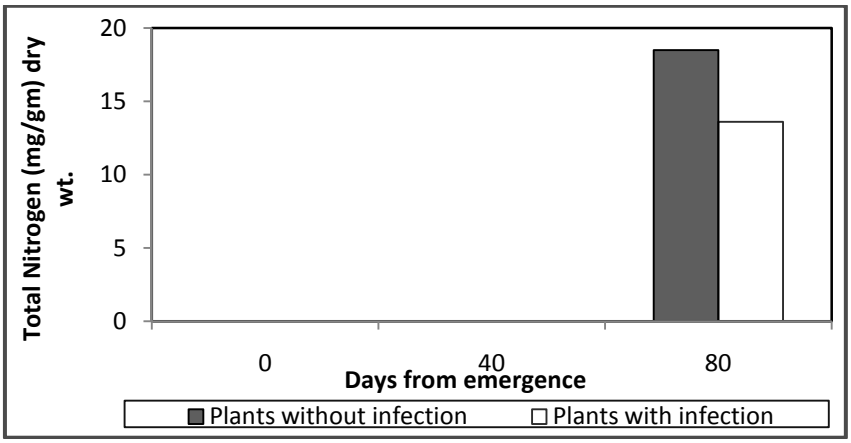

Figure 5. Total nitrogen (mg/gm) dry wt. of pollen grains in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

Table 3. Total Phosphate (per gram dry weight) uptake and distribution in healthy and infected plant parts of *Oryza sativa*

Days from emergence	Soil with plant (Blank) mg/kg	Soil with plant mg/kg	Total phosphate level in			
			Stem	Leaf	Anther	Pollen rains
			mg/gm dry wt.			
Plant without infection (Control)						
0	280.0	280.0	.....	.....	.....	.....

40	275.0	275.0	13.80	16.10	…..	…..
80	270.0	270.0	15.10	16.60	17.50	14.60
Plant with infection						
0	280.0	280.0	....	....	.....	.....
40	276.0	274.0	12.00	14.00	.....	.....
80	269.0	268.0	13.50	15.00	15.80	12.70

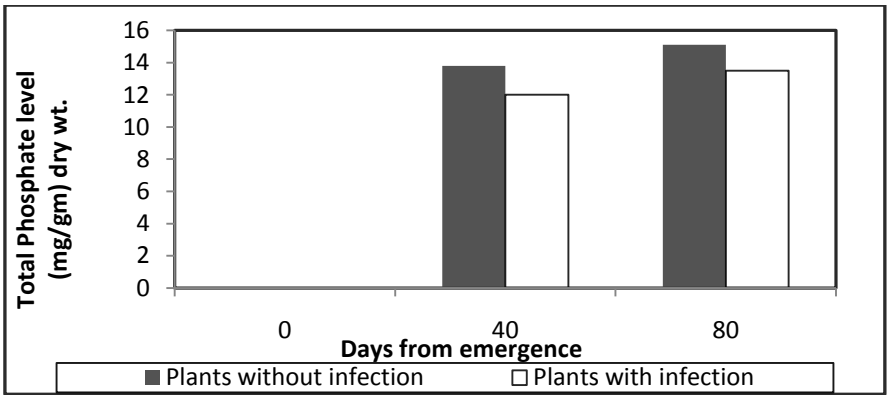

Figure 6. Total phosphate (mg/gm) dry wt. of stem in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

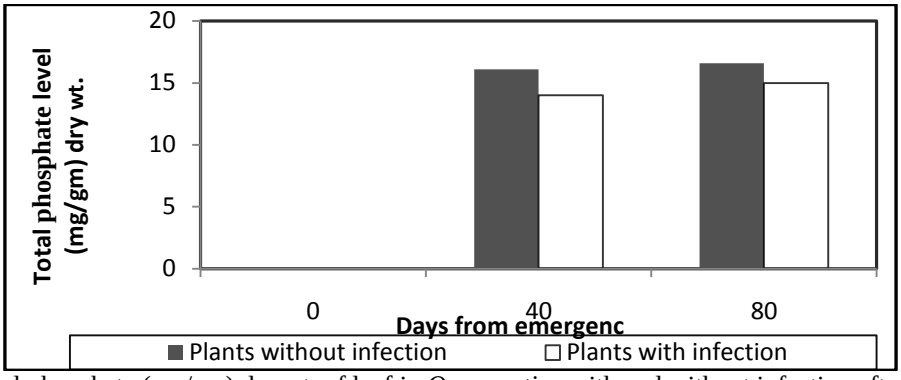

Figure 7. Total phosphate (mg/gm) dry wt. of leaf in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

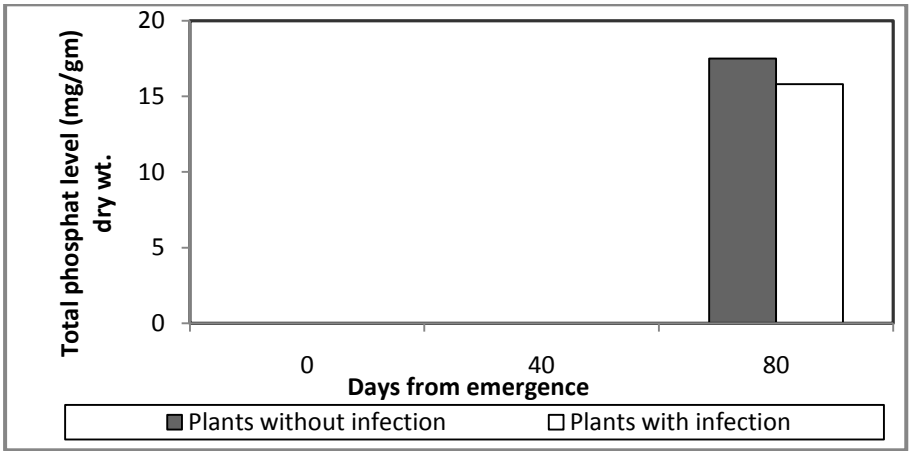

Figure 8. Total phosphate (mg/gm) dry wt. of anthers in *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

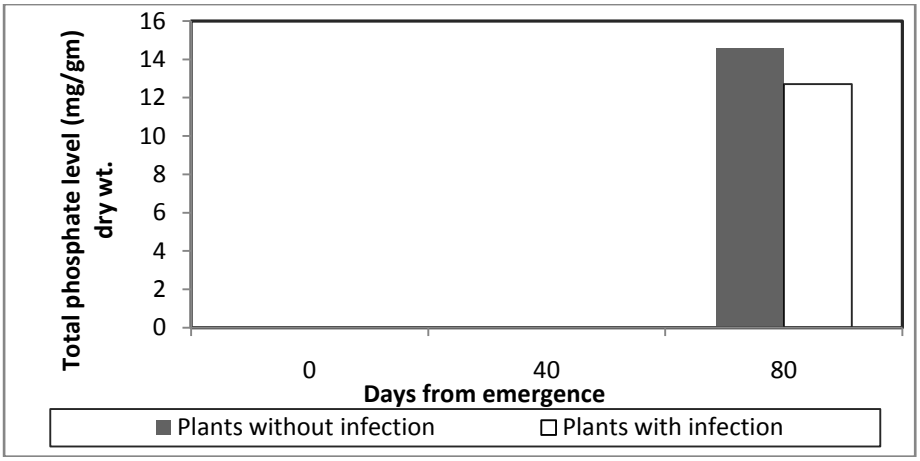

Figure 9. Total phosphate (mg/gm) dry wt. of pollen grains *Oryza sativa* with and without infection after 0, 40 and 80 days of emergence.

Table 4. Chlorophyll development in healthy and infected leaf disc in *Oryza sativa*

Treatment	Leaf disc		Chlorophyll content in healthy and infected plant							
			mg/g fw^{-1}				mg/g dw^{-1}			
	Fresh weight mg, leaf $disc^{-1}$	Dry weight mg, leaf $disc^{-1}$	chl-a	chl-b	chl-a+b	chl-a/b	chl-a	chl-b	chl-a+b	chl-a/b
Healthy plant	19.75	6.30	0.22	0.25	0.47	0.88	1.30	1.35	2.65	0.96
Infected plant	19.70	6.31	0.20	0.23	0.43	0.86	1.22	1.30	2.52	0.93

RESULT AND DISCUSSION

Observation indicates that non-acetolysed pollen grains of *Oryza sativa* show reduction in size. This decrease in size was found 12.5 % in non-acetolysed pollen grains, while it was increased under acetolysed pollen grains (Table 1 & fig.1). Our results are in agreement with the result of Sampat & Ramanathan (1957), Sheeba & Vijyavalli (1998), Rawat *et al*. (2004), Bhat *et al.* (2006).

Table-2, fig-2-5 show decline of total N content in infected plant parts as compared to healthy plant parts. At 80^{th} days anther and pollen grains of infected plant contain 81.3% and 73.5% of total N as compared to pollen grains of healthy (control) plant. Similarly total N content of infected leaf was 87.7% and 88.6% respectively at 40^{th} days and 80^{th} days as compared to healthy plant leaf. Total N per plant organ is suppressed in infected plant. In case of soil without plant the total N content per kg decline from 0- 80^{th} days in both healthy and infected plant (Table-2). Our finding of total N in various plant parts of healthy and infected plant are agreement with previous work done by Vasil (1987) Dhingra & Verghese (1990), Singh (2002), Divya (2003), Pridhi (2004), Bhargava (2006) and Reshu (2006).

Total P uptake and its distribution was found decreased in fungal infected plant parts which also inhibited the growth rate of plants. It was 86.9 % and 90.3 % in the infected leaf at 40^{th} and 80^{th} days respectively as compared to non- infected (control) leaf. Translocation of P from vegetative part to pollen grains is much affected in the infected (86.9%) plant as compared to healthy (control) plant pollen grains. (Table 3 & fig-6-9).

Decline in total P content in stem, leaf in infected plant might be due to fungal infection. In case of soil the decline in total P content per kg was noticed from 0-80^{th} days in without plant crop field, however this decline is more in the soil with infected plant. Our finding with total P in healthy and infected plant parts of experimental plant are in agreement with previous work done by Jensen (1962), Singh (2002), Divya (2003), Bhargava (2006) and Reshu (2006).

Result shows that there is an increase in chlorophyll development in healthy leaf disc as compared to infected leaf disc. In healthy plant leaf disc total chlorophyll development is promoted by 9% as compared to infected leaf disc on mg/ g fresh weight, in which it was found retarted. Total chlorophyll on g fw- 1 basis was 91% in healthy plant leaf disc (Table -4).

Likewise development of chlorophyll-a and chlorophyll-b are also affected by fungal infection in plant. Thus a comparison of chl-a and chl –b development indicates that in general chl-a development is more as compared to chl-b in healthy plant leaf disc. Our present studies with chlorophyll development in leaf disc of both healthy and infected plant are in agreement with the work done by Vasil (1987), Datta & Sharma (1990), Sheoran & Singh (1996).

CONCLUSION

Results of all observations revealing the effects of infection on the uptake rates of total N and P and its distribution in selected plant parts clearly define the nutritional aspects and role of macronutrients and pigments in growth and development. Our observation indicates that non-acetolysed pollen grains of *Oryza sativa* show reduction in size as compared than that of acetolysed pollen grains. Likewise total N, P and chlorophyll content uptake and its distribution in plant parts decline in infected plant parts as compared to healthy plant parts as in stem, leaf, anther & pollen grains.

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OPTIMISED METHODOLOGY FOR HIGH QUALITY DNA ISOLATION FROM LEAVES AND SEEDS OF FENNEL (*FOENICULUM VULGARE*)

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Abstract: In this study, an efficient, simple and rapid protocol is described for high quality DNA isolation from leaves and seeds of fennel (*Foeniculum vulgare*). The protocol gives highly reproducible results and can be carried out easily. Young leaves and seeds of fennel were kept at -80º C for 20 min to freeze the tissues and make the grinding easy without any tissue damage. This protocol eliminates the use of liquid nitrogen. The protocol is inspired by the CTAB method and Sambrook principles.

