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Contents

RESEARCH ARTICLE

Morphological and genetical diversity analysis of *Alternaria* isolates from different host plant
—Tapoti Das, Sujata Chaudhuri and Srikanta Das---------- **1065**

Evaluation of physiochemical and antibacterial properties of honey samples from Bani (J&K): Pollen morphology of selected bee forage plants
—Mohammed Urfan, Mehnaz Bano and Bilal Ahmed----------1073

Leaf physiognomic analyses of available species of *Avicennia* L. in Indian Sundarbans for using as taxonomic tool
—Bidyut Kr. Mandal, Mithun Biswas and Sudha Gupta ----------1081

Phenological studies in a dioecious hepatic, *Pellia endivaefolia* (Dicks.) dumort
—Kanu Anand, Anu Sharma and Anima Langer ----------1087

Livelihood security of farmers in eastern Uttar Pradesh: An economic analysis
—Mukesh Kumar Maurya and V. Kamalvanshi ----------1095

Studies on yield and quality of french bean *(Phaseolus vulgaris* L.) genotypes, under net- house conditions
—Jitendra Meena, T.S. Dhillon and Anita Meena ----------1101

Feeding potential of *Chrysoperla zastrowi* Sillemi on solenopsis mealy bug, *Phenacoccus solenopsis* tinsley infesting cotton
—Bhojani D.V., Desai H.R., Shinde C.U. and Solanki B.G.----------1107

Impact of Krishi Vigyan Kendra's training on adoption of improved rice production technology in Rewa district. (M.P.)
—Dharmendra, B.K. Tiwari, Sanjay Singh R.K. Tiwari and K.S. Baghel and Toran lal Nishad ---------1113

Effect of balanced nutrition and bio-inoculants on flower yield and quality attributes of chrysanthemum *(Dendranthema grandiflora* Tzvelev*)*
—Mahantesh Biradar, B. Hemla Naik, M. Ganapathi and K.M. Asha----------1119

Effect of accelerated and natural ageing on total soluble seed protein profile of wheat (*Triticum aestivum*)
—D.S. Chauhan and D.P. Deswal ----------1123

Analysis of microbial contamination of drinking water at Meerut district, Northen India
—Rekha Yadav and Mukta Sharma----------1127

Management of prevalence of natural enemy, *Eublema amabilis* (Moore) by novel insecticides at Korba district of Chhattisgarh
—Y.K. Meshram, Rajeev Gupta, K.N.S. Banafar, B.P. Katlam and Bhupesh Joshi ----------1131

Empowerment of rural women through national rural livelihood mission in Rewa block of Rewa district (M.P.)
—Dharmendra, Sanjay Singh, B.K. Tiwari, R. K. Tiwari, K.S. Baghel and Samrat Dhingra----------1135

SHORT COMMUNICATION

Use of ink for staining am structures in hepatics
—Anu Sharma and Eshan Sharma ----------1139

Effect of seed rates and seed water soaking on wheat under delayed condition
—Ramakant Singh Sidar and Akhilesh Kumar Lakra ----------1141

RESEARCH ARTICLE

MORPHOLOGICAL AND GENETICAL DIVERSITY ANALYSIS OF *ALTERNARIA* ISOLATES FROM DIFFERENT HOST PLANT

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Abstract: *Alternaria* is a plant pathogenic fungus with a wide host range and causes disease in different types of plant. In the present study, eleven *Alternaria* isolates were collected from infected samples of different host plant belonging to diverse families. Identification and study of diversity study was done based on the morphological features of the isolates i.e., colony characteristics size, septation and beak length of conidia. Genetical variability among the isolates was carried out by using three RAPD primers. All isolates were identified as belonging to the genus *Alternaria*. The diversity analysis showed that seven of the isolates were different from each. However, TD7 and TD2 resembled in their morphological as well as genetical characters, similarly TD17 and TD12 were also found similar. No significant relationship could be established between host plant infected and pathogen morphological or genetics. It was however apparent that *Alternaria* sp. may be morphologically similar but genetically dissimilar. The genus *Alternaria* was highly variable in their morphological and genetical characters. All the eleven isolates, including the two pairs of similar isolates, showed significant genetical variability.

Keywords: *Alternaria* sp., Conidia, Plant pathogen, RAPD

INTRODUCTION

Alternaria is a plant pathogenic fungus belonging to the Phylum Ascomycota. The genus has more than 300 species. It causes black spot disease in different types of plants including cereal and vegetables crops, ornamentals and fruits. *Alternaria* disease has been reported to cause huge economic loss throughout the world (Solel, 1991; Strandberg, 1992; Rotem, 1994; Shabana et al., 1995; Thomma, 2003; Akimitsu et al., 2003; Kosiak et al., 2004; Peever et al., 2004). The infection in plants can be easily identified by its characteristic symptoms of black spot with concentric rings and surrounded by a yellow colored halo. The genus is diverse in terms of its morphology, conidial structure and host range (Elliot, 1917; Wiltshire, 1947; Simmons, 1967) and its taxonomy and affinities are controversial (Simmons, 1992). Therefore, various molecular tools (e.g., rDNA sequencing, RAPD, RFLP) have been employed by different workers, to identify the organism and study its diversity (Kumar et al., 2008; Saikia et al., 2006; Morris et al., 2000; Roberts et al., 2000 ; Weir et al., 1998). Morphology of different species of *Alternaria* is different and it is not easy to differentiate the species from other closely related fungi (e.g., *Ulocladium* sp., *Embellisia* sp., *Chalastospora* sp., *Nimbya* sp.) (Pryor and Gilbertson, 2000; Woudenberg, 2013). Molecular tools, especially rDNA sequencing method is helpful in such a situation to differentiate from one another (Pryor & Gilbertson, 2000).

Alternaria is an opportunistic pathogen and the dark colored spores which are in chains, have vertical and horizontal septations. Molecular analyses of plant pathogen populations are vital in comprehending epidemiology, host–pathogen relationship, and disease management methods. In this study, eleven *Alternaria* isolates were obtained from different hosts and their variability studied morphologically and their RAPD analysis.

MATERIAL AND METHOD

Isolation, characterization and identification of pathogen

Alternaria sp. infected leaf samples of plants including cereal and vegetable crops and ornamentals and fruits were collected from the Gangetic alluvial regions of Nadia District, West Bengal, India during 2009- 2013. The causal organism was isolated from the infected leaf pieces by surface sterilizing in 0.1% mercuric chloride solution followed by 3-4 washings with sterilized distilled water. The pieces were then transferred into potato carrot dextrose agar (PCA) plate and incubated at 28^0C. Pure cultures were made from single spore suspension of the pathogen and maintained at 4^0C - 5^0C, for further study. Identification of the cultures was done based on the morphological characteristics and spore size and shape.

Isolation of genomic DNA

Genomic DNA was extracted by slight modification of the CTAB protocol (Manicom *et al.*1987). 1 g fresh mycelium of each isolate was harvested, dried on sterile blotting paper and ground in liquid nitrogen to make a fine powder. DNA was extracted

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following the protocol of Raeder and Broda (1985), with slight modification. Presence of the genomic DNA was confirmed using 0.8% agarose gel electrophoresis. Quantification of the genomic DNA was done in a spectrophotometer (CECIL, CE7200, 7000 Series, England) at 260 nm and the purity of the genomic DNA measured by taking the absorbance ratio of 260:280.

RAPD analysis of isolates

Three 10-mer oligonucleotide primers (GeNei TM) were tested on the different *Alternaria* isolates (Table 1). 50µL PCR reaction volumes containing 2µL (40 ng) of DNA, 5µL of 10 × buffer, 3 µL of 25 mM $MgCl_2$ (GeNei ^{TM}), 5µL of dNTP mixture（2.5 mM each, 5µL of primer (10 pico mole/ µl), 0.5µL of Taq polymerase (GeNei ^{TM}) 3U/µl and nuclease free water (GeNei ^{TM}), to complete the volume was taken. 1.6% agarose gel with 1 X TAE buffer was used, and visualized as bands by staining in 0.5µg/mL aqueous ethidium bromide with
Low Range DNA Ruler Plus MBD27 (GeNei ^{TM}) as a standard marker. The RAPD bands
were analyzed and phylogenetic tree draw by GenAlEx.

Table 1. RAPD Primers used

Primer	Primer Sequence (5′→ 3′)	Temperature profile	Reference
1	**CACAGCTGCC**	95^0C-7min;95^0C-15sec; 36^0C-15sec; 72^0C-15sec; 72^0-10min; cycle-40	Roberts *et al.,* (2000)
2	**CCCGTTGCCT**	95^0C-7min; 95^0C-15sec; 33^0C-15sec; 72^0C-15sec; 72^0C-10min; cycle-40	Roberts *et al.,* (2000)
4	**GTGATCGCAG**	95^0C-7min; 95^0C-15sec; 38^0C-15sec; 72^0C-15sec; 72^0C-10min; cycle-40	Cooke *et al*, (1998)

RESULT AND DISCUSSION

The genus *Alternaria* is highly variable (Kusaba & Tsuge, 1995). Morphological and genetical diversity of the eleven isolates studied was observed to be highly significant (Table 2).

Table 2. Host plant and isolate name of 11 *Alternaria* sp.

Name of the organism	Host plant	Host plant family	Isolate name
Alternaria sp.	*Capsicum frutescens* (fruit)	Solanaceae	TD2
Alternaria sp.	*Spinacia oleracea*	Amaranthaceae	TD7
Alternaria sp.	*Capsicum frutescens* (leaf)	Solanaceae	TD10
Alternaria sp.	*Raphanus sativus*	Brassicaceae	TD11
Alternaria sp.	*Brassica rapa*	Brassicaceae	TD12
Alternaria sp.	*Solanum lycopersicum*	Solanaceae	TD13
Alternaria sp.	*Triticum aestivum*	Poaceae	TD14
Alternaria sp.	*Brassica juncea*	Brassicaceae	TD17

Alternaria sp.	*Capsicum annuum*	Solanaceae	TD30
Alternaria sp.	*Brassica oleracea*	Brassicaceae	TD31
Alternaria sp.	*Musa paradisiaca*	Musaceae	TD32

The length of conidia ranged from 7.7-12.2 µm. Isolates TD10, TD14, TD7, TD2, TD13, TD32 produced large sized conidia compared to the others (Table 3). While most isolates showed three horizontal and one vertical septation, TD12 produced large conidia with four horizontal and two vertical septa. The length of the conidial beak also varied and ranged from 5.2 – 0.1 µm. On the basis of beak length, three groups could be identified. Long beaked (TD32), medium-sized beak (TD17 and TD13) and short beaked which included all the rest. All the conidia were dark colored the characteristic feature of typical *Alternaria* genus (Woudenberg et al., 2013). The conidial character is independent of host plant it infects and its morphology depends upon other factors (Misaghi et.al., 1978). The similarity and dissimilarity in length, breadth and beak sizes of the 11 isolates did not reflect any relation with the host plant in our study also.