Keywords: Seed spices, DNA, Fennel, Seeds, Leaves

INTRODUCTION

Fennel (*Foeniculum vulgare*), is a highly aromatic and flavourful herb with culinary and medicinal uses from the family Apiaceae. It has a long history of herbal uses and widely cultivated in India, Pakistan, Suria and Egypt, for its edible strongly flavoured leaves and seeds. This crop is the very rich source of antioxidants and used in many medicines to cure diseases (Oktay, 2003, Bruyas-Bertholon V, 2012 and Lucinewton S, 2005). Saravanaperumal and Terza (2012) also studied and recommended the Polyphenolics free DNA isolation from mature and young leaves of fennel. Fennel is the very potential seed spice and plays a significant role in Indian economy and yet very limited information is available about genome of this crop. Now a day's use of advanced biotechnological tools is becoming a very important part of breeding programmes. Conventional breeding processes are very tedious and time consuming but molecular marker assisted breeding is time saving process. Molecular markers are the very essential for advance breeding programmes but unfortunately presently very few molecular markers are available for seed spices. It's a great need to do some molecular studies of these crops in this aspect we have isolated DNA using an effective and rapid method following principles of Sambrook (1989).

The DNA extraction process involves separation of DNA from naturally occurring plant cell constituents such as polysaccharide and polyphenolic compounds (Porebski *et al.,* 1997) followed by removal of the contaminating biomolecules such as the proteins, polysaccharides, lipids, phenols and other secondary metabolites from the aqueous solution containing the DNA and then precipitation and purification of DNA. DNA extraction and purification by CTAB method for various plants were standardized by Krizman *et al*.,(2006).

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MATERIAL METHOD

Plant material

Fennel dry seeds and fresh leaf tissue were used for DNA isolation. Plant materials (seeds) were obtained from the seed bank of NRCSS (AF-12). The seeds were placed on a moist filter paper in a Petri dish, 10 seeds/plate at 25ºC. After germination seeds were transplanted in pots for growth, young leaves from plants and dry seeds were taken for DNA isolation.

Solutions and reagents

Extraction Buffer, Chloroform, Isopropanol (pre-chilled), Isoamyl Alcohol, Ethanol, Tris-EDTA, RNase A, 70% ethanol, Absolute ethanol, Double distilled water, Concentrated HCl and NaOH pellets

Equipments

High speed centrifuge, Agarose gel electrophoresis equipment, Power supply, Vortex mixer, Refrigerator (-80º C), Mortar and pestle, Balance, Gloves, Forceps, Centrifuge tubes, Centrifuge, Micropipettes and tips and Water bath

Protocol (method)

- 100mg fennel seeds and approx 100mg young fennel leaves were kept at -80º C for 20 minutes; mortar and pestle were also kept in freezer for 30 minutes. Freezed seeds and leaves were grinded separately immediately in freezed mortar and pestle and transferred in 50ml tubes.
- 22.5ml extraction buffer was added and mixed well (cetyl trimethyl ammonium bromide (CTAB) which disrupts the membranes, β mercaptoethanol which helps in denaturing proteins and EDTA which chelates the magnesium ions). The samples were incubated at 65º C for one hour.
- 22.5ml chloroform: isoamyl alcohol (24:1) solution was added and mixed well for five minutes. Samples were centrifuged at 5000rpm for 10minutes. (To denature the contaminants

which accumulate in the organic phase and the nucleic acids preserved in the aqueous phase). Supernatant was removed and was transferred to fresh labelled 50ml tube. Step was repeated twice for contamination.

- Samples were centrifuged for 10 minutes at 6000rpm and transferred to a new tube. 2volume of ice cold isopropanol was added and kept in freeze for 30 minutes (nucleic acid precipitation). Samples were centrifuged at 6000rpm for 10minutes. Solution was pipette off, taking care not to lose the DNA pellet at the bottom of tubes.
- 12.5ml of 70% ethanol was added. Samples were centrifuged for 10 minutes at 6000rpm. Supernatant was removed and DNA pellet was air dried till small of ethanol lasts and diluted with 2.5ml TE and stored at 4ºC for future use.

RESULT AND DISCUSSION

The ratio of absorbance at 260 nm and 280 nm is used to assess the purity of DNA. A ratio of ~1.8 is generally accepted as "pure" for DNA (Leninger, 1975). If the ratio is appreciably lower, it may indicate the presence of protein, phenol or other contaminants that absorb strongly at or near 280 nm but our samples are showing no contamination by protein or polysaccharides **(**table 1). The 260/230 Ratio is used as a secondary measure of nucleic acid purity. The 260/230 values for "pure" nucleic acid are often higher than the respective 260/280 values. Expected 260/230 values are commonly in the range of 2.0-2.2. If the ratio is appreciably lower than expected, it may indicate the presence of contaminants which absorb at 230 nm. The isolated DNA was measured by using the Nano-Drop spectrophotometer where the measurement at OD 260/280 was ranged 1.81 for seed and 1.80 for leaf tissue where as at OD 260/230 purity (nm) was 2.05 for seed and 2.10 for leaf. Total yield for seed DNA was 1130.1ng/µl and for leaf DNA yield was 1271.1ng/µl (table 1). DNA concentrations were confirmed using agarose gel electrophoresis. Ten microliters of purified DNA from the proposed procedure was run on a 1% (w/v) agarose gel containing 0.1 µg/mL of ethidium bromide. DNA was visualized using the Gel Doc System gel was showing very good results (Fig.1). The quantity of DNA was much higher in fennel leaf tissues in comparison with the fennel dry seeds.

In order to facilitate the efficiency and reliability of the DNA extraction method and the quality of the extracted DNA. The purified DNA was incubated with RNaseA (10mg/ml) at 37°C and precipited following phenol: chloroform extraction to remove the RNase. The resulted DNA was amplified using RAPD primers and PCR product was run on 1.5% agarose gel (Fig. 2). A good PCR product indicates the good quality of DNA.

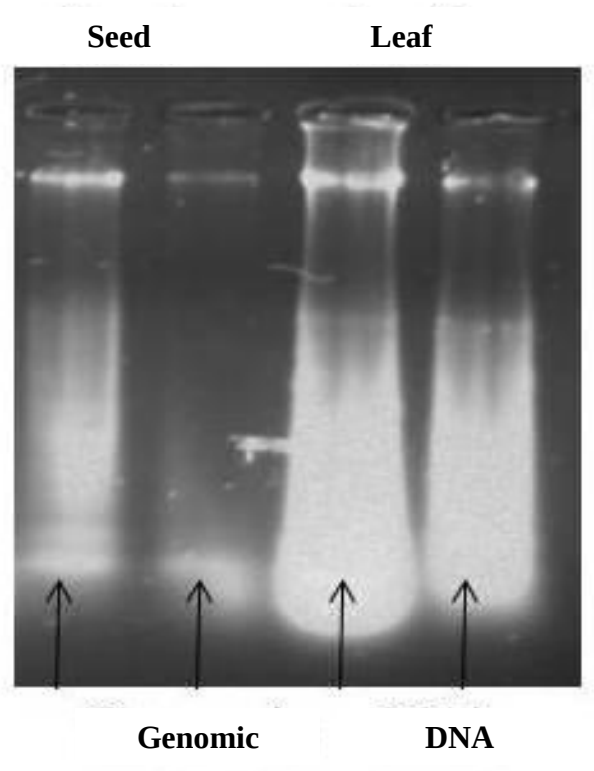

Fig.1 A gel image showing genomic DNA of Fennel Seed and Leaf (AF-12)

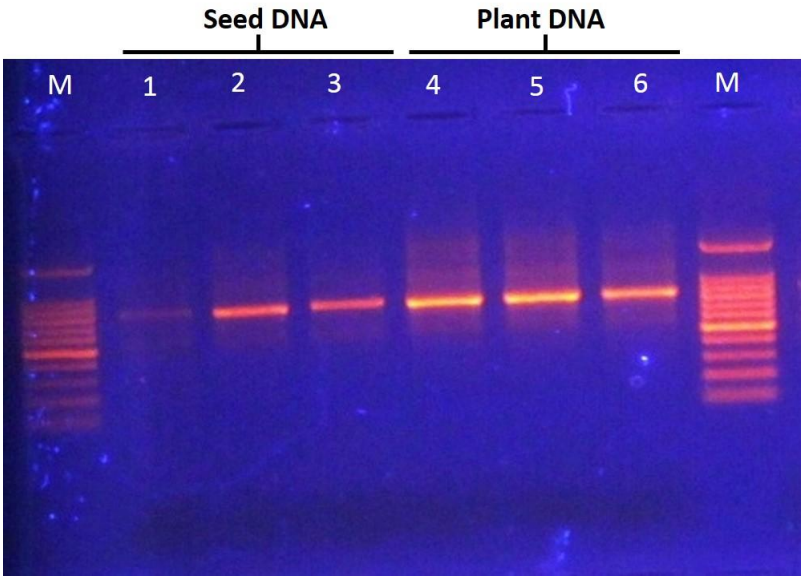

Fig.2 PCR result showing good amplification with fennel seed DNA (1-3) and leaf tissue DNA (4-6) with RAPD primer OPD-04

Table 1. The ratios of OD $A_{260/A280}$ and OD $A_{260/230}$ of Genomic DNA

Crop/Accession	DNA		
	Purity (nm)		Yield
	$A_{260/280}$	$A_{260/230}$	Con.(ng/µl)
Fennel-1 (seed)	1.81	2.05	1130.1
Fennel-2 (leaf)	1.80	2.10	1271.1

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ESTIMATES OF VARIABILITY PARAMETERS FOR YIELD AND ITS COMPONENTS IN LINSEED (*LINUM USITATISSIMUM* L.)

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Abstract: The present study of genetic variability was carried out using 30 genotypes of linseed for 10 quantitative characters. The results showed significant differences and wide range of variability for all the characters. The seed yield per plant was recorded highest values for phenotypic and genotypic coefficients of variation followed by number of capsules per plant. The high heritability coupled with high genetic advance as percent of mean was observed for seed yield per plant, test weight, capsules per plant, plant height, branches per plant, days to first flowering and days to 50% flowering indicated the predominance of additive gene action in the expression of these traits and can be improved through individual plant selection.

Keywords: Linseed, Variability, Heritability

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is one of the important oil and fiber yielding crop of India. It has nutritional, medicinal and industrial uses. India is the third largest producer of linseed oil in the world. Linseed occupies an area of about 525.5 lakh ha with an annual production of 211.9 lakh tones and average productivity of 403 kg/ha in India (Agropedia, 2010). In Madhya Pradesh, it is grown in an area of 126 thousand hectare with a production of 48 thousand tonnes with productivity of 381 kg/ha (Anonymous 2009-10). Seed yield per hectare of this crop is very low in India. Its cultivation under marginal/sub-marginal lands and poor crop management are the major reasons for low productivity of the crop. Thus, there is need to develop or identify high yielding linseed varieties. Development of high yielding cultivars requires information on nature and magnitude of variation in the available germplasm. The observed variability is a combined estimate of genetic and environmental cause of which only the former one is heritable. Heritability and genetic advance of the seed yield and its components is pre-requisite for the improvement through selection. The present investigation provides better insight and scope for the improvement of seed yield through component characters in linseed.

MATERIAL AND METHOD

The experimental material comprised of 30 linseed strains/varieties were grown in Randomized Block Design with three replications at Research Farm, Rajoula, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (Madhya Pradesh) during *Rabi* 2011-12. Observations were recorded on five randomly selected plants from each plot for 9 quantitative characters *viz*. days to flowering, days to 50% flowering, number of branches per plant, plant height (cm), number of capsules per plant, number of seeds per capsule, 1000-seed weight (g), days to 80% maturity and seed yield per plant (g). The variability parameters were determined as per the methodology suggested by Burton and de Vane (1953) and Johnson *et al.*, (1955).

RESULT AND DISCUSSSION

The analysis of variance among the genotypes for various characters is given in Table 1. The analysed data revealed highly significant differences among the genotypes evaluated for all the characters studied, indicating the exixtence of genetic variability among the selected material. Mean, range, GCV, PCV, heritability and genetic advance as per cent of mean are presented in Table 2. The variability estimates, in general, phenotypic coefficient of variation (PCV) was higher than corresponding genotypic coefficient of variation (GCV). The estimates of phenotypic and genotypic coefficients of variation indicated the existence of fairly high degree of variability for seed yield per plant and number of capsules per plant. Moderate variability was observed for number of branches per plant, 1000-seed weight and plant height. The minimum genotypic and phenotypic coefficients of variation were observed for days to first flowering, days to 50% flowering, number of seeds per capsule and days to 80% maturity. Days to first flowering, days to 50% flowering, plant height, number of capsules per plant, number of seeds per capsule, 1000-seed weight and days to 80% maturity showed almost similar values of phenotypic and genotypic coefficients of variation, indicating that variability was primarily was due to genotypic

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differences and environment has played little role in the expression of this character. The observations are in agreement with the findings of Savita *et al*. (2007) and Dubey *et al.* (2007).