The colony colour of all the isolates was dark and varied from black, grey and their different shades with lighter coloured margins, which was typical of the *Alternaria* genus (Fig.2). Isolates TD2 and TD7 produced black colonies, colonies of TD10, TD12 and TD17 were greyish to lighter shades of black while TD11, TD14 and TD32 showed blackish gray colonies. Isolates TD13 and TD30 produced deep brown and grey ash colonies.

Isolates TD2 and TD7 produced colonies with irregular margins while in the rest the margins were smooth. The margin colour of the colonies also varied. It ranged from creamy white to dull white and grey. Mycelial growth of the *Alternaria* isolates was also different. It was either cottony or flat or raised (Table 4).

Table 3. Spore Characters of the *Alternaria* isolates

Isolates	Avg. Length (µm)	Avg. Breadth (µm)	Avg. Horizontal septa	Avg. Vertical septa	Avg. beak length (µm)
TD2	12.2	5.8	3	1	0.2
TD7	11.1	5.7	3	1	0.2
TD10	13.3	4.8	3	1	0.1
TD11	8.6	5.3	2	1	0.1
TD12	8.8	5.4	4	2	2.4
TD13	10.0	1.2	3	2	2.0
TD14	12.1	5.3	3	1	0.2

TD17	7.7	4.3	3	1	2.7
TD30	7.8	5.0	3	1	0.1
TD31	8.7	4.4	3	1	0.1
TD32	10.7	6.6	3	1	5.2

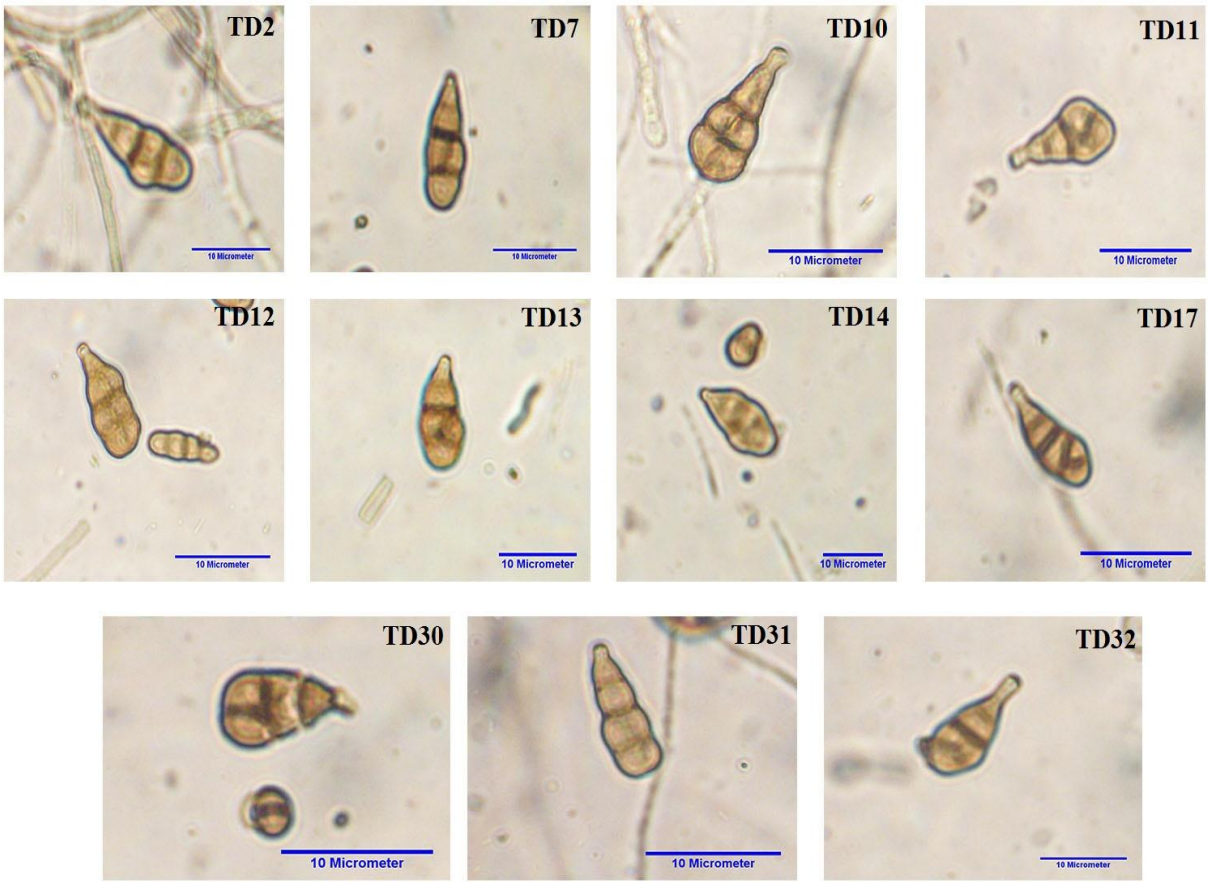

Fig.1: Spore morphology of *Alternaria* isolates

Table 4. Colony characters of the *Alternaria* isolates

Isolate	Colony colour	Margin of colony	Colour of margin	Mycelial growth
TD2	Blackish	Irregular	Creamy white	Flat
TD7	blackish	Roundish	Dull white	cottony
TD10	Grayish black	Irregular	Creamy white	Flat
TD11	Blackish gray	Irregular	White grey	Raised
TD12	Grayish black	Irregular	Creamy white	Raised
TD13	Brownish black	Irregular	Dull white	Raised
TD14	Blackish gray	Round	Creamy white	Cottony
TD17	Grayish black	Irregular	white	Cottony

TD30	Blackish gray ash	Round	White	Cottony
TD31	Blackish	Round	White	Cottony
TD32	Blackish gray	Roundish	Dull white	cottony

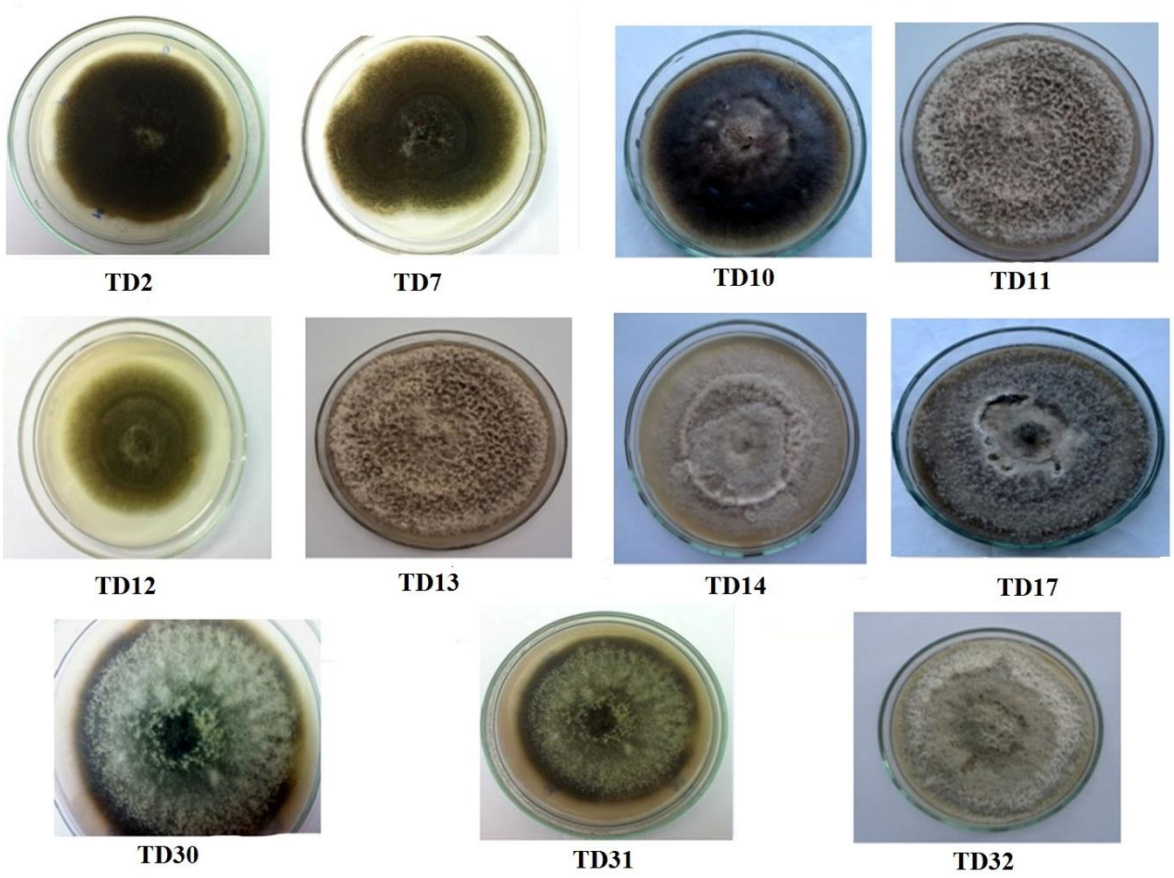

Fig. 2: Colony morphology of the *Alternaria* isolates.

The phylogenetic analysis of the eleven isolates showed notable genetic variability (Fig.3). TD10, TD30, TD14 and TD31, pathogenic on different host belonging to diverse families, belonged to a monophyletic cluster on the basis of RAPD primer1 and 3 (Fig 4A &C). The morphological features were also dissimilar i.e., TD10 and 14 formed large conidia while TD30 and 31 were small-spored isolates. These results indicated that variability study on the basis of morphological features and molecular markers differed and each parameter must be treated separately (Jadhav et al, 2011; Naik et al., 2010). 100% similarity was observed between TD7 and 2 in case of primer 1 and in TD12 and 17 in case of primer 3. TD12 and 17 were found to be infect plants from the same family Brassicaceae but TD7 and TD2 were isolated from plants of different families. TD17 and 12 were morphologically similar i.e., small sized spore with short beak, just as TD2 and 7 shared similar morphological features (long sized spore with short beak), the hosts of the latter two belonged to different families. Thus no distinct relationship could be drawn between morphology, genetical and pathogenic variability.

Three monophyletic clusters could be recognized on the basis of primer 2 viz TD10 and 2 (Group 1), TD11, 32, 14, 13 (Group 2) and TD30, 7, 17, 31, 12 (Group 3) (Fig.4B). No relation between host specificity, morphological and genetic characters was found. The three RAPD primers presented three phylogenetic trees and all trees were dissimilar. Thus phylogenetic analysis reveals that the genus *Alternaria* is genetically highly variable. This has been reported by earlier workers also (Pryor & Michailides, 2002). From the above results we can conclude that though different *Alternaria* may be morphologically similar they may differ genetically while genetically similar isolates may be different in their morphology. However, for 100% genetical similarity the isolates must share morphologically similar features.

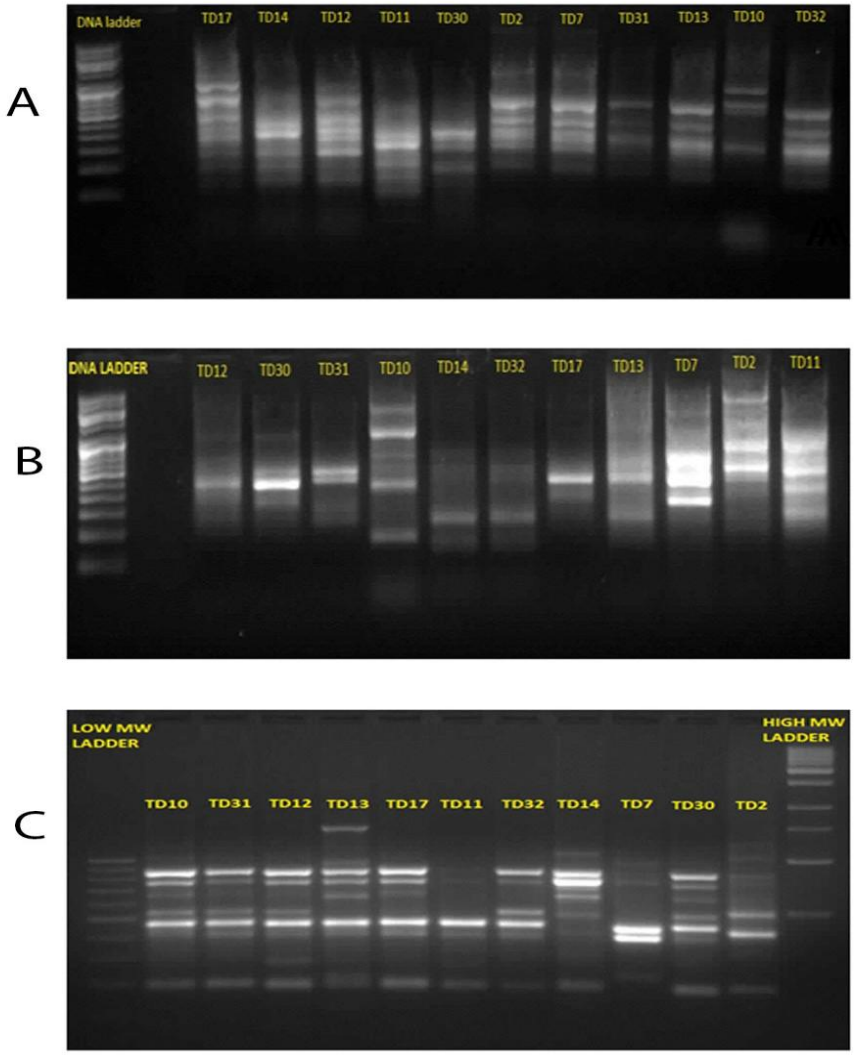

Fig.3: Gel electrophoresis of amplified products by three RAPD primers of *Alternaria* isolates. (A) Primer 1 (B) Primer 2 (C) Primer 3.

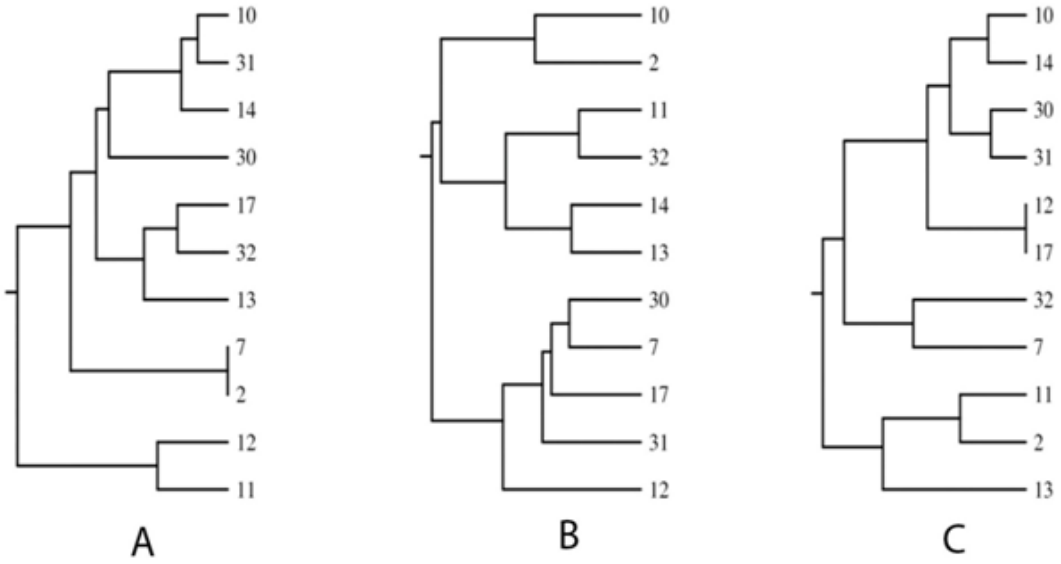

Fig.4: Phylogenetic trees constructed from the RAPD gel electrophoresis. (A) Primer 1 (B) Primer 2 (C) Primer 3.

CONCLUSION

Thus from this study we can conclude that seven *Alternaria* isolates show notable variability. Among the other four, the pairs TD7 & TD2 and TD17 & TD12 are genetically and morphologically similar. However, no significant relationship between morphological and genetical characteristics and host specificity of the seven isolates could be established. The genus *Alternaria* was morphologically and genetically highly variable.

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RESEARCH ARTICLE

EVALUATION OF PHYSIOCHEMICAL AND ANTIBACTERIAL PROPERTIES OF HONEY SAMPLES FROM BANI (J&K): POLLEN MORPHOLOGY OF SELECTED BEE FORAGE PLANTS

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Abstract: Present study was aimed to investigate the physio-chemical and antibacterial properties of honey samples and pollen morphology of selected bee forages obtained from Bani region of Jammu and Kashmir. Honey samples collected were not identical because of having different physio-chemical properties such as glucose content, moisture content, colour, refractive index and pH. Antibacterial activity of honey determined using different strains of bacteria viz. *Staphylococcus aureus, Streptococcus pyogenes, Klebsiella pneumoniae and Pseudomonas aeruginosa* in comparison to antibiotic (Ofloxacin) showed no significant results. During the present investigation, pollen reference slides of flowering plants (Bee forages) explored by honeybees of different ecological origin were prepared and studied for pollen taxonomy and a total of fifteen flowering plants of 11 families visited by honey bees were collected and studied for pollen morphology and production along with their carbohydrate content. Pollen grains of these plants were variable in shape, class, aperture, exine thickness and ornamentation. Besides, they also differ in their pollen production rate as well as their carbohydrate content.

Keywords: Honey, Physio-chemical properties, Antibacterial activity, Bani, Bee forages

INTRODUCTION

Honey, defined as the sweet syrup substance is prepared by bees from the nectar of plants, secretion of living plant parts and excretion of plants sucked by insects from the floral part of the plants. Honey bees collect and transform this extract by combining it with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature (Codex Alimentarius, 1997). The taste, colour, flavour and density of honey differ greatly. The colour of honey depends entirely on the flowers from which it was collected (White *et al*., 1963). Flavour of honey depends on the type of vegetation from where the bees collect the nectar and pollen. Honey is the quintessence of flowers and its savouriness depend on the fragrance of the blooms. Water content, temperature and moisture content are three important components of sugars present in honey that must be in natural proportion to prevent granulation. The high sucrose and low dextrin contents of honey increases the crystallization of honey, on the other hand low sucrose and high dextrin contents lowers its crystallisation (Babcan, 2007). Honey has been demonstrated in many studies to have antibacterial effects, attributed to its high osmolarity, low pH, hydrogen peroxide content and contents of other uncharacterized compounds. The low pH alone is inhibitory to many pathogenic bacteria. When consumed orally, honey is diluted by body fluids so that any effect of low pH is likely to be lost (Molan, 1995).

History of honey dates back to 2100 B.C., where it was mentioned in Sumerian and Babylonian cuneiform writings, Hittite code, and the sacred writings of India and Egypt (White and Doner, 1980). Honey is widely used in India for food preparation, medicine and alcoholic beverages. Madhuparka (drink), a mixture of honey and curd, plays a pivotal role in the Hindu wedding ceremony (Singh and Bath, 2006). The clinical observations recorded for honey are: infection is rapidly cleared, inflammation, swelling, pain and odour are quickly reduced, sloughing of necrotic tissue is induced, granulation and epithelialisation are hastened and healing occurs rapidly with minimal scarring (Dustman, 1989). There is much anecdotal evidence to support its use and randomised controlled clinical trials that have shown that honey is more effective than silver sulfadiazine and polyurethane film dressings for the treatment of burns (Saxena et al., 2010).