The major function of heritability estimates is to provide information on transmission of characters from the parents to the progeny. Such estimates facilitate evaluation of hereditary and environmental effect in phenotypic variation and thus aid in selection. Heritability estimates are used to predict expected advance under selection so that breeders are able to anticipate improvement from different selection intensity. Johnson *et al*. (1955) have suggested heritability estimates in association with genetic advance are much useful for selection than heritability alone.

In the present study, estimates of heritability in broad sense ranged from 79.80 per cent for number of branches per plant to 99.83 for 1000-seed weight. High heritability estimates were found for all the characters indicated that the dependence of phenotypic expression reflect the genotypic ability to transmit the genes to their offspring. Similar results were also reported by Rao and Singh (1985).

Genetic advance expressed as per cent of mean ranged from 4.90 per cent to 69.45 per cent. High estimates of expected genetic advance were found for seed yield per plant, number of capsules per plant, 1000-seed weight, and plant height, number of branches per plant, days to first flowering and days to 50% flowering. Low estimates of expected genetic advance were found for number of seeds per capsule and days to 80% maturity.

High heritability coupled with high genetic advance was observed for seed yield per plant, number of capsules per plant, 1000-seed weight, plant height, number of branches per plant, days to first flowering and days to 50% flowering indicated that most likely the heritability is due to additive gene effects and the improvement of these characters can be achieved by adopting simple selection procedure. High heritability coupled with low genetic advance was observed for number of seeds per capsule and days to 80% maturity indicated non-additive type of gene action and selection is less effective. Similar results were also observed by Naik and Satapathy (2002).

The present study revealed that the clusters per plant, seed yield per plant, 1000-seed weight, branches per plant and plant height possessing high heritability alongwith high genetic advance and high to moderate variability estimates indicating a greater scope for the improvement through selection from the population.

Table 1. Analysis of variance for nine quantitative characters in linseed.

Source of variation	d.f.	Mean square								
		Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Days to 80% maturity	Seed yield per plant (g)
Replication	2	1.14*	5.80*	0.03	1.30	10.41	0.02	0.01	0.89	1.64
Treatments	29	94.32**	117.77**	3.22**	314.92**	677.29**	0.88**	3.28**	31.65**	55.20**
Error	58	0.32	1.87	0.25	3.29	6.50	0.06	0.01	0.42	3.65

* Significant at 5% probability level.

** Significant at 1% probability level.

Table 2. Mean, range, coefficient of variation, heritability and genetic advance as per cent of mean for nine characters in linseed.

S.N.	Characters	Grand mean X±SE	Range		GCV	PCV	Heritability (%)	Genetic advance as % of mean
			Min.	Max.				
1	Days to first flowering	56.70±0.32	49.20	68.93	9.87	9.92	98.98	20.23
2	Days to 50% flowering	77.55±0.79	69.27	88.93	8.01	8.20	95.36	16.12
3	Number of branches per plant	5.66±0.28	4.47	10.00	17.59	19.69	79.80	32.37
4	Plant height (cm)	62.01±1.04	38.40	80.47	16.43	16.69	96.92	33.33
5	Number of capsules per plant	61.50±1.47	28.13	95.53	24.31	24.66	97.17	49.37
6	Number of seeds per capsule	7.45±0.14	6.13	8.33	7.02	7.77	81.63	13.07
7	1000-seed weight	5.59±0.02	4.03	7.83	18.73	18.74	99.83	38.55
8	Days to 80% maturity	132.82±0.37	125.53	138.20	2.42	2.47	96.13	4.90
9	Seed yield per plant (g)	11.17±1.10	4.70	26.37	37.12	40.88	82.46	69.45

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STUDY THE MARKETING COST AND PRICE SPREAD UNDER DIFFERENT MARKETING CHANNEL OF TOMATO IN JASHPUR DISTRICT OF CHHATTISGARH

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Abstract: The present study was conducted in the Jashpur districts of Chhattisgarh. Sixty farmers were selected randomly from three villages namely Ludeg, Saraitola and Katangjor and were categorized into marginal, small, medium and large farmers based on their holding size. The primary data were collected for the year 2010-11. The major findings of this study revealed that the average size of farm was worked out to be 1.93 hectares, overall on an average cropping intensity was observed to be 101.64 per cent. Out of total cropped area kharif, rabi, and zaid crops occupied about 88.38, 8.32 and 3.22 per cent of total cropped area respectively. On an average the cost of cultivation per hectare of tomato was found Rs. 26576.89. Overall on an average the cost of production per quintal of tomato was observed as Rs. 222.84. Cost of production per quintal of these vegetables shows decreasing trend with increase in farm size where as cost of cultivation increases with increase in the farm size. There were two marketing Channels for tomato, which are: Channel-I: Producer–Village-merchant–Wholesaler–Retailer–Consumer and Channel-II: Producer–Retailer–Consumer. That price received by tomato producer was 800 Rs/qtl. in both Channels. The major constraints pertaining to cultivation of tomato was problem of decreasing yield due to growing the crop regularly in same field and lack of irrigation. A major constraint in marketing of tomato was fluctuation of price and storage facility in the study area. In view of findings study suggested that the Irrigation facilities are to be developed in the proper way so that farmers can adopt improved technologies with assured irrigation facilities. Extension agencies should provide information on new varieties and package of practices as well as procedures of standardization, grading of produce and their benefits. Horticultural crop producer's co-operative societies should be formed for better performance and achievement. Some specific minimum prices should be declared for tomato to ensure benefit for the producers.

Keyword: Constraints marketing channel, Tomato

INTRODUCTION

More than 93 per cent rainfed area of Jashpur district of the Chhattisgarh state has produced the maximum tomato throw that of other district of the state and famous for tomato producing district. During 2010-2011, the tomato was cultivated in 4.04 thousand hectare and production 50.51 thousand tons of tomato with average productivity of 12.50 t/ha (office record, 2010-11, Department of Horticulture C.G. Govt., Jashpur) Jashpur district is lying under Northern Hill Zone of Chhattisgarh State. This district is dominated having abundance with tribes and natural resources biodiversity.

Jashpur district comprised of eight blocks of Jashpur, pathalgaon is known for red desert due to cultivation of tomato in more than 80 per cent area to the total cropped area of pathalgaon.

Chhattisgarh state is known for rainfed rice production system and recognized for "rice bowl" state of the country. Despite the rice cultivation of state vegetable have also been cultivated in 4.38 per cent area to the net cropped area of the state. Among the vegetable cultivation, tomato was cultivated in the maximum area (20.86%) followed by potato (16.46per cent), brinjale (12.73%), okra (12.06%), cauliflower (8.11%), cabbage (6.90 %) and minimum area in sweet potato (1.84%). Area under other vegetables was recorded by 16.46 per cent area includes beans, chili, coriander, cluster been, pea, sponge gourd, bottle gourd etc.

The area, production and productivity of vegetables in the Chhattisgarh state during 2009-10 vegetables was about 197.95 thousand hectares and production was 2781.45 thousand tones. The share of tomato to the total area and production of vegetables was 20.86 and 21.59 Per cent, which placed 1st rank in area and 2nd rank in production by ordering the different vegetables of the state.

It has been observed that tomato was cultivated in 6.51 per cent area of Chhattisgarh to the total area of tomato of the country and ranked in 7th position by area and 8th position by production. This important crop are grown on 634.37 thousand hectares area and production of 12,433.17 thousand tonnes with average productivity 14.55 t/ha of Chhattisgarh state, which is quit lower than that of the country production of 19.6 t/ha.

Table 1. Crop wise area, production and productivity of major vegetables in India (2009-10).

S.No.	Crops	**Area ('000 ha)**	**Production ('000 tons)**	**Productivity (t/ha)**
1	Potato	1,835.34	36,577.32	19.93

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		(24.84)	(29.82)	
2	Onion	756.14	12,158.81	16.08
		(10.23)	(9.91)	
3	**Tomato**	634.37	12,433.17	19.60
		(8.59)	(10.14)	
4	Brinjal	589.71	10,164.65	17.24
		(7.98)	(8.29)	
5	Okra	452.52	4,803.17	10.61
		(6.12)	(3.92)	
6	Cauliflower	337.85	6,410.46	18.97
		(4.57)	(5.23)	
7	Cabbage	331.02	7,281.50	22.00
		(4.48)	(5.94)	
8	Sweet potato	118.87	1,094.64	9.21
		(1.61)	(0.89)	
9	Other	2,332.43	31,724.51	13.60
		(31.57)	(25.87)	
10	Total	7,388.24	1,22,648.24	
		(100.00)	(100.00)	

Source: Indian Horticulture Database, 2010, NHB, Ministry of Agriculture. Government of India, New Delhi. (Figure Indicate percentage to total.)

Table 2. Crop wise area, production and productivity of major vegetables in Chhattisgarh (2009-10).

S.No.	**Crops**	**Area ('000 ha)**	**Production ('000'mt.)**	**Productivity (t/ha)**
1	**Tomato**	41.29	600.6	14.55
		(20.86)	(21.59)	
2	Potato	32.59	449.8	13.8
		(16.46)	(16.17)	
3	Sweet potato	3.64	32.42	8.91
		(1.84)	(1.17)	
4	Onion	9.06	160.32	17.7
		(4.58)	(5.76)	
5	Okra	23.87	217.3	9.1
		(12.06)	(7.81)	
6	Cauliflower	16.06	268.87	16.74
		(8.11)	(9.67)	
7	Cabbage	13.66	227.84	16.68
		(6.9)	(8.19)	
8	Brinjal	25.19	374.5	14.87
		(12.73)	(13.46)	

9	Other	32.59	449.8	13.8
		(16.46)	(16.17)	
10	Total	197.95	2781.5	
		(100.00)	(100.00)	

Source: Indian Horticulture Database, 2010, NHB, Ministry of Agriculture. Government of India, New Delhi.
Note: Figure Indicate percentage to total.