Honeybees and flowering plants have been considered as an example for co-evolution and mutualism because bees need plants as source of food (nectar and pollen) whereas plants need them for pollination. Beekeeping is entirely dependent on the types of plants available in any given area. An important pre-requisite for developing apiary is the pollen of various flowering plants that represent potential source of nectar and pollen for the honeybees (Kalpana and Ramanujam 1997). Microscopic analysis such as shape, size and ornamentation of pollen of plants forged by bees is an established method to determine the source of honey in the area. Various workers have earlier carried out palynological investigations in this regard. While, Noor *et al*., (2004) recorded palynological studies of cultivated plants of Rawalpindi (Pakistan), Adekanmbi and Ogundipe (2006) described the pollen morphology of 20

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cultivated plants of Nigeria and Perveen and Qaiser, (2009) conducted the pollen studies of the family Moringaceae and Berberidaceae. Several taxonomists identify the plant species on the basis of pollen morphological studies. An interest in pollen morphology has increased and its full application in systematic, paleobotany and aeropalynology has been recognized (Noor et al., (2004).

Keeping this in mind the present study was carried out to determine the physio-chemical properties and antibacterial activity of honey and prepare the reference slides (LM and SEM) of pollen grain of bee forage plants collected from the study area.

MATERIAL AND METHOD

Study area

Bani is a small glaciated valley located at a height of 4200 ft in the lap of lofty mountains. Town Bani is flourished along the river 'SEWA'. Situated 165 kilometres away from district Kathua, it is bounded by Chamba district of Himachal Pradesh and Doda district of Jammu and Kashmir. The total geographical area of Tehsil Bani is 600 sq. kms. The soil varies between alluvial sandy loams to gravel type. The climate varies from subtropical to temperate. It is hot during April to June and severe cold during December to January. During summer, highest day temperature is in between 26℃ – 29℃ and average temperature of winter season is 25℃. The area is rich in biodiversity for both flora and funna.

Sampling

A total of three samples were collected from Tehsil Bani viz. Sample A from Roulka (1350 m), Sample B from Asso (1260 m) and Sample C from Barmota (1290 m) during summer and monsoon. Bee responsible for synthesis of these samples was identified as *Apis indica*. Sample A (Sullie Honey) and sample B (Ajvan Honey) were unifloral type of honeys whereas Sample C (Mixed Honey) was of multifloral type.

Physio-chemical properties

Moisture content: It was determined using Wedmore (1955), modification of Chataway (1933) method.

Sugar content: Sugar content was determined by using refractometric assays.

Refractive index: It was determined using an Abbe refractometer at a temperature of 32^0C.

pH: 10 gm of honey was added to 75 ml of dH_2O to prepare a solution for recording pH.

Colour: It was determined using colorimetric technique. Five grams of honey was added in 10 ml of distilled water and absorbance was taken at the wavelength of 635 nm.

Antibacterial activity

Antibacterial activity was tested against four standard strains such as *Pseudomonas aeruginosa, Staphylococcus aureus, Klebsilla pneumonia and Streptococcus pyogenes,* obtained from Department of Botany and Microbiology, H.N.B. Garhwal University, Uttarakhand. Different honey dilutions (undiluted, 75%, 50%, 25% and 10%) of each sample were made and checked for their antibacterial activity in comparison to antibiotic Ofloxcin.

a) Nutrient agar media: Agar was prepared by suspending 28.5 g of the media in 1000 ml of distilled water followed by shaking and sterilization at 121^0C for 15 minutes. After which it was poured into sterile petri-plates under specific conditions. For preparation of smear for solid culture of the microorganisms, a drop of sterile normal saline was placed with a sterile loop in the agar plates. Normal saline in the nutrient agar plates was uniformly spreaded and placed in the incubator for overnight (Ceyan and Ugur, 2001).

b) Sensitivity test of honey: Using a flamed and cooled 8 (mm) diameter cork borer, wells were cut out in the inoculated agar plates. Four wells in each plate were made corresponding to the different concentrations of bee honey. The agar plugs were removed by a sterile blade, wells were filled with (50 µl) of the honey solutions, plates were left for an hour to allow the seeping of honey solutions, followed by their overnight incubation at 37 °C (Ceyan and Ugur, 2001).

Pollen morphology methodology

During present investigation, 15 bee plant species from 11 families of apiculture importance were identified and studied. For pollen morphology, mature pollen grains were collected and preserved in 70% alcohol. For further investigation mature floral buds were directly taken from the field after the plant was confirmed as bee plant by visual observation that bees are foraging on plant either for nectar or for pollen or both.

Preparation of pollen slides

The preserved material was prepared by acetolysis method according to Erdtman (1960) for light microscope. The prepared slides were studied for analysing different pollen morphology parameters viz. pollen shapes, polar axis and number of apertures of bee forage plants.

Carbohydrate estimation

Carbohydrate content of collected plants was determined using Anthrone method.

RESULTS AND DISCUSSION

Physiochemical properties of honey

During present study, moisture content was highest in sample A i.e. 20 % (Table 2). The differences between the values obtained for moisture content were highly significant ($p \leq 0.01$). Average value of moisture content in present samples was found out to be 17.03%. These values obtained were within the range reported by various workers viz. White *et al*., 1975 (13.4-22.9%); Ibrahim, 1985 (13.0-26.08%) and Ghoshdastidar and Chakrabarti, 1992 (17.4-

19.4%). The moisture content values compared with the proposed value of Codex Alimentarius Commission (1997) revealed that it should not be more than 21% and the moisture content above 18% in the honey samples is under the risk of fermentation (Krill, 1996).

Sample B contained the highest sugar content (85.1%, Table 2) that is in contrast to the values reported by Ibrahim (1985) [57.08-75.7%] and El-Sarrag (1997) [67.38, 72.7 and 73.4%] for Sudanese honey. In present case, average value of sugar in honey samples found was 79.6% that is in conformity to the value of Egyptian honeys i.e. 74.42% (Ismaeil, 1972). As per Codex Alimentarius Commission (1997), sugar content of honey sample should not be less than 65%.

During present investigation, pH value was highest in sample C (4.1) and this value is same to that reported by Kaushik *et al*. (1993) of fresh honey. While, Molan (1992) claimed honey to be quite acidic with its pH ranging between 3.4- 4.5 Determination of pH is important in honey in relation to darkening; as pH increases, its darkening also increases.

Colour depends on general characteristics of floral types (White, 1978) and varies with botanical origin, age and storage condition; but transparency of clarities depends on the amount of suspended particles such as pollens (Krell, 1996). Table 1 shows the variation in colours of the present honey samples.

Table 1. Physio-chemical properties of three honey samples

Honey Sample	Parameters				
	Sugar Content	**Moisture Content**	**pH**	**Refractive Index**	**Colour (Spectrophotometer)**
A	79.5%	20%	3.8	1.4851-1.4853	Water white (0.125)
B	85.1%	14.9%	4.0	1.4994-1.4995	Extra white (0.141)
C	83%	17%	4.1	1.4940-1.4941	Light amber (0.303)

Antibacterial activity of honey

During the present investigation, different honey dilutions (undiluted, 25%, 50% and 75%) of each sample produced no significant difference in antibacterial activities in comparison to the action of antibiotic (Ofloxacin) (Fig. 1-3). Molan *et al*., (1992) reported various factors i.e. quite acidic nature and pH ranging from 3.2-4.5 responsible for antibacterial activity of honey. As for as our case is concerned, the pH value of honey samples was found above 4 (4.4, 5.2 and 4.8), that provide the growth condition for some bacterial species viz. *P. aeurginosa* (pH 4.4) and *S. pyogenes* (pH 4.5).

Antibacterial activity also gets affected to a greater or lesser extent by handling, storage and processing of the honey after it is removed from the hive (Dold *et al*., 1937). It has been found that heating honey above 40^{o}C inactivates the glucose oxidase that causes the loss of activity against some species of bacteria (Molan 1992). Allen *et al.* (1992) reported the mean antibacterial activity of undiluted honey equivalent to 14% solution of phenol in water. Depending upon the floral source, some honey samples had no detectable antibacterial activity, while others had activities up to the equivalent of 42% phenol.

Pollen morphology of bee forage plants

The present study deals with 15 Bee forage plants (Fig. 4, Table 2)

Number of anthers per flower, rate of pollen production per anther and per flower was estimated (Table 2). During the study highest, number of anthers was found in *Punica granatum* (264) and least in *Jacranda mimosifolia* (4). As far as the rate of pollen production/anther is concerned, it was highest in *Cannabis sativa* (13,00,000) and pollen/flower was highest in *Callistemon citrinus* (1,70,50,000). Besides, pollen morphology studies (pollen shapes, polar and equatorial axis and number of aperture) carried out on 15 different bee forage plants using light microscope (LM) revealed that pollen differ in their shape; majority of them having oblate-spheroid shape (Table 2, Fig. 5). Four types of pollen apertures (porate sulcate, zonocolpate, zonocolporate) were observed during the study, with zonocolporate aperture being the frequent. In addition to this; surface, exine thickness and exine ornamentation (Fig. 6) of pollen were studied using scanning electron microscope (SEM).

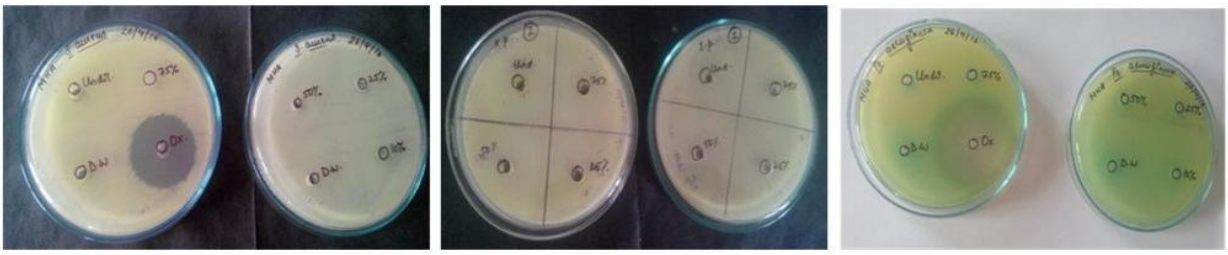

Fig. 1: Plates showing the results of Antibacterial activity of honey sample-A using different honey dilutions (undiluted, 25%, 50% and 75%) in comparison to antibiotic Ofloxacin.

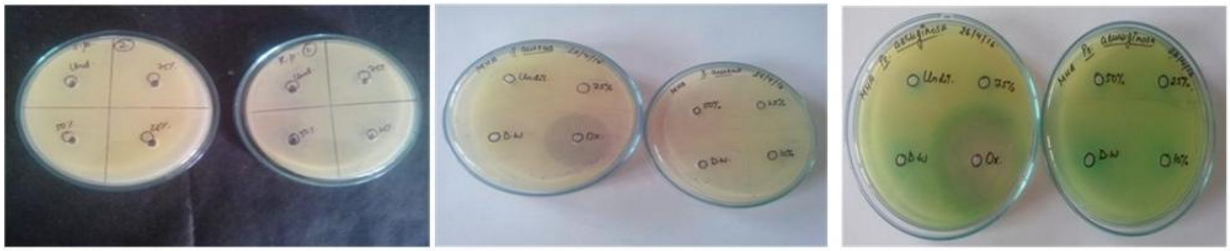

Fig. 2: Plates showing the results of Antibacterial activity of honey sample-B using different honey dilutions (undiluted, 25%, 50% and 75%) in comparison to antibiotic Ofloxacin.

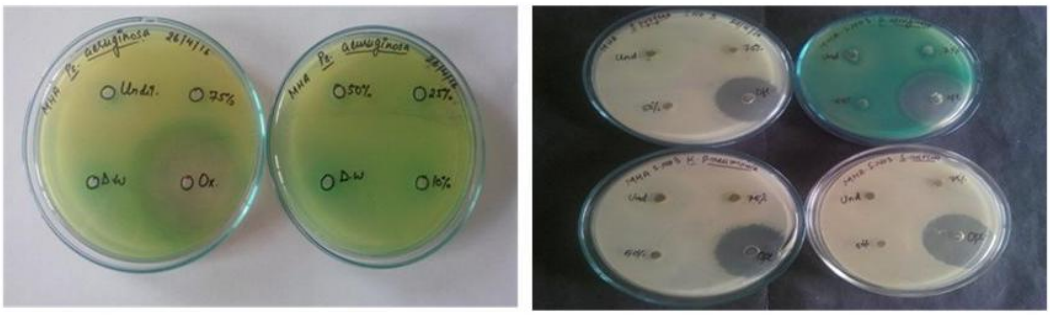

Fig. 3: Plates showing the results of Antibacterial activity of honey sample-C using different honey dilutions (undiluted, 25%, 50% and 75%) in comparison to antibiotic Ofloxacin.

Table 2. Pollen production of plants per anther as well as per flower and pollen morphology

S. No	Name of species	TAF	PA	PF	PAx	Ed	PAx/Ed ×100	Shape	Aperture
1	*Allium cepa*	5	462500	2312500	20.8	33.8	61.53	Oblate	1-Sulcate
2	*Brassica campestris*	6	364583	2187500	26.86	26.86	100.0	Spheroidal	3-zonocolpate
3	*Callistemon citrinus*	62	275000	17050000	19.50	18.20	107.14	Prolate-spheroidal	3-zonocolporate
4	*Cannabis sativa*	5	1300000	6500000	22.53	23.4	96.28	Oblate-spheroidal	3-porate
5	*Cupressus torulosa*	16	(P/M) 296875	(P/C) 4750000	27.74	27.74	100.0	Spheroidal	1-porate
6	*Eucalyptus citriodora*	111	113636	12613596	19.06	19.96	95.49	Oblate-spheroidal	3-zonocolporate
7	*Jacranda mimosifolia*	4	390625	1562500	40.9	24.54	166.6	Prolate	3-zonocolpate
8	*Litchi chinensis*	7	166666	1166662	19.93	23.4	85.17	Oblate -spheroidal	3-zonocolporate

9	*Pinus roxburghii*	104	(P/M) 54687	(P/C) 5687500	53.98	67.60	79.85	Sub-oblate	1-colpate
10	*Prunus persica*	43	137500	5912500	41.6	41.6	100.0	Spheroidal	3-zonocolporate
11	*Punica granatum*	264	237500	62700000	23.4	24.26	96.45	Oblate-spheroidal	3-zonocolporate
12	*Woodfordia fructicosa*	9	645833	5812497	16.03	17.33	92.49	Oblate-spheroidal	3-zonocolporate
13	*Riccinus communis*	∞	91666	-	29.03	27.73	104.68	Prolate-spheroidal	3-zonocolporate
14	*Tecoma stans*	4	531250	2125000	39	32.93	118.43	Sub-prolate	3-zonocolpate
15	*Pyrus pashia*	38	226562	8609356	23.4	24.26	96.45	Oblate-spheroidal	3-zonocolporate

TAF= Total anther/flower; PA= Pollen/anther; PF= Pollen/flower; PAx=Polar axis; Ed= Equatorial Diameter

Fig. 4(a-o). Bee foraging plants collected from Bani region.
a. *Allium cepa b. Brassica campestris* **c.** *Callistemon citrinus* **d.** *Cannabis sativa*
e. *Cupressus torulosa* **f.** *Eucalyptus citriodora* **g.** *Jacranda mimosifolia* **h.** *Litchi chinensis*
i. Pinus roxburghii j. Prunus persica k. Punica granatum **l.** *Woodfordia fructicosa*
m. Riccinus communis n. Tecoma stans o. Pyrus pashia

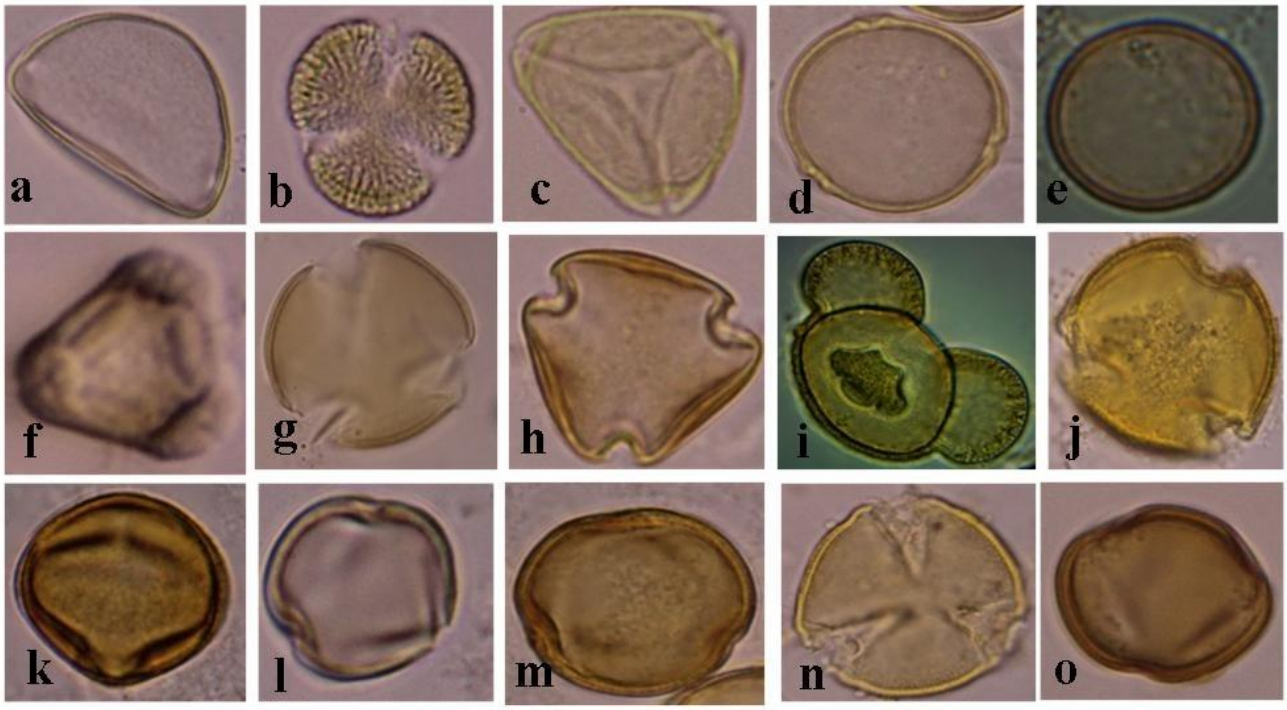

Fig. 5(a-o): Light microphotographs of pollen collected from 15 different bee forage plants showing pollen morphology .