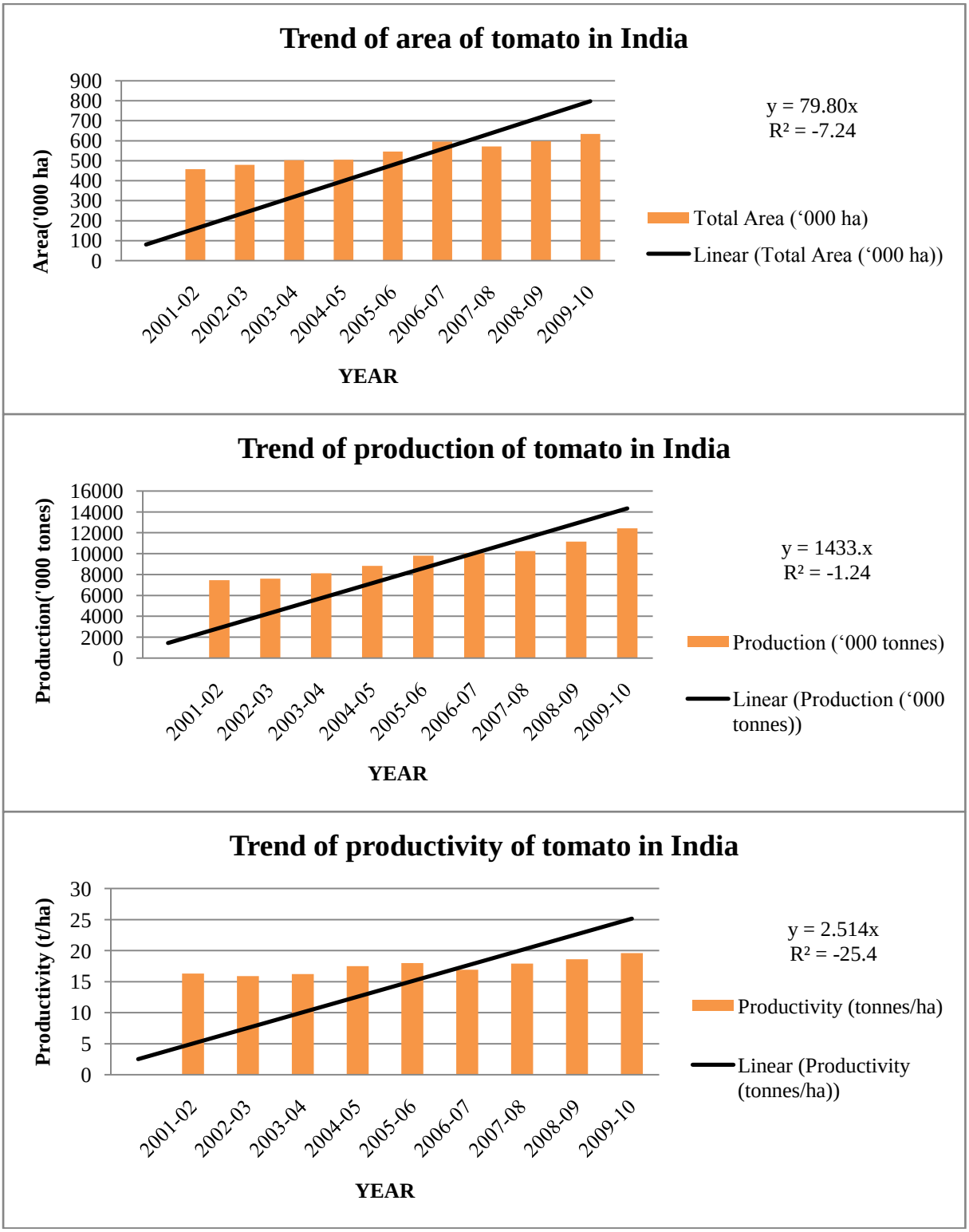

Fig. Trend of area, production and productivity of tomato in India

RESEARCH METHODOLOGY

Methodology of the study which has been used at various stages. It has been applied particularly for selection of area, block, villages, sample size, collection of information from farmers, traders and method of analysis.

Sampling design
The selection of state, district, block, villages and crops are presented under the following sub- sections:

Selection of study area
This study was conducted in the Jashpur district of Chhattisgarh State, since this district is famous for tomato production than that of other districts of the State. This district included eight blocks among these blocks Pathalgaon block, occupied more than 80 per cent area and production of tomato among all the blocks of Jashpur District. Therefore Pathalgaon block was selected for the present study.

Selection of Tomato Growers
Pathalgaon block of Jashpur district having 109 villages. Out of them 30 where tomatoes growing village among them 3 villages were selected proportionally. From each sampled village, 20 tomato growers were randomly selected and then categorized into marginal (below 1 ha), small (1-2 ha), medium (2-4 ha) and large (above 4 ha). Totally 60 farmers were selected for the study comprise of 25 marginal, 20 small, 5 medium and 10 large farmers.

Selection of Intermediaries
Though, no official records are available in the market about the number of wholesaler/commission agents and retailers involved in the tomato marketing. Hence the information about number of middleman and number of large farmers were cultivating the tomato. Were functioning in the study area, collected through RAEO'S. A proportionate sample of 15 of each intermediary was considered for the study.

Table 3. Selection of middlemen involved in tomato marketing Jashpur district of Chhattisgarh.

Market	Total Middlemen				Sample Middlemen			
	Wholesalers	Village Merchants	Retailers	Total	Wholesalers	Village merchants	Retailers	Total
Ludeg	25	10	10	45	5	5	3	13
Saraitola	20	5	5	30	2	1	2	5
Katangjor	7	5	5	17	1	1	1	3
Total	52	20	20	92	8	7	6	21

(B) Method of enquiry and data collection
Primary data from the farmers were collected through well prepared schedule designed for the study. The cost of different operations along with quantity of produce, were recorded on item wise included of fixed as well as variable costs of Tomato production. The relevant on cropped area, cropping pattern, irrigated area their sources inventory, etc. were recorded on the schedule designed for the study.
In order to compute the growth rate of area, production and productivity of Tomato in the Jashpur district of Chhattisgarh state. Time series secondary from 2000-2001 to 2009-2010 was collected.

Period of Inquiry
The detail inquiry was done for the year of 2010-11.

Analytical tools
Compound growth rate
To compute the growth rate of area, production and productivity of Tomato of Jashpur district, the following mathematical model was used

$Y= aB^t$
Log Y= log a+ t log B
Where,
Y= Area/ production /productivity
a= Constant
B= Regression coefficient
t= time in year (from 2000-2001- to 2010-2011)
Compound growth rate (per cent) = (Antilog B-1)100

Marketable Surplus
It is the quantity of produce, which is left by the farmers to meet out the requirement of the family consumption etc. in this marketable surplus was computed by use of following mathematical model:-
MS = P – (C + W+ S)
Where,
MS – Marketable surplus
P – Total production
C – Family consumption
W - Quantity use for wage
S – Quantity kept other purpose

Marketing Cost, Margins and Price Spread

For fulfillment of the objective second of the present study i.e. involvement of marketing cost for tomato, market margin and price spread was worked out by applying the following formula :-

$C = C_f + Cmi + Cmii + \ldots\ldots + Cmn$

Where,

C – Total marketing cost of produce

C_f – Cost paid by producer (from the time produce leaves the farm till he sells it) and

Cmi – Cost incurred by i_{th} middlemen in the process of buying and selling the product.

RESULT AND DISCUSSION

Marketing of tomato

Like other agricultural commodities, marketing is playing very important role for the disposal of tomato. The Jashpur district of Chhattisgarh is difficult terrain and lack of infrastructural development for the marketing of agricultural commodities including tomato. The Ludeg, Saraitola and Pathalgaon villages of the study area were situated in interior area of Pathalgaon having unorganised market.

During the course of study, producers, village merchants, wholesalers and retailers were generally engaged in assembling of tomato and their marketing**.**

Producers:

Tomato growers dispose their produce by themselves in Jashpur vegetable market. It has been observed that about 70-80 per cent of the total produce was assembled by the growers themselves. Generally, the farmers of the nearby villages bring their produce to sell in the market in order to secure better prices. Small producers consider it better to sell their produce in the village to avoid deception existed in the marketing at Jashpur vegetable market.

2. Village merchant

Tomato producers were sold their produce mostly to the Village Merchant. Generally, Village Merchant contact with farmer and purchase the tomato at appropriate rate which is suitable to producer. The Village Merchant charges their commission and sells to wholesaler at more prices.

3. Wholesalers

Mostly, Tomato producers were sold their produce of wholesaler in market. After purchase the produce by wholesaler them transfer the produce to other district market or at processing units.

4. Retailer

The retailer was the last intermediary in market. The retailer purchases the tomato in market by farmers and sold out them by to various small markets at their own prices.

Market functionaries

In the marketing of Tomato, the main market functionaries engaged in the marketing of tomato were pacca arhatias (brokers), kachcha arhatias, weight men, palledars and sweepers etc.

Marketable surplus

Marketable surplus is defined as from the total quantity of produced output subtracted the quantity of produced output used for payment of wages of labours, quantity stored or used for home consumption, etc. as per the theoretical concept, the marketable surplus is worked out and shown in Table 4.12. It reveal that 123.22 q/ha of tomato was produced at the sample farms, irrespective to the farm size of holdings. Nearly, 95 per cent of tomato was for marketable surplus. However quantity used for wage payment and quantity used for home consumption was found to be 2.36 and 2.27 per cent, respectively. It is important to note that almost nearly 95 per cent quantity was used for marketable surplus with respect to all the farm size of holdings.

Marketing channels and cost of Tomato

There were two types of marketing channels identified, in the study area. Those which are as follows:

Channel– I:

Channel – II:

Table 4. Marketable surplus of tomato of sampled households

(q/ha)

S.No.	Particulars	Farm size				
		Marginal	**Small**	**Medium**	**Large**	**Average**
1.	Total quantity produced (q)	118.19	122.09	129.17	135.08	123.22

		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
2.	Quantity paid for wages	2.95	3.05	2.58	2.70	2.91
		(2.50)	(2.50)	(2.00)	(2.01)	(2.36)
3.	Quantity used for home	2.36	2.44	3.88	4.05	2.80
		(2.00)	(2.00)	(3.00)	(3.02)	(2.27)
4.	Total quantity utilized	5.32	5.49	6.46	6.75	5.71
		(4.50)	(4.50)	(5.00)	(5.04)	(4.64)
5.	Marketable surplus	112.87	116.60	122.71	128.33	117.06
		(95.50)	(95.50)	(95.00)	(95.71)	(95.00)

Note: Figures in parenthesis indicate percentage to total quantity produced.

The marketing charges paid by the tomato producer to the commission agents and retailers (Channel-I), which was worked out and found to be Rs.24, Rs.40, Rs.55 and Rs.80 per quintal respectively. The marketing charge paid by the tomato producer to wholesaler (channel-II) was Rs.56 and Rs.105 per quintal, respectively. Total marketing charges were higher being Rs. 199 per quintal in channel-I than that of channel-II Rs.161 in the study area. In channel –II, the producer directly sold their produce to retailer and finally retailer sold this produce in Bilaspur, Korba, Ambikapur, Jharkhand, Orissa and other markets. In those channel, producers paid Rs. 80 cost and Rs. 105 to the retailers for marketing of tomato. Therefore, producer has paid more marketing cost in channel-II as compared to channel-I.

Marketing and Price spread

The difference between price paid by consumer and price received by producers is price spread and the share goes to the different functionaries in the market is marketing margin of commodities. The price spreed and marketing margin is worked out with use of theoretical concept and presented in table 4.13 it was noticed that price received by tomato producer was Rs.800 in both Channels i.e. channel-I and II. Net price received by tomato producers was Rs. 776 in channel-I and Rs. 744 per quintal in channel-II. Commission charges paid by producers to the commission agent by an amount of Rs. 24 and Rs. 16 in Channel-I and Channel-II. The per cent of commission paid by tomato produce in Channel-I was comparatively more than that of Channel-II. The sold out tomato by farmers was ultimately reached to the consumers through different market functionaries and consumers paid the price of Rs/q 1600 and Rs/q 1400 in channel-I and Channel-II. The marketing margins were noticed to be 50 and 42 per cent in channel-I and channel-II. In Channel-I, the gross margin of Village merchant, wholesaler and retailer are Rs. 200, Rs. 300 and Rs.300 respectively as well as in channel-II, the gross margin of wholesaler is Rs. 600.

Marketing charges paid by various intermediaries in different marketing channel of tomato.

(Rs/qt)

Particulars		**Channels**	
		Channel-I	**Channel-II**
A	**Producer**		
1	Transport charge	-	30
3	Mandi fees	-	5
4	Loading-unloading	-	5
5	Others (include commission)	24	16
	Subtotal	**24**	**56**
B	**Village Merchant**		
1	Transport charge	30	-
2	Mandi fees	5	-
3	Loading-unloading	5	-
	Subtotal	**40**	**-**
C	**Wholesaler**		
1	Transport charge	30	-
2	Packaging / Weighting	10	-
3	Mandi fees	5	-
4	Loading-unloading	5	-
5	Others	5	-

	Subtotal	**55**	**-**
D	**Retailer**		
1	Transport charge	55	75
2	Loading-unloading	5	10
3	Mandi fees	5	5
4	Packaging	5	5
5	Other	10	10
	Subtotal	**80**	**105**
	Total	**199**	**161**

Table 5. Market margin and Price spread under different marketing channels of tomato.