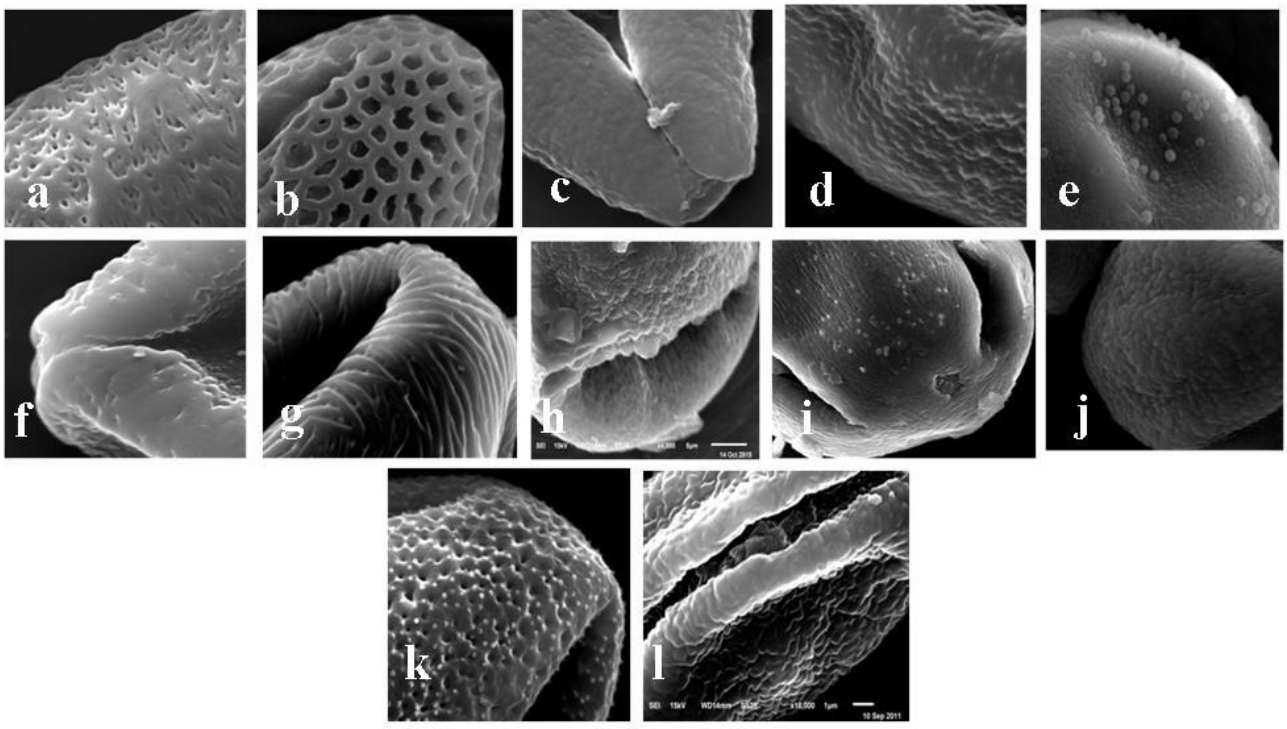

Fig. 6(a-l): Scanning electron micrographs of pollen grains collected from 12 different bee forage plants showing pollen morphology.

Carbohydrate content

Carbohydrate content was estimated in all the collected plants using anthrone method; and it was found to be highest in *Allium cepa* and lowest in *Pinus roxburghii* (Table 3)

Table 3. Carbohydrate content of different bee forage plants

S. No.	Name of species	Total carbohydrate content (Mean values ± standard deviation)
1	*Allium cepa*	19.8 ± 0.384
2	*Brassica campestris*	8.74 ± 0.120
3	*Callistemon citrinus*	6.13 ± 0.254
4	*Cannabis sativa*	18.5 ± 0.057
5	*Cupressus torulosa*	2.3 ±0.005
6	*Eucalyptus citriodora*	13.8 ± 0.29
7	*Jacranda mimosifolia*	16.81 ± 0.075
8	*Litchi chinensis*	3.68 ± 0.060
9	*Pinus roxburghii*	0.676 ± 0.066
10	*Prunus persica*	6.3 ± 0.174
11	*Punica granatum*	0.9 ± 0.132
12	*Woodfordia fructicosa*	0.79 ± 0.036
13	*Riccinus communis*	6.86 ± 0.026
14	*Tecoma stans*	16.11 ± 0.514
15	*Pyrus pashia*	12.31 ± 0.419

CONCLUSION

Physio-chemical properties of honey vary in all the honey samples and their characteristics depend on the type of vegetation of that area. Antibacterial activity of honey not only depends on a single factor, however, many factors like pH, moisture content hydrogen peroxide and enzymatic activity etc. play an additive role in this property. Applications of basic palynological studies on bee forage plants are helpful in identifying the botanical origin of honey and also used in solving various taxonomic problems even upto the specific and varietal level.

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RESEARCH ARTICLE

LEAF PHYSIOGNOMIC ANALYSES OF AVAILABLE SPECIES OF *AVICENNIA* L. IN INDIAN SUNDARBANS FOR USING AS TAXONOMIC TOOL

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Abstract: Leaf physiognomic analyses with both macro and micro morphological traits of three species of *Avicennia* namely, *A. alba* Blume, *A. marina* (Forsk.) Vierh, and *A. officinalis* L. have been done to identify the variability among them. A wide range of variations in leaf shape, length, apex, base, texture, venation pattern, epidermal cell type, stomatal cell type, stomatal frequency and stomatal index are observed in the studied species which might be used as taxonomic tool. Moreover, the detailed micro morphological features as revealed through present study are new observations which will enrich the existing database on leaf morphology of *Avicennia*.

Keywords: *A. alba, A. marina, A. officinalis,* Micro morphology, Identification

INTRODUCTION

One of the true mangrove plant taxa, *Avicennia*, is the only genus of family Avicenniaceae Endl. containing 10 species worldwide (Tomlinson 1986). The species of *Avicennia* are found to grow at seaward zone as primary successor in any mangrove ecosystem. Amongst the ten worldwide species, only three namely, *A. alba* Blume, *A. marina* (Forsk.) Vierh, and *A. officinalis* L. are available in Indian Sundarbans, world's most unique mangrove site (Naskar and Mandal 1999; Barik and Chowdhury 2014). All three species of *Avicennia* are mostly utilized for fuel-wood and timber by local people in Sundarbans. Beside wood, the leaves of *Avicennia* spp. are also important part for having their therapeutic values (Naskar and Mandal 1999). The leaf extract of *A. marina* can inhibit the growth of HIV, HSV and DNA viruses and it is exploited more than *A. officinalis* for better antioxidant property (Shanmugapriya et al. 2012; Rahele et al. 2013). As such, the identification of *Avicennia* spp. on basis of leaf morphology might be explored to exercise on leaves for several other aspects. Furthermore, the existing database on leaf morphology of *Avicennia* spp. especially the micro morphological features is insufficient which also demand for thorough leaf physiognomic study of the taxa.

Leaf physiognomy is an important tool which is mainly used by botanists and ecologists to interpret ecological variations as well as climatic analyses (Bailey and Sinnott 1915; Wolfe 1993, Dilcher 1974; Traiser et al. 2004). But its uses as taxonomic tool for identifying the plant taxa at non flowering stage is underexplored as in most of the cases the taxonomists rely on plant twig with flowers for identification purpose. The study can also help to recognize the fossilized plant species easily as we know besides all other plant parts, the leaves are mostly preferred to be fossilized due to its chemical nature.

In view to the above, a comparative assessment of a number of leaf physiognomic traits of three available species of *Avicennia* L. (*A. alba*, *A. marina*, *A. officinalis*) in Indian Sundarbans has been carried out by highlighting micro-morphological characters.

MATERIAL AND METHOD

Almost 100 mature leaf samples from each of the species that is *A. alba*, *A. marina*, and *A. officinalis* were collected from mangrove forest of four different sites (Uttar Kashiabad, Jharkhali, Bally island, and Kaikhali) belonging to South 24 Parganas district of West Bengal, India. The considered macro morphological traits for physiognomic study are both qualitative (leaf symmetry, shape, size, apex, base, margin, mid-vein, texture, and attachment of petiole) and quantitative (leaf length, width, area, and length-width ratio).

Trichome, salt/foliar gland, other cell types, venation (1º vein- size, course, 2º vein- angle of divergence, variation, relative thickness, course, behavior of loop forming branch, 3º vein- angle of origin, arrangement, distribution, no. of highest vein orders, quaternary vein, marginal ultimate venation, areole), epidermal cell (frequency, size), stomata (type, shape, arrangement, guard cell thickening, frequency, size, index) were studied as micro morphological traits.

Primarily the specimens were studied by using a hand lens. Finer morphological characters were studied under incident light microscope (Leica S8 Apo) following the methodologies recommended by Hickey (1973), Dilcher (1974), and Leaf Architecture Working Group of Smithsonian Institution (1999).

RESULT

Leaf physiognomic characters of A. alba

Macro morphology: Symmetry dorsiventral, base asymmetrical; shape oblong linear; mesophyll; size

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length 3-10cm; apex acute; base cuneate acute; margin entire (Fig. 1a); mid-vein massive; texture coriaceous; attachment of petiole normal (Fig. 1d).

Micro morphology: Leaf micro morphological observation of *A. alba* shows venation pinnate, camptodromous, brochiodromous (Fig. 1g); 1^0 vein size massive (4.91%), course markedly curved (Fig. 1g); 2^0 vein angle of divergence-wide, acute (78°) variation, upper more obtuse than lower, relative thickness of 2° moderate, course curved abruptly, behaviour of loop forming branch joining supra adjacent, secondary at right angles; inter-secondary veins simple (Fig. 1j); 3^0 vein angle of origin lower acute upper acute, pattern percurrent, forked, giving order to 3 order ramification, inter 3°s are parallel to each other at some parts of the leaf (Fig. 1j); highest vein order showing excurrent branching 3°-6°, quaternary size thick, course random, quinternary size thin, course random, marginal ultimate venation looped; areole development imperfect, arrangement random, shape quadrangular, size large, 1-2mm veinlets branched thrice (Fig. 1j); epidermal trichome glandular and non-glandular, oil cells present, epidermal cell frequency 2167/mm^2, size (µm) 29.5x20.4; Stomata sunken, anomocytic, shape oval, size (µm) 35.4x25, guard cell thickening with thick hair covering, frequency 141/mm^2, index 6.04, arrangement irregular (Fig. 1m); salt gland frequency higher in 1° and lower in other veins, shape elliptic, number of cells 7 (Fig. 1p).

Leaf physiognomic characters of A. marina

Macro morphology: Symmetry dorsiventral; shape narrow-elliptic; mesophyll; size length up to 10cm; apex acute; base obtuse, cuneate; margin entire; mid-vein stout; texture chartaceous; attachment of petiole normal (Fig. 1e).

Micro morphology: Venation pinnate, camtodromous, brochiodromous (Fig. 1h); 1^0 vein size stout, course almost straight; 2^0 vein angle of divergence narrow, acute, variation uniform (almost), relative thickness of 2^0 moderate, course curved abruptly, behaviour of loop forming branch joining supra-adjacent secondary at right angles (Fig. 1h); inter-secondary veins simple (Fig. 1k); 3^0 vein angle of origin lower, upper both acute, pattern random reticulate; highest vein order showing excurrent branching 3^0-6^0, quaternary, size thin, course random, quinternary size thin, course random, marginal ultimate venation looped; areole development imperfect, arrangement random, shape quadrangular, size large, 1-2mm, veinlets branched thrice (Fig. 1k); Epidermal trichome glandular and non-glandular; other cell oil cells; epidermal cell frequency 2053/mm^2, size (µm) 31.5x26.0; stomata sunken, anomocytic, shape oval, size (µm) 30.5x21.7, guard cell thickening with thick hair covering, frequency 254.3/mm^2, index 10.3, arrangement irregular (Fig. 1n); salt gland shape elliptic, number of cells 7 (Fig. 1q), frequency higher in $1^0$and lower in other veins.

Leaf physiognomic characters of A. officinalis

Macro morphology: Symmetry dorsiventral; shape wide elliptic; mesophyll; size length over 10cm; apex rounded; base obtuse, cuneate; margin entire; mid-vein stout; texture chartaceous; attachment of petiole normal (Fig. 1f).

Micro morphology: Venation pinnate, craspedodromous, semi-craspedodromous (Fig. 1i); 1^0 vein size stout, course straight; 2^0 vein angle of divergence moderately acute, 55^0, variation upper more acute than lower, relative thickness of 2^0moderate, course branched, recurved and curved uniformly, behaviour of loop forming branch enclosed by 2^0, 3^0 arches (Fig. 1i); inter-secondary veins composite (Fig. 1l); 3^0 vein angle of origin upper right, lower acute, pattern percurrent, sinuous in relation to midvein, 3^0<decreased outward, predominantly opposite joining (Fig. 1l); highest vein order showing excurrent branching 3^0-6^0; quaternary size thin, course random, quinternary size thin, course random, marginal ultimate venation fimbriate; areole imperfect, arrangement random, shape irregular, size large, 1-2mm, veinlets branched thrice (Fig. 1l); epidermal hairs glandular in both sides non-glandular in on abaxial side; oil cells present; epidermal cell frequency 2106/mm^2; size (µm) 19x16; stomata sunken anomocytic, arrangement irregular, shape elliptic, size (µm) 28.7x21.5, guard cell thickening dense hair covering on stomata, frequency 287.5/mm^2, index 12.07 (Fig. 1o); salt gland frequency higher in veins, gradually lower in veinlets, number of cells 7 (Fig. 1r).

Comparative assessment

The detailed observations on leaf physiognomy of *A. alba*, *A. marina*, and *A. officinalis* detect a wide variability among the characters which mainly exist in leaf shape, length, apex, base, texture, venation pattern, epidermal cell type, stomatal cell type, stomatal frequency, and stomatal index (Table 1).

DISCUSSION

Earlier, Naskar and Mandal (1999) used only four physiognomic traits (leaf shape, size, apex, and petiolar length) along with other features like habit, stem, flower, and fruit to differentiate *Avicennia* spp. present in Indian Sundarbans. The micro morphological details of leaves of the species are not emphasized by early workers. As such, the present observations on micro morphological characters are new of its kind and it will definitely enrich the existing database.

Further, the study depicts 20 more leaf traits for consideration in identifying different species of *Avicennia*. The comparative assessment (Table 1) shows that the leaf of *A. officinalis* can easily be distinguished from other two species by its length (more than 10cm), apex (rounded), inter secondary vein (composite), marginal venation (fimbriate), areole shape (irregular), small epidermal cell size

(19.0x16.0μm), different stomatal shape (elliptic), more stomatal frequency (288/mm^2) and index (12.07). Oblong-linear leaf shape, somewhat smallest leaf length (3-10cm), massive primary vein size, and thick quaternary vein size, lowest value of stomatal frequency (141/mm^2) and stomatal index (6.04) are the features uniquely present in leaves of *A. alba*.

Table 1. Variations in leaf physiognomic traits in three *Avicennia* spp. available in Indian Sundarbans

Leaf Physiognomic Traits	**Plant Species**		
	Avicennia alba	***Avicennia marina***	***Avicennia officinalis***
Leaf shape	Oblong-linear	Narrow-elliptic	Wide-elliptic
Leaf length	3-10cm	up to 10cm	Over 10cm
Leaf apex	Acute	Acute	Rounded
Leaf base	Acute	Obtuse	Obtuse
Leaf texture	Coriaceous	Chartaceous	Chartaceous
Venation	Pinnate, camptodromous, brochiodromous	Pinnate, camptodromous, brochiodromous	Pinnate, craspedodromous, semi-craspedodromous
1° vein size	Massive (4.91%)	Stout	Stout
1° vein course	Markedly curved	Almost straight	Straight
2° vein angle of divergence	Wide, acute (78°)	Narrow, acute	Moderately acute (55°)
2° vein course	Curve abruptly	Curve abruptly	Branched, re-curved and curved uniformly
Behavior of loop forming branch of 2° vein	Joining supra-adjacent	Joining supra-adjacent	Enclosed by 2°, 3° arches
Inter secondary veins	Simple	Simple	Composite
3° vein angle of origin	Upper and lower acute	Upper and lower acute	Upper right, lower acute
3° vein pattern	Precurrent, forked giving 3 order remification	Random reticulate	Precurrent, sinuous in relation to mid vein
Quaternary vein size	Thick	Thin	Thin
Marginal ultimate venation	Looped	Looped	Fimbriate
Areole shape	Quadrangular	Quadrangular	Irregular
Epidermal cell size (μm)	29.5x20.4	31.5x26	19.0x16.0
Epidermal cell frequency (/mm^2)	2167	2053	2106
Stomatal shape	Oval	Oval	Elliptic
Stomatal size (μm)	35.4x25	30.5x21.7	28.7x21.5
Stomatal frequency (/mm^2)	141	254	288
Stomatal index	6.04	10.3	12.07

Figure 1

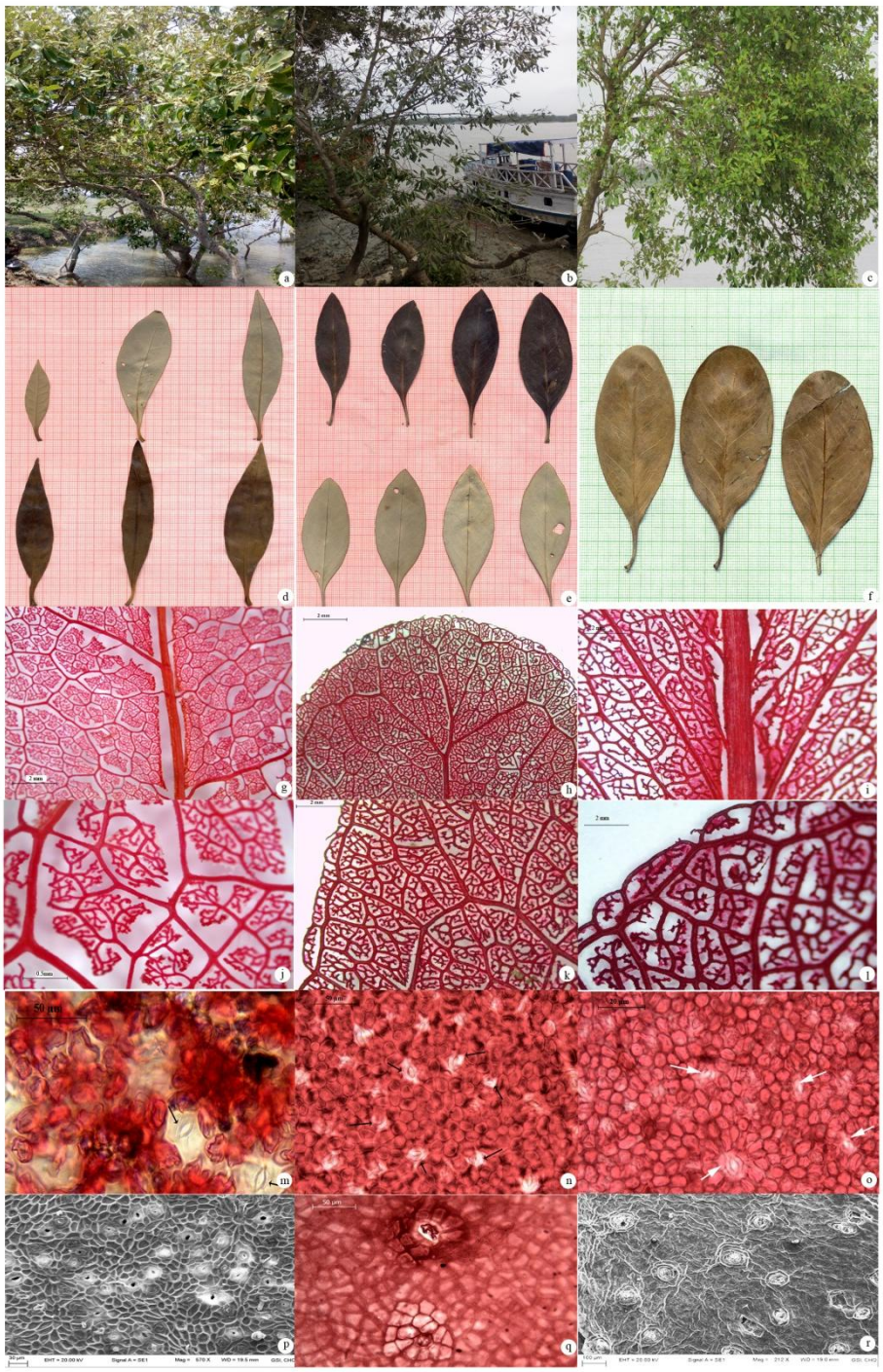

FIGURE LEGEND

(Fig. 1a-c) Habit of *Avicennia* spp. **(a)** *A. alba*; **(b)** *A. marina*; **(c)** *A. officinalis*; **(Fig. 1d-f)** Macro morphology of *Avicennia* spp. **(d)** *A. alba*; **(e)** *A. marina*; **(f)** *A. officinalis*; **(Fig. 1g-l)** Vein architecture of *Avicennia* spp. **(g, j)** *A. alba;* **(h, k)** *A. marina*; **(i, l)** *A. officinalis*; **(Fig. 1m-o)** Sunken stomata on epidermal layer of *Avicennia* spp. **(m)** *A. alba;* **(n)** *A. marina*; **(o)** *A. officinalis*; **(Fig. 1p-r)** Salt gland on epidermal layer of *Avicennia* spp. **(p)** *A. alba;* **(q)** *A. marina*; **(r)** *A. officinalis*

CONCLUSION

Detailed leaf physiognomy analyses could be utilized successfully as taxonomic tool for identification of both living as well as fossil plant taxa.