S.N.	**Particulars**	**Channels-I**	**(percentage)**	**Channels-II**	**(percentage)**
		Producer			
1.	Net price received by producer	800	(50.00)	800	(57.14)
2	Market cost incurred by producer (include commission)	24	(1.5)	56	(1.14)
3	Gross price received by producer	776	(48.50)	744	(53.14)
		Village-merchant			
1	Purchase price	800	(50.00)	-	-
2	Market cost incurred	40	(2.50)	-	-
3	Net price	840	(52.50)	-	-
4	Selling price	1000	(62.50)	-	-
5	Profit	160	(10.00)	-	-
	Market margin	200	(12.50)	-	-
		Wholesaler		-	
1	Purchase price	1000	(62.50)		-
2	Market cost incurred	55	(3.44)	-	-
3	Net price	1055	(65.94)	-	-
4	Selling price	1300	(81.25)	-	-
5	Profit	245	(15.31)	-	-
	Market margin	300	(18.75)	-	-
		Retailer			
1	Purchase price	1300	(81.25)	800	(57.14)
2	Market cost incurred	80	(5.00)	105	(7.50)
3	Net price	1380	(86.25)	905	(64.64)
4	Selling price	1600	(100.00)	1400	(100.00)
5	Profit	220	(13.75)	495	(35.36)
	Market margin	300	(18.75)	600	42.86
		Consumer price			
	Consumers price	1600*	(100.00)	1400*	(100.00)

Note :-(*) Indicate ultimate consumer.

Producer's share in consumer rupee

Table 4.17 shows that the price paid by consumers for per quintal of tomato was Rs.1600.00 in Channel-I. Producer's share in consumer rupee was 50.00 per cent in Channel-I of the tomato as well as the producers share in consumer rupee in channel-II was 60.04 per cent. On the basis of above results the hypothesis that large marketing channels reduced producer's share in consumer rupee is accepted.

Table 6. Producer's share in consumer rupee.

(Rs /q)

Particular	**Channels**			
	I		**II**	
Retailer				
(a.) Marketing cost	80	(5.00)	56	(4.00)
(b.) Net price received	220	(13.75)	495	(35.35)
Wholesaler				
(a.) Marketing cost	55	(3.43)		-
(b.) Net margin	300	(18.75)		-
Village merchant				
(a.) Marketing cost	40	(2.50)	-	-
(b.) Net margin	200	(12.50)		-
Producer				
(a) Marketing cost	24	(1.50)	56	(4.00)
(b) Net price received	776	(48.50)	744	(53.14)
Producer share in		50.00		60.04
Consumer rupee (%)				-
Price paid by consumer	1600	(100.00)	1400	(100.00)

Note: Figures in parenthesis indicate percentage to the price paid by consumer.

Constraints

Constraints in tomato production

Under vegetable production some of the constraints was noticed which are essential to understand the real practices performed for tomato cultivation in the study area. The opinion of farmers with regarding to tomato production was asked to the sample farmers on various aspects namely infestation of crop with insect/pest/disease, lack of irrigation, non-availability of labour in peak season /time etc. The elicitation of sample farmer's with regard to production of tomato was decreasing the yield of tomato due to cultivation of same crop since long period of time, which was reported by 88.33 per cent farmers and was the most burning constraints for tomato cultivation. The second most important constraint was lack of irrigation which was reported by 85 per cent farmers followed by lack of availability of fund in proper time (75%), lack of latest technical knowledge (70%), infestation of insect/pest/disease (66.67%) and minimum farmers reported for scarcity of labour during peak season/time.

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EFFECT OF DIFFERENT FLORAL PRESERVATIVES SOLUTIONS ON POST HARVEST QUALITY OF TUBEROSE (*POLIANTHES TUBEROSA* L.) CV. DOUBLE

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Abstract: The present study was conducted during 2013-14 to prolong the post-harvest life of tuberose using single or combined holding solutions. Tweleve holding solutions, viz. T_1: 300ppm Al_2SO_4 T_2: 100ppm $CoCl_2$ T_3: 5%Sucrose + 300ppm Al_2SO_4, T_4: 5%Sucrose + 250ppm Citric Acid T_5: 5%Sucrose + 25 ppm $KMnO_4$, T_6: 5%Sucrose +100ppm $CoCl_2$ T_7: 200ppm Citric Acid T_8: 5%Sucrose +200ppm Citric Acid, T_9: 5%Sucrose + Calcium hypochlorite(Ca(ClO)2), T_{10}: 5%Sucrose + 200ppm 8HQC, T_{11}: 5%Sucrose + 200ppm 8HQC + GA_3 100ppm and T_{12}: Control (Deionized water) were used in a completely randomized block design with 3 replications. The results showed that holding solutions in single or in combined form significantly affected the post harvest quality of tuberose. The maximum vase life, floret size, vase life of individual flower, floret opening percentage and solution absorption by spikes were obtained with T_4 (5%Sucrose + 250ppm Citric Acid) while maximum days to opening of basal florets and number of florets open at senescence of basal floret were obtained when spikes were held in containing the solutions (5%Sucrose + 300ppm Al_2SO_4) under the treatment T_3.

Keywords: Pulsing solution, Holding solution, Floral preservatives solutions, Tuberose, Vase life

INTRODUCTION

Tuberose botanically known as (*Polianthes tuberosa* L.) is a very popular bulbous flowering plant grown for cut flowers as well as for loose flowers in India. It is native of Mexico and belongs to the family Amaryllidaceae. The white and sweet scented flowers are valued as cut flower, used in bouquets for making garlands, venis and also as a source of essential oils for perfumery industries. Tuberose flowers are highly perishable and therefore need to be treated with suitable chemicals, to enhance their vase life and improve quality. It has been proved that post harvest treatments with chemicals prevent vascular infections and inhibit ethylene production and thereby result in prolong storage period and higher quality flowers with increased vase life (Vidhya Sankar and Bhattacharjee 2002). Among the chemicals, silver nitrate, aluminium sulphate, cobalt sulphate, 8-hydroxyquinoline sulphate, boric acid, citric acid, ascorbic acid, sucrose etc. have been used in different formulations and combinations to enhance the vase life of tuberose (Reddy *et al*. 1995). Therefore, the present investigation was undertaken to study the combined influence of holding solutions on post harvest quality of tuberose spikes

MATERIAL AND METHOD

The experiment was conducted at Post harvest laboratory, Department of Horticulture, SVPUAT, Meerut during July to August, 2014 at ambient temperature of 30-35ºC in completely randomized block design. Each flower spike was harvested with uniform length between 7.00 am to 7.30 am at a stage when the first 1-2 florets start opening. Immediately after harvest, the flowers are put in deionized water for 20 minutes and then they were stored in different holding solutions. Treatment details of holding solutions used in the experiment consists of : T_1: 300ppm Al_2SO_4 T_2: 100ppm $CoCl_2$ T_3: 5%Sucrose + 300ppm Al_2SO_4, T_4: 5%Sucrose + 250ppm Citric Acid T_5: 5%Sucrose + 25 ppm $KMnO_4$, T_6: 5%Sucrose +100ppm $CoCl_2$ T_7: 200ppm Citric Acid T_8: 5%Sucrose +200ppm Citric Acid, T_9: 5%Sucrose + Calcium hypochlorite(Ca(ClO)2), T_{10}: 5%Sucrose + 200ppm 8HQC, T_{11}: 5%Sucrose + 200ppm 8HQC + GA_3 100ppm and T_{12}: Control (Deionized water). Observations were recorded on vase life of spikes, floret size, days to opening of basal florets, vase life of individual flower, number of florets open at time, floret opening percent and solution absorption by spikes.

RESULT AND DISCUSSION

A perusal of data (Table 1) revealed that all the holding solutions in different treatments were significantly affected the vase life of spikes. Vase life of spikes was recorded by calculating the number of days taken for 50% withering of flowers on the spike as suggested by Padaganur *et al*. (2005). Vase life of individual florets was recorded by taking the number of florets wilted every day divided by the total number of florets per spike. The results showed that the maximum vase life (7.99 days) was observed in treatment T_4 followed by, in the treatment T_3 (7.55 days) and it was minimum (4.85 days) in control. The increased vase life in days under the treatment T_4 and T_3 might be due to better water relations, delay in protein degradation, maintenance of membrane integrity, leading to delay in petal senescence (Vijaylakshmi and Rao, 2014). The present results were in accordance with Jature *et al.*, (2009) and Kumar *et al.* (2010). Improvement in

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vase life of spikes with citric acid was due to acidification of the solution, improvement in water balance and reduction in stem plugging (Durkin, 1979). Significant variation was observed among the treatments in terms of floret size and varied from 2.10-3.17 cm. The maximum floret size (3.17 cm) was observed when spikes were held in the solution containing 5% sucrose + 250 ppm citric acid under the treatment T_4 followed by, treatment T_3(2.62 cm) which was statistically at par with T_1 and T_6 and minimum floret size (2.10 cm) observed under control. Flowers held in citric acid @ 250 ppm along with sucrose 4% influenced flower size by increasing water uptake, maintaining normal levels of transpirational loss of water, improved water balance, there by increased the diameter of flower. Treatment comprising sucrose with citric acid and Al_2SO_4 had shown a significant effect on days to opening of basal floret and it was maximum (3.67 days) noted under the treatment T_3 which was significantly at par with T_1 followed by, (3.43 days) under the treatment T_{11} when spikes were kept with containing the solution 5%Sucrose + 200ppm 8HQC + GA_3 100ppm and treatment T_5, (3.28 days) which was also at par with the treatment T_8 and T_{10} and minimum days to opening of basal floret (2.43 days) was observed under control. Vase life of individual flower also differed due to different treatments and it was maximum under the treatment T_4 (5.83 days) followed by, (4.30 days) under the treatment T_3 and it was statistically at par with the treatment T_2, T_4, T_5, T_7, T_8, T_9, T_{10} and T_{11} while minimum vase life of individual flower (1.11 days) was recorded under control when spikes were kept deionized water. Sucrose in combination with either citric acid or aluminium sulphate maintains endogenous levels of soluble sugars and soluble proteins which in turn provide energy for floret development and increased the longevity of flower (Hussain *et al.,* (2001). These results were in accordance with Varu and Barad (2008) and Kumar *et al.* (2007) in tuberose. Pal and Sirohi (2007) also reported that combination of sucrose + citric acid and sucrose + aluminium sulphate, increased the cut flower longevity by increasing water uptake and maintaining cut flower longevity in gladiolus. Further, significant influence of different chemical solutions as single and in combined form was observed in terms of number of florets open at senescence of basal floret and it was maximum (4.59 floret) observed under the treatment T3 followed by, treatment T_2 (4.12 florets) when spikes were held in 100 ppm CoCl2 solution and it was minimum (3.39 floret) recorded under control. The maximum number of flower open at senescence of basal florets might be due to better water relations, delay in protein degradation, maintenance of membrane integrity, leading to delay in petal senescence. The data indicated that floret opening percentage was also influenced by different chemical solutions and it was maximum observed (80.77%) under the treatment T_3 followed by, (75.61%) when spikes were treated with 5% sucrose + 250 ppm citric acid solutions under the treatment T_4 and minimum opening (51.74%) was recorded under control. $Al_2(SO_4)_3$ has been found to acidify the holding solution to reduce bacterial and fungal growth hence increases the water absorption by spikes and increased the opening of florets percentage. (Halevy and Mayak 1981, Bhattacharjee, 1999) Significant variations in the solutions absorbed by the spikes were also observed with different treatments. The spikes held in solution with 5% sucrose + 300 ppm Al_2SO_4 under the treatment T_3 significantly absorbed maximum (93.69 ml) solutions followed by, the treatment T_5 (88.24 ml) and minimum absorption (57.91 ml) was observed under control. High transpiration loss of water by tuberose spikes held in citric acid 250 ppm might be due to higher water uptake to avoid temporary water stress and minimum loss of water was observed in control due to decreased water uptake, there by the quantity of water. Similar results were also reported by (Vijayalakshmi and Rao, 2014) in tuberose.

Table 1: Effect of different floral preservatives solutions on post harvest quality of tuberose (*Polianthes tuberose* L.) cv. Double

	Treatment	Vase life(days)	Floret size(cm)	Days to opening of basal floret(days)	Vase life of individual flower (days)	No. of florets open at senescence of basal floret	Floret opening %	Solution Absorption/ spike(ml)
T_1	300ppm Al_2SO_4	6.75	2.53	3.62	3.90	3.75	61.94	68.56
T_2	100ppm $CoCl_2$	6.65	2.32	2.91	3.09	4.12	65.27	69.81
T_3	5%Sucrose + 300ppm Al_2SO_4	7.55	2.62	3.67	4.30	4.59	75.61	88.24
T_4	5%Sucrose + 250ppm Citric Acid	7.99	3.17	2.88	5.83	3.59	80.77	93.69
T_5	5%Sucrose + 25 ppm $KMnO_4$	6.52	2.19	3.28	3.31	3.73	65.52	62.06
T_6	5%Sucrose +100ppm	7.11	2.53	3.09	2.81	3.63	60.33	

	$CoCl_2$							64.57
T_7	200ppm Citric Acid	6.50	2.43	3.09	3.74	3.67	68.43	74.29
T_8	5%Sucrose +200ppm Citric Acid	7.14	2.51	3.25	3.55	3.81	63.43	83.67
T_9	5%Sucrose + Calcium hypochlorite(Ca(ClO)2)	6.27	2.41	2.89	3.00	3.59	57.76	66.87
T_{10}	5%Sucrose + 200ppm 8HQC	6.00	2.33	3.20	3.16	3.73	57.82	73.18
T_{11}	5%Sucrose + 200ppm 8HQC + GA_3 100ppm	6.40	2.38	3.43	3.46	4.06	62.83	75.08
T_{12}	Control	4.85	2.10	2.43	1.11	3.39	51.74	57.91
	MSE	**0.015**	**0.031**	**0.029**	**3.813**	**5.627**	**0.081**	**0.846**
	CD at 5%	**0.100**	**0.144**	**0.140**	**1.594**	**1.937**	**0.232**	**0.751**

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SOIL VEGETATION INTERRELATIONSHIP IN EUCALYPTUS AND SHISHAM PLANTATIONS OF DEHRADUN

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Abstract: The soils under two Plantations i.e Eucalyptus (*Eucalyptus globulus*) and Shisham (*Dalbergia sissoo*) were analysed for physio-chemical properties and vegetation analysis. Soil samples were analyzed for texture, water holding capacity, pH, available potassium, available phosphorus, total nitrogen, organic carbon, electrical conductivity, calcium and magnesium. Average available potassium was maximum (73.00ppm) in *Eucalyptus globules* plantation, whereas it was (32.00ppm) in shisham plantation. Similarly available phosphorus was highest in Eucalyptus (18.17ppm) whereas in shisham it was (2.75ppm). Organic carbon and total nitrogen were also maximum under eucalyptus plantation. The soil pH under eucalyptus was near neutral, whereas it was slightly acidic in shisham. The average available calcium and magnesium were also higher in eucalyptus plantation. The average electrical conductivity in both the plantations was 0.03dsm^{-1}. The highest tree density was 733 trees ha^{-1} in shisham plantation, declining to 433 trees ha^{-1} in eucalyptus plantation.

Keywords: Eucalyptus, Nutrients status, Physico-chemical, Soil, Shisham, Vegetation

INTRODUCTION

The soil and vegetation have a complex interrelation because they develop together over a long period of time. The vegetation influences the chemical properties of soil to a great extent. The selective absorption of nutrient elements by different tree species and their capacity to return them to the soil brings about changes in soil properties (Singh et al. 1986). Concentration of elements in the soils is a good indicator of their availability to plants. Their presence in soil would give good information towards the knowledge of nutrient cycling and biochemical cycle in the soil–plant ecosystem (Pandit and Thampan, 1988). The yearly contribution of surface vegetation to soil, in the form of needles, leaves, cones, pollen, branches and twigs, gradually decomposes and becomes a part of the soil (Singh and Bhatnagar, 1997). Thus the present study was carried out to study the impact of *Eucalyptus globules* (eucalyptus) and *Dalberga sissoo* (shisham) vegetation covers on the physicochemical properties of soils.

MATERIAL AND METHOD

This study was carried out in two different vegetation types at Dehradun of Uttarakhand, which lies between 77 20'4"- 78 18'30" E longitude, 29 58'40"- 30 20'4" N latitude at an elevation of 620 m (a.m.s.l).The study was conducted at two different sites (Site 1-Manduwalla, Site 2- Sidduwala) of Dehradun Forest Division. Soil samples were collected at three different places, randomly selected in each selected site and thus nine pits were dug out (3 pits at each site) Soil samples were collected from three predetermined depths i.e. 0-10, 10-30 and 30-60cm by opening pits. The water holding capacity (WHC) was determined as per Mishra (1968), whereas the bulk density was estimated by the method of Wilde *et al*. (1964). Porosity was expressed in percent by volume calculated from the bulk density (BD) and particle density (PD) of soil (Brady 1996). Munsell Colour Chart was used to determine the soil colour. Walkley and Black rapid titration method as modified by Walkley (1947) was adopted for organic carbon estimation. The pH of soil was determined directly with using a Control Dynamics digital pH meter (model AP + 175E/C). Total nitrogen was determined by the colorimetric technique (Jackson 1993). Available potassium was extracted by neutral normal ammonium acetate (Morwin and Peach; 1951). Available phosphorus was determined in the soil by Olsen's method, (Olsen *et al*. 1954). The vegetation analysis was done by laying out quadrats. On each selected site 25 quadrats were laid (each 10 x 10 m) randomly to study tree components as described by Curtis and McIntosh (1950) and Mishra (1968).

RESULT

The soil texture in *Eucalyptus globules* was silty clay loam at 0-10 and 30-60 cm depths and silty loam at 10-30cm depth. The bulk density increased with the increase in depth. Moreover, due to the increase of bulk density with depth the porosity thus showed the reverse trend and decrease with the depth. The moisture content and water holding capacity was found higher (13.38%) and (52.77%) at 30-60cm

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depth respectively. The soil pH was slightly acidic and ranged from 6.97 to 6.30. The organic carbon content was found higher in the surface horizon and decrease with the increasing depth. The available phosphorus was found maximum (11.3ppm) at the upper horizon and decrease with increase in depth. Soil potassium was also found maximum (117ppm) at the surface of the soil and it also decreased with the increasing depth. Similarly the total nitrogen was also found higher (0.16) in the upper surface of the soil and decreased with increasing depth. The electrical conductivity ranged from 0.02dsm-1 to 0.57 dsm^{-1}. The exchangeable calcium was found higher 0.11% at 10-30cm depth. The exchangeable magnesium was found higher 0.04% at 30-60cm depth. (Table 1)

Similarly in *Dalbergia sissoo* (Shisham) plantation, the soil texture was found loamy at 10-30cm depth and silty loam at 0-10cm depth and 30-60cm depth respectively. The bulk density increased with the depth and the porosity in turn showed the reverse trend and decreased with the increased in depth. The water holding capacity (WHC) was found higher (46.66%) at 0-10cm depth. The WHC is influenced by the clay content, thus it was higher when the percent clay was high. The organic carbon was found maximum (0.72%) at the surface horizon of the soil and decrease when increase in depth. The soil pH was near neutral and ranged from 5.66 to 6.36. The phosphorus was found maximum (3.75ppm) at 0-10cm depth, whereas potassium was found maximum (51ppm) at the upper surface and decrease with increase in depth. The total nitrogen was also found maximum (0.098%) at the upper surface and decrease with increase in depth. The electrical conductivity ranged from 0.03dsm^{-1} to 0.5 dsm^{-1}. The ex. calcium was found higher 0.15% at 10-30cm depth. The exchangeable magnesium was found higher 0.03% at 0-10cm depth. (Table 2).

The tree density was recorded maximum 733 trees ha^{-1} for shisham plantation whereas, it was 433 trees ha^{-1} in eucalyptus vegetation. In eucalyptus plantation a highly significant correlation was found between OC and T.N (0.86). Similarly in shisham plantation a highly significant correlation was found between organic carbon and total nitrogen (0.99) and available phosphorus and total nitrogen (0.99). (Table 3 & 4).

DISCUSSION

The volume-weight relationship of soil in oven dry conditions is termed as the bulk density (Gupta and Sharma, 2008). In both the vegetation types of the present study the bulk density increased with the increasing soil depths because the lower layers were more compact under the weight of upper portion of soil and also due to the lower amount of organic matter in deeper layers (as was also suggested by Haans, 1977, Patil and Prasad, 2004). The water holding capacity increased with the increase in the clay content at all the sites and was low on the sites, where percent sand was higher. Sandy soils generally have less favorable moisture holding capacity and nutrient retention characteristics than non-sandy soils (Pastor and Post, 1986; Perry, 1994). In the present study a positive correlation was found between organic carbon, total nitrogen, organic matter and available phosphorus in all the vegetation types. Gupta and Sharma (2008) also showed that nitrogen, organic carbon and phosphorus were positively correlated chiefly because all these attributes are intimately linked with soil humus.

Potassium performs very vital processes like regulating transpiration and respiration, influencing enzyme action, synthesis of carbohydrates and proteins etc. (Brady, 1966). Potassium is not much influenced by soil organic matter because it is not the direct supplier of potassium (Gupta and Sharma, 2008). The maximum potassium was recorded under Eucalyptus plantation.

Table 1. Physio-chemical properties of soil under Eucalyptus plantation (site 1)

Depths	WHC %	Soil porosity %	Bulk Density %	Soil Texture %	Total Nitrogen %	Organic Carbon %	C/N Ratio	Available Phosphorus (ppm)	Available Potassium (ppm)	pH	EC dSm^{-1} (1:5)	Ca%	Mg%
0-10	48.2	63.84	0.94	Silty Clayey Loam	0.16	1.40	8.94	11.3	117.0	6.97	0.05	0.10	0.03
10-30	47.5	61.53	1.00	Silty Loam	0.084	0.78	6.34	7.5	67.5	6.75	0.02	0.11	0.03
30-60	46.1	57.30	1.11	Silty Calyey Laom	0.097	1.18	7.22	6.3	34.5	6.30	0.02	0.05	0.04
Mean	50.54	60.89	1.01		0.11	0.91	7.5	18.17	73.00	6.67	0.03	0.86	0.03

Table 2. Physico-chemical properties of soil under shisham plantation (Site 2)

Depths	WHC %	Soil porosity %	Bulk Density %	Soil Texture %	Total Nitrogen %	Organic Carbon %	C/N Ratio	Available Phosphorus (ppm)	Available Potassium (ppm)	pH	EC dSm^{-1} (1:5)	Ca%	Mg %
0-10	46.66	63.70	0.85	Silty Loam	0.098	0.722	7.36	3.75	51	5.66	0.05	0.15	0.03
10-30	38.45	66.15	0.88	Loam	0.064	0.290	4.53	2.50	25	5.71	0.03	0.09	0.02
30-60	23.38	56.15	1.14	Silty Loam	0.042	0.132	3.14	2.00	20	6.36	0.03	0.08	0.002
Mean	36.16	62	0.95		0.068	0.38	5.01	2.75	32	5.91	0.03	0.10	0.017

Table 3. Statistical Correlation between various parameters in *Eucalyptus globulus* plantation

	WHC	*P*	*B.D*	*TN*	*OC*	*AP*	*AK*	*pH*	*EC*	*Ca*	*Mg*
WHC	**1**										
P	**1.00**	**1.00**									
B.D	**-1.00**	**-1.00**	**1.00**								
TN	**0.64**	**0.66**	**-0.66**	**1.00**							
OC	**0.17**	**0.19**	**-0.19**	**0.86**	**1.00**						
AP	**0.89**	**0.90***	**-0.90**	**0.92**	**0.60**	**1.00**					
AK	**0.95**	**0.96**	**-0.96**	**0.84****	**0.46**	**0.98**	**1.00**				
pH	**1.00**	**1.00**	**-1.00**	**0.64**	**0.16**	**0.88**	**0.95**	**1.00**			
EC	**0.76**	**0.77**	**-0.77**	**0.99***	**0.77**	**0.97**	**0.92**	**0.75**	**1.00**		
Ca	**0.88***	**0.87**	**-0.87**	**0.21**	**-0.32**	**0.56**	**0.70**	**0.89**	**0.36**	**1.00**	
Mg	**-0.94**	**-0.94**	**0.94**	**-0.36**	**0.17**	**-0.69**	**-0.80**	**-0.95**	**-0.50**	**-0.99**	**1.00**

*significant at 1% level & **significant at 5% level

Table4. Statistical Correlation between various parameters in *Dalbergia sissoo* plantation