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RESEARCH ARTICLE

PHENOLOGICAL STUDIES IN A DIOECIOUS HEPATIC, *PELLIA ENDIVAEFOLIA* (DICKS.) DUMORT

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Abstract: Events of the sexual reproductive cycle of 40 populations of *Pellia endivaefolia* were noticed for 3 years.. The phenological events were different among different populations at different sites. There was a seasonal effect on the maturation of gametangia and sporophytes. Some populations exhibited sporophyte formations twice a year whereas others had sporophyte formation only once. Such variations could be on account of various environmental factors.

Keywords: Bryophyte, Egg, Phenological studies, Sexual reproduction

INTRODUCTION

Sexual reproduction of bryophytes is a tightly harmonised and coordinated process involving a number of phenological stages, from the production of gametangia and gametes, via the fertilisation of eggs to the development and maturation of the sporophytes which occur sequentially. The whole process of production of various stages is a seasonal phenomena (Arnell 1875, Grimme 1902, Van der Wijk 1960). The length of the reproductive cycle as a whole and the duration of the individual stages differs considerably between species as well as within species. Comparisons between populations and species have been made easier by a standardized subdivision of the life cycle. Detailed studies of the phenology of particular species show, that there is also quite some variation among individuals within populations in this respect (Hancock and Brassard 1974).

Pellia is a widespread genus represented by six different species namely *P. endivaefolia, P. megaspora, P.columbiana, P.borealis, P.epiphylla* and *P. neesiana.* All the species of this genera are worldwide in distribution. However, the common species are *P.endivaefolia, P. epiphylla* and *P. neesiana*.

Among bryophytes, the seasonality of gametangial and sporophyte development recorded in the phenological cycle has been reported for many mosses (Egunyomi, 1979; Odu, 1981; Miles *et al.*, 1989) but such data available for hepatics are quite meagre. Stark *et al.* (1997) and Solli *et al.,* (1998) reported the winter and late autumn as the suitable season for antheridial formation in *Syntrichia inermis* and *Dicranum majus* respectively. Such results prompted the bryophyte reproductive biologists to undertake phenological studies in larger number of taxa growing in various regions. While Ayukawa *et al.,* (2002) recorded antheridial formation in subalpine moss *Polytrichum ohiense* in May-August, Madhu's (2014) work in this direction is quite interesting as she compared the phenology of male phase in several members of families Aytoniaceae and Marchantiaceae (order Marchantiales) growing in Jammu region (North West Himalaya) and observed a striking difference in the period of antheridial initiation/ maturation between these families. Thus, while antheridia were formed during May and August-September in Aytoniaceae, these events took place in the family Marchantiaceae during entirely different months (February-March). Comparable results were obtained by Sharma (2014) on male phenological events in four taxa belonging to Aytoniaceae (*Plagiochasma appendiculatum, Reboulia hemispherica, Asterella wallichiana* and *A. multiflora)* growing under almost uniform conditions in Sunderbani area of Jammu. Antheridia were produced during the same period (July-August) in three taxa (*P. appendiculatum, R. hemispherica* and *A. wallichiana*) but during a different season in *A. multiflora* (November).

The reproductive system operating within a plant population has a profound influence on both, the pattern of variation and evolutionary flexibility exhibited by the population (Longton and Miles, 1982). Utility of phenological studies in understanding the factors which permit the

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development of a given stage (vegetative, gametangial initiation, maturation and dehiscence, fertilisation, formation and dispersal of spores, elaters etc.) was suggested by Forman (1965). It also helps in interpreting physiological responses controlling these life cycle events. In view of the tremendous significance of phenological studies, studies were undertaken to carry out phenological studies in various populations of *Pellia endivaefolia*.

MATERIAL AND METHOD

Periodical explorations were undertaken between February 2011 and March 2014 from various sites of Jammu region (Table 1). During collection trips in the field, photography was done for the populations growing in diverse habitats and a field book was maintained with all the information regarding various ecological parameters like place and date of collection, temperature, habitat, altitude, pH, thallus colour, texture and patch size.

Phenology

Young thalli of *P.endivaefolia* appeared in the field during April as innovations from the dried thalli and formed dense patches which later bore reproductive structures under favourable conditions. Various populations exhibited variation in their phenological pattern. Antheridial initiation occurred during April-May in 50% of populations while in three populations, they were recorded during June. Still more glaring deviation was recorded in all the five populations from Kishtwar as they produced antheridia twice a year, once in summer (May), then in winters (November, Pe 03, Pe 08 and Pe 09; September, Pe 10, and October, Pe 12). Mature antheridia were first observed during May-June and remained at this stage till July (Table 2). They matured earlier also i.e. April in two populations. In general, antheridia began to dehisce from August onwards till September. V.S. of male thalli revealed that antheridium was globular with a small stalk, embedded in the thallus in an antheridial chamber.

Female phase of *P.endivaefolia* also showed phenological variation as young involucres appeared during July and August in six and four populations respectively. However, they were formed twice i.e. during July-August and November in Pe 19 and Pe 27. Archegonia matured during August-September and remained at this stage till November. In the fertile populations from Himachal Pradesh, mature archegonia were collected in October only, probably due to lack of more field visits. Archegonia typically a flask shaped structure with broad venter and long neck; present in groups of 3-10 per involucre. Two populations (Pe 08 and Pe 10) showed unique variation as in these thalli, 1-2 archegonia per involucre were collected which also degenerated at very early stages of development.

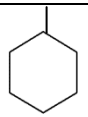
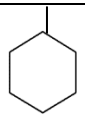
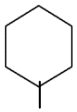
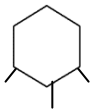
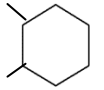
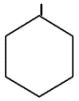
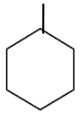
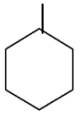
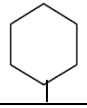
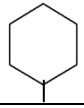
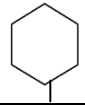
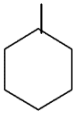
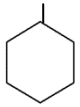
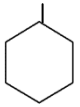
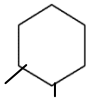
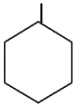
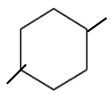
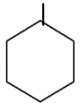
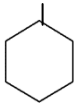
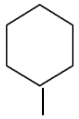
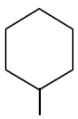
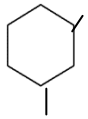
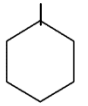
Only one sporophyte within each involucre developed to maturity, the other archegonia degenerated; sporophyte formation occurred during different months in different populations. Production of sporophytes started during August in two populations (Pe 17 and Pe 27), while September was most suitable for three populations (Pe 12, Pe 16, Pe 30). Two more populations (Pe 22 and Pe 25) showed deviation as sporophyte formation occurred during November. Populations from Himachal Pradesh (Pe 37 and Pe 40) and Patnitop (Pe 01) also exhibited variation as in these three populations sporophytes were observed during October (Table 2). It is worthwhile to mention here that there were 4 populations from where sporophytes were collected twice a year. Besides, August, in two populations, Pe 17 and Pe 27, sporophytes were collected in the month of February also where as in Pe 16 and Pe 19, they were recorded during peak winter months i.e. December- January.

Table 1: Sites of collection of various accessions of *Pellia endivaefolia.*

S.No.	District	Site	Accession No.	Altitude (m)
1.	Udhampur	Ghordi	Pe 32	650
			Pe 33	-
		Jib	Pe 34	545
			Pe 35	540

		Pancheri	Pe 20	756
		Patnitop	Pe 01	2060
			Pe 02	2030
		Ram nagar	Pe 18	628
		T.Morh	Pe 36	550
2.	Doda	Bhaderwah		
		Chhabra	Pe 22	1520
		Jaii	Pe 23	1938
		Nalthi	Pe 24	1813
		Gandoh	Pe 19	1250
		Prem Nagar	Pe 25	1350
		Thopal	Pe 28	1200
			Pe 29	1210
3.	Jammu	Nagbani	Pe 14	350
			Pe 15	-
			Pe 16	-
			Pe 17	-
4.	Kishtwar	Kudaya	Pe 03	1016
		Dool	Pe 04	1524
		Ekhala	Pe 05	1706
		Galhar	Pe 06	1707
		Keru Nallah	Pe 07	1706
		Kwarh	Pe 08	1676
		Mughal Maidan	Pe 09	1005
		Nageni	Pe 10	1219
			Pe 11	-
			Pe 12	-
		Waserkund	Pe 13	1280
5.	Poonch	Noori Chhamb	Pe 27	1850
6.	Rajouri	Shahadra Sharief	Pe 31	1668
		Thanna Mandi	Pe 30	1478
7.	Reasi	Pouni	Pe 26	510
8.	Ramban	Ramsoo	Pe 21	1210
9.	Himachal Pradesh	Bagsu waterfall	Pe 39	2223
		Dal Lake	Pe 38	-
		Naddi	Pe 40	1875
			Pe 41	2188

Table 2. Phenological details of gametangial/sporophyte formation in *P.endivaefolia.*

Acc.No	January	February	March	April	May	June	July	August	September	October	November	December
Pe 01	-	-		-								-
Pe 03		-	-	-			-	-	-			-
Pe 08		-		-								-
Pe 09		-		-								-
Pe 10		-		-								-
Pe 12		-		-								-
Pe 14												-

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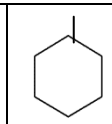
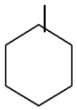
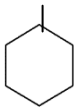
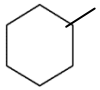
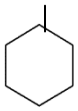
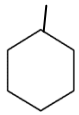
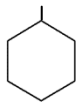
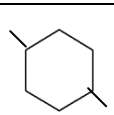
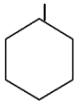
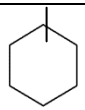
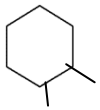
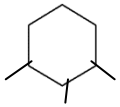
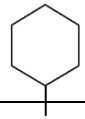
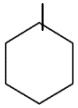