	WHC	*P*	*B.D*	*TN*	*OC*	*Av.P*	*Av.K*	*pH*	*EC*	*Ca*	*Mg*
WHC	**1.00**										
P	**0.83**	**1.00**									
B.D	**-0.97**	**-0.95**	**1.00**								
TN	**0.96**	**0.63**	**-0.85**	**1.00**							
OC	**0.91**	**0.52**	**-0.77**	**0.99***	**1.00**						
Av.P	**0.92**	**0.54**	**-0.78**	**0.99***	**1.00**	**1.00**					
Av.K	**0.86**	**0.42**	**-0.70**	**0.97**	**0.99***	**0.99**	**1.00**				
pH	**-0.96**	**-0.95**	**1.00**	**-0.84**	**-0.75**	**-0.76**	**-0.67**	**1.00**			
EC	**0.77**	**0.28**	**-0.58**	**0.92**	**0.97**	**0.96**	**0.99**	**-0.55**	**1.00**		
Ca	**0.85***	**0.41**	**-0.68**	**0.96**	**0.99**	**0.99**	**1.00**	**-0.66**	**0.99**	**1.00**	
Mg	**1.00**	**0.83**	**-0.96**	**0.96**	**0.91**	**0.92**	**0.86**	**-0.96**	**0.77**	**0.85**	**1.00**

*significant at 1% level & **significant at 5% level

T.N. = Total Nitrogen, OC = Organic carbon, AV.P = Available phosp, AV.K = Available potassium, WHC = Water Holding Capacity, Soil. P = Soil Porosity, B.D. = Bulk density,

Table 5. Phyto-sociological attributes of site -1 (*Eucalyptus globules* plantation)

S. No	Name of Tree spp.	Frequency %	Density plants/ha	Abundance	Dominance	Relative dominance %	Relative density %	Relative frequency %	IVI
1	**Eucalyptus**	**83.33**	**433**	**5.2**	**1454.98**	**100**	**100**	**100**	**300**

Table 6. Phyto-sociological attributes of site -2 (*Dalbergia sissoo* plantation)

S. No	Name of Tree spp.	Frequency %	Density plants/ha	Abundance	Dominance	Relative dominance %	Relative density %	Relative frequency %	IVI
1.	**Shisham**	**100**	**733**	**733**	**1754.54**	**100**	**100**	**100**	**300**

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SHORT COMMUNICATION

RESPONSE OF GENOTYPES AND GROWTH REGULATORS ON NUTRIENT UPTAKE, ECONOMICS AND ENERGY OUT-PUT OF PIGEONPEA (*CAJANUS CAJAN* (L.) MILLSP) IN *VERTISOLS* OF CHHATTISGARH PLAINS

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Abstract: In Chhattisgarh, pigeonpea occupies an area of 164.72 m ha with a production of 85.69 m t and productivity of 520 kgha^{-1}. Present study was undertaken to assess the effect of genotypes and growth regulators on nutrient uptake, economics and energy output of pigeonpea in *Vertisols* of Chhattisgarh plains. Field experiment was conducted during *kharf* (rainy) season of 2000-01 at IGKV, Raipur on *Vertisols* having pH 7.19 with available N 218, P 12.15 and K 363 kgha^{-1} . The N and K uptake were found to be higher in cv. Asha, even though their concentration was low; it is due to higher biological yield of cv. Asha. As regards to economics comparison of both cultivars, the gross and net realization estimated to be significantly higher in cv. Asha than cv. C-11. Highest seed protein content was observed in 2,4-D , which is corroborates the findings of Borriobera *et al.* (1995). Protein yield was found to be highest in cycocel and 2,4-D for seed and stalk respectively. Economics of pigeonpea production was inf1uenced by growth regulators. Highest gross and net realization were found in cycocel treatment

Keywords: Growth regulators, Economics, Nutrient uptake

INTRODUCTION

Pigeonpea *Cajanus cajan* (L.) Millsp cultivation in Chhattisgarh state occupies a distinct position in the pulse map of India. In Chhattisgarh, it occupies an area of 164.72 m ha with a production of 85.69 m t and productivity of 520 kgha^{-1} and productivity of pigeonpea can be ascribed to the constraints associated with its agro-ecological and physio-morphological traits. Pigeonpea genotypes have been classified into early, medium and long duration types, each forming a different production system. The expression of variability for different characters differs among the various production systems. Thus, a generalized production strategy can not be formulated for pigeonpea (Sachan,1992). Plant growth substances play a significant role in modification of crop growth, yield and quality of crop (Randhawa and Singh, 1970; Pando and Shrivastava, 1985 and Wang and Zapata,1987). Agro- ecological situations, management factors and renewable energy sources affects the crop production. Considering these points in view this study was undertaken to assess the effect of genotypes and growth regulators on nutrient uptake, economics and energy output of pigeonpea in *Vertisols* of Chhattisgarh plains.

MATERIAL AND METHOD

A field experiment was conducted during *kharf* (rainy) season of 2000-01 at IGKV, Raipur on *Vertisols* having pH 7.19 with available N 218, P 12.15 and K 363 kgha^{-1}. Climate of the region is drying moist, sub-humid with average rainfall of 1200-1400 mm. The crop received 214 mm rainfall during the growth period. The experiment was laid out in a RBD (factorial) with four replications. The treatments consisting of three growth regulators (control, 2,4-D @ 20ppm and cycocel @ l000ppm) and two pigeonpea genotypes (Asha and C-11). Pigeonpea seeds were sown at a seed rate of 20 kg ha^{-1} on 5th August, 2000 with a spacing of 60 cm x 15 cm. Recommended fertilizer dose@ 20:50:30 kg NPK ha^{-1} was applied uniformly. Harvesting was done on 2nd February, 2001. The N, P and K content in seed and stalk were estimated by micro kjeldahl method, Vanado molybdo phosphoric yellow colour method and flame photometry respectively as described by (Jackson, 1967). Protein content, N P K uptake, energetics and economics were also worked out by respective formulas. Cost of production for all treatments was worked out on the basis of the prevailing input and market price of the produce.

RESULT AND DISCUTION

Results revealed that the N, P and K content in seed and stalk was significantly higher in cv. C-1l than cv. Asha (Table l). This is due to the dilution effect on account of higher biological yield of cv. Asha. The N and K uptake were found to be higher in cv. Asha, even though their concentration was low; it is due to higher biological yield of cv. Asha (Table 2). But the phosphorus uptake followed the exact pattern of its concentration. The protein content being a function of nitrogen content is obvious to follow a similar trend as that of nitrogen. But the protein yield was statistically more in cv. Asha because of higher productivity (Table 2). Jarillo *et al*. (1998) also found

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that the highest seed yields were generally correlated with relatively high crude protein content.

As regards to economics comparison of both cultivars, the gross and net realization estimated to be significantly higher in cv. Asha than cv. C-11 (Table 3). This high return in cv. Asha might be due to higher productivity. Energetics in relation to energy input, output input ratio and use efficiency were significant1y higher with cv. Asha, due to higher energy output, which is nothing but the outcome of higher yield (Table 3).

Growth regulators causes variation in N, P, K content at plant. The higher seed N, P and K contents were observed in 2,4-D treatment, but their concentration in stalk were noted in cycocel (Table 1), On the contrary, Shende *et al*. (1987) observed increased N and P contents in seed due to foliar spray of cycocel. Since, the seed yield in 2,4-D was less as compared to cycocel a comparatively lower seed nutrient concentration in cycocel, might be due to dilution effect. This was also noticed in case of stalk yield, but because the stalk yield was higher in 2,4-D, its nutrients concentration was found to be lower. Low N concentration was found in seed due to cycocel, but its uptake was highest might be due to higher yield. Higher N uptake in stalk is positively correlated with high N concentration in it. The seed P concentration was the highest in 2,4-D which ultimately resulted in higher seed P uptake, but highest P uptake, inspite of low stalk P concentration might be due to higher stalk yield. As regards seed K uptake, 2,4-D and cycocel had the same K uptake values which was significantly more than the control. But incase of stalk, the K uptake was highest in 2,4-D obviously due to more of stalk yield (Table 2). The protein content based on N concentration obviously followed the similar trend of nitrogen. Highest seed protein content was observed in 2,4-D , which is corroborates the findings of Borriobera *et al.* (1995). Protein yield was found to be highest in cycocel and 2,4-D for seed and stalk respectively.

Economics of pigeonpea production was inf1uenced by growth regulators. Highest gross and net realization was found in cycocel treatment (Table 3). Gupta (2000) also observed higher gross and net return with cycocel application. From energy considerations, the energy output, energy output input ratio and energy use efficiency were highest in case of 2,4-D due to highest biological yield coupled with low energy input on accounts of its application of a lower concentration.

Although cv. Asha and application of 2,4-D @ 20 ppm increased N P K content, but from economics and energy considerations cv. Asha and cycocel spray was the most viable.

Table 1. Nutrient content in pigeonpea as affected by genotypes and growth regulators

Treatment	Content (%)							
	Nitrogen		Phosphorus		Potassium		Protein	
	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk
Genotypes								
Asha	3.36	0.85	0.24	0.08	0.45	0.74	21.37	5.09
C-11	3.57	0.91	0.31	0.09	0.50	0.83	22.38	5.89
SEm±	0.11	0.01	0.008	0.001	0.008	0.010	0.31	0.61
CD (p=0.05)	0.33	0.04	0.024	0.003	0.024	0.033	0.93	0.49
Growth Regulators								
Control	3.34	0.83	0.23	0.08	0.45	0.78	20.90	5.22
2, 4-D@ 20 ppm	3.57	0.85	0.30	0.08	0.50	0.77	22.88	5.30
Cycocel @ 1000 ppm	3.49	1.00	0.25	0.09	0.47	0.80	21.84	6.11
SEm±	0.18	0.03	0.010	0.003	0.010	0.013	0.40	0.20
CD (p=0.05)	NS	0.09	0.030	0.009	0.030	NS	1.20	0.60

Table 2. Nutrient uptake in pigeonpea as affected by genotypes and growth regulators

Treatment	Nutrient Uptake (kg ha^{-1})						Protein yield (kg ha^{-1})	
	Nitrogen		Phosphorus		Potassium			
	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk
Genotypes								
Asha	71.44	74.97	4.34	6.49	9.45	69.03	454.79	467.01
C-11	59.25	71.18	5.18	7.35	8.15	68.49	375.30	475.81
SEm±	2.72	1.22	0.22	0.28	0.27	1.06	17.09	15.19
CD (p=0.05)	8.20	3.67	0.66	0.84	0.81	NS	51.09	NS
Growth Regulators								
Control	57.77	73.26	4.58	6.66	7.80	68.99	361.04	457.61
2, 4-D@ 20 ppm	66.46	69.84	5.55	7.33	9.31	70.52	415.37	484.35
Cycocel @ 1000 ppm	71.79	76.12	5.06	6.77	9.31	66.76	465.72	472.27
SEm±	3.33	1.94	0.27	0.32	0.33	1.30	18.32	18.60
CD (p=0.05)	10.05	5.84	0.81	NS	0.99	NS	55.20	NS

Table 3. Effect of genotypes and growth regulators on energetics and economics of pigeonpea

Treatment	Energy input (MJ x 10^{-3} ha^{-1})	Energy input (MJ x 10^{-3} ha^{-1})	Energy output input ratio	Energy use efficiency (q MJ x 10^{-3} ha^{-1})	Cost incurring (Rs ha^{-1})	Gross realization (Rs ha^{-1})	Net realization Rs ha^{-1}	Re $^{-1}$ invested
Genotypes								
Asha	7.79	14.95	18.93	14.67	14052	3730	21371	2.57
C-11	7.79	127.08	16.30	12.66	14052	3275	14553	2.02
SEm±	-	1.61	0.21	0.16	-	872	419	0.06
CD (p=0.05)	-	4.84	0.62	0.47	-	2028	1264	0.19
Growth Regulators								
Control	7.76	132.76	17.43	13.56	13632	29449	15817	2.15
2, 4-D@ 20 ppm	7.77	141.69	18.23	14.16	13938	31724	17786	2.22
Cycocel @ 1000 ppm	7.85	135.10	17.20	12.08	14588	34871	20283	2.53
SEm±	-	1.87	0.25	0.19	-	1068	603	0.08
CD (p=0.05)	-	5.66	0.76	0.58	-	3218	1316	0.24

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SHORT COMMUNICATION

PRODUCTION POTENTIAL OF DIFFERENT VARIETIES OF SORGHUM (*SORGHUM BICOLOR* L.) UNDER SEMI ARID AGRO-ECOLOGICAL SITUATIONS

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Abstract: Five shorgum varieties were evaluated and compared with farmers' local variety for their grain and straw yield at farmers' own field. The results revealed that sorghum varieties differed significantly for grain and straw yield. Among varieties, CSV 15 recorded highest grain (1945 kg ha^{-1}) and straw (12200 kg ha^{-1}) yield. The results proved that the CSV 15 was most suitable varieties under prevailing climatic condition of the study area.

Keywords: Shorgum, Variety, Grain, Straw yield, Production

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is the staple cereals and important source of fodder for animals in the semi-arid and arid parts of India (Murty *et al*., 2007). It makes comparatively quick growth and gives not only good yield of grain but also very large quantities of fodder. It is grown for dual purpose i.e., food for home consumption and fodder for their livestock. Shorgum has enormous potential for fodder and is fast emerging as promising crop for dual purpose. Ullah *et al*. (2007) reported that its grains contain about 10-12% protein, 03% fat and 70% carbohydrates, therefore, it can replace other grains in the feeding program for dairy cattle and poultry. Sorghum is also a good subtract for ethanol production which can be added to fuel for saving precious foreign exchange (Reddy *et al*., 2005). Sorghum is in important crop in Tonk distirct of Rajasthan. However, the average productivity of sorghum in the district is very low (571.00 kg ha^{-1}) as compared to average state productivity (700.00 kg ha^{-1}) (anonymous, 2011). Among various factors responsible for low yield, lack of suitable high yielding variety as well as poor knowledge about production practices are ascribed as main reasons for low productivity of sorghum in the district. Keeping this in view, the present study was conducted to evaluate genotypic potential among different sorghum genotypes for their grain yield and other associated characteristics under agro-climatic condition of semi arid ecosystem of Rajasthan.

MATERIAL AND METHOD

Five sorghum varieties were evaluated at the farmers' field during the rainy season of two consecutive years 2010 and 2011 under "Action Research for Refinement of Package of Practices for Productivity Enhancement of Crops in Different Agro-Ecological Situations" of Rashtiya Krishi Vikash Yojana. The trial was laid out in a randomized complete block design with 4 replications, farmer as a replication. Six varieties namely CSH 9, CSV 10, CSV 15, CSH 16, CSH 23 and local germplasm (farmer practice) were included in the experiment. The experiment was conducted in rainfed condition. The soils of the demonstration fields were medium to coarse textured with pH ranging from 8.32 to 8.53, medium in available nitrogen (145-160 kg/ha), phosphorus (23-34 kg/ha) and high in available potassium (345-434 kg/ ha). The average annual rainfall received during crop season was about 659 mm. Plant spacing was maintained 45x15 cm. The crop was sown on 28 June, 2010 and 3 July, 2011 and harvested at maturity. Recommended fertilizer dose 40kg N and 20kg P was applied as basal dose to raise the crop. All other agronomic practices were kept uniform for all the treatments.

Five plants were selected randomly from central 2-rows of each plot for recording data on stalk and grain yield. Grain and stalk yields were recorded and then converted to kg per hectare. The data were analyzed statistically and means were compared local variety. The technology gap and technology index were calculated using the following formulas as given by Samui *et al*. (2000):

Technology gap = Potential yield –Demonstration yield

Technology index = Potential yield –Demonstration yield/Potential yield ×100

RESULT AND DISCUSSION

Grain yield (kg ha^{-1})

Five shorgum varieties (CSH 9, CSV 10, CSV 15, CSH 16 and CSH 23) were evaluated for their grain and straw yield at farmers' field. The data revealed that sorghum varieties differed significantly for grain yield (Table-1). The highest grain yield was obtained

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from sorghum variety CSV-15 (1945 kg ha^{-1}) which was 83.15 % higher over farmers local germ plasm.

Stalk yield (kg ha^{-1})

Varieties also differed significantly in stalk yield (Table-1). The highest stalk yield was obtained from varieties CSV 15 (12200 kg ha^{-1}) which was significantly higher (29.79 %) over farmers local germ plasm. The data further showed that proved CSV 15 as dual-purpose variety under Semi-arid and transitional zones with reasonable grain and straw yields.

Table 1. Comparative yield performance of different sorghum varieties at farmers' field (Mean of two years)

Variety	Yield (kg ha $^{-1}$)		% increase over local check	
	Grain	Straw	Grain	Straw
CSH 9	1561	12000	46.99	27.66
CSV 10	1372	11000	29.19	17.02
CSV 15	1945	12200	83.15	29.79
CSH 16	1742	11000	64.03	17.02
CSH 23	1469	10900	38.32	15.96
Local	1062	9400	-	-

Yield of the demonstrations and potential yield of the varieties under study was compared to estimate the technological gap which shows the gap in the demonstration yield over potential yield. It was observed that technological gap in variety CSV 15 (2055 kg ha^{-1}) was substantially lower than that of all other varieties.

Technology index shows the feasibility of the variety at the farmer's field. The lower the value of technology index more is the feasibility. Table 2 revealed that, the technology index value of CSV 15 was lowest (51.38 %) followed by CSV 10 (60.80 %). The results proved that the CSV 15 was most suitable varieties under prevailing climatic condition of the study area.

Table 2. Yield gap and technology index of sorghum varieties at farmers' field

Year	**Technology gap (kg ha^{-1})**	**Technology index (%)**
CSH 9	2439	60.98
CSV 10	2128	60.80
CSV 15	2055	51.38
CSH 16	2258	56.45
CSH 23	2531	63.28

CONCLUSION

It may concluded that sorghum varieties differed in their capability of producing higher straw and grain yield. Among the tested genotypes, CSV 15 produced higher grain and straw yield than all other varieties. Sorghum variety CSV 15 found as dual-purpose variety under semi-arid agro eco system.

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SHORT COMMUNICATION

THE NEGLECT OF POTASSIUM: NECESSITY OF K FOR CROP SUSTAINABILITY A REVIEW

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Abstracts: In ancient time, agriculture was more or less sustainable due to regular organic fertilization. Due to various economic constraints, farmers are forced to apply agrochemicals that give higher returns resulting in relatively high N input and a coincidental decrease of other nutrients including K. This situation is accompanied by negative K balance for many agricultural regions and indicates only a short- term consideration. A long term neglect of K would result in a non-sustainable situation for crop productivity.

Keywords: Productivity, Crop, Potassium, Agrochemicals

INTRODUCTION

From the various physiological functions of K in crop production, particularly, in avoidance of various biotic and abiotic stresses, it can be concluded that the practice of imbalanced fertilization with the neglect of proper K fertilization will result in increasing problems, particularly, under stress- prone environments. Innovative K fertilization management strategies have to be developed to efficiently counteract the decline in crop sustainability due to an imbalanced fertilizer use.

As shown in Fig.1 the agricultural growth trend peaked in 1980's and has declined since then (Ahluwalia, 2005). The response ratios appreciated with a rising trend only when chemical fertilizers were supplemented with multi-nutrient source of organic manure. In a long term fertilizer experiment (LTFE- ICAR), the response ratios to applied nutrients were computed for rice, wheat maize and finger millet in different places, the application of N alone caused reduction in response ratio, primarily due to deficiency of P and K. The response ratio increased with the application of P along with N, but its reduction with time was again conspicuous in the absence of K application (Samra, 2006).

Importance of K on Yield

Prasad (2006) reported that except for pulses, the production growth rates during 2000- 01 to 2002-03 for all crops are negative. As regard the productivity during this period, it is negative for all the crops except wheat**.** Xiong *et al*. (2000) reported that purple soil, which is K-rich soil, when fertilized with potassic fertilizer, increased the rice yield from 6.8 to 14.7% and denoted that the input of K has been one of the factors or potential factors for high yield. Saxena (1995) clearly indicated that wheat yields become uneconomical after 5 years when only N fertilizer is applied. Even annual field application of NP fertilizers is insufficient to sustain yields over long term. The increasing trend in response to K over the years suggests the need for its application in intensive rice- wheat cropping system. Malakouti *et al*. (2005) reported the synergistic interaction between K and Zn on yield increase of wheat and rice.

Disease Resistance

Christensen *et al*. (1981) reported that KCl together with ammonium fertilizer suppressed take- all disease. Prabhu *et al*. (1999**)** reported that the K-fertilization in absence of additional N greatly decreased panicle blast. The response was significantly linear and negative with increasing levels of K. On the other hand, the response of panicle blast to different levels of K was quadratic at 30 kg/ha of N. Disease severity increased as the N rate increased from 0- 60 kg/ha and decreased at rates above 60 kg/ha. Malakouti *et al*. (2005) reported that potassium along with Zn also reduced concentration of pollutants such as nitrate (NO_3) and cadmium (Cd) in the edible parts of the plants.

Quality of Crops

K increased significantly the yield and quality of tomatoes, higher % of marketable tomatoes were obtained from K treatments as compare to control; and MOP sources gave better results than SOP. K as MOP had positive effect on vitamin C (Akhtar *et al*., 2003). Jeyakumar *et al*. (2001) reported that potassium nutrition significantly influenced fruit weight, fruit yield/plant and the quality of the fruits including the quality of the latex.

Stress factor

Cakmak *et al*. (1994) reported that the photo-oxidative damage to the chloroplast is a key process in the occurrence of leaf symptoms under conditions

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of Mg or K deficiency. Leaf chlorosis, such as found in K and Mg deficient plants, is not typical of P deficient plants. Because of the distinct effects of Mg and K on photosynthetic carbon metabolism, photo-oxidative damage in plants grown under marginal conditions, such as drought, chilling, and salinity can be exacerbated when the soil supply of Mg or K is low. Even K-rich clay soil requires a regular K fertilization particularly under frequently occurring adverse soil conditions with inhibited replenishment and acquisition of K. Jensen *et al.* (2003) reported that legumes (Pea, Red Clover, Lucerne) accumulated large amount of N but lower amount of K than ryegrass, barley and rapeseed. Rye had an outstanding root surface, which in total and per unit root matter was twice than other crops. Crops modify their root hair length as response to low K conditions and maintain the uptake from soluble K sources.

Effect on Soil

Santhy *et al.* (1998) reported that the continuous cropping and fertilization had a deleterious effect on total K level of the soil, application of K fertilizer at 150% optimal level could maintain the initial status of the total K. Sharma *et al*. (2002) reported that the organic carbon, microbial biomass carbon and microbial count increased with the application of recommended NPK+ FYM compared to NPK, NP or N alone in a long term experiment on *Typic Hapludalf* at Palampur. Similarly, different K fraction *viz*., WS-K, NH_4OAc-K, Exch.-K, HNO_3, Non-exch.-K and TK-K was gradually decreased in 2007 from its base year values *i.e*. 2003 under FYM (0 and 10t/ ha) and NP application (0,50, 100 and 150% RD) at different depth of soil profile under *Bajra*-Mustard- Cowpea cropping system at Anand (Anon. 2008).

Potassium Balance in soil

Apparent potassium use efficiency of applied K in the 100% NPK treated plot was about 45.6% which increased to 55.6 % in NPK 100% + GM and 54.4% in 100% NPK + FYM treated plots. This could be due to higher crop removal of sol potassium and its available content in all the treatments (Yaduvanshi and Swarup, 2006). Nambiar and Ghosh (1984) shown K balances from two long term experiments in middle and lower Gangatic plains (West Bengal) in which treatments consisted of increasing levels of NPK, the higher K levels applied due to smectite nature of clay minerals resulted in K balances ranging from 0 to 75 kg K/ha. In sharp contrast K balances in illitic soils in pantnagar were highly negative even at low K application levels.

CONCLUSION

Application of only NP fertilizers is insufficient to sustain yields over long term. A long term neglect of K would result in a non sustainable situation for crop productivity. The application of K not only helps to increase crop yields in balanced application of nutrients but also improves crop quality, storage besides imparting resistance against drought and certain pest and disease.

Future Needs

Long term studies to monitor the effects of nutrients management in different agro- eco region and major cropping systems.

Ways and means of offset nutrient depletion: because application of nutrients as current recommendations seems to be insufficient.

Accurate nutrient balance sheets to be worked for the various agro- eco regions.

Development of farmer- friendly plant diagnostic technique that aids a rapid correction of limiting nutrient.

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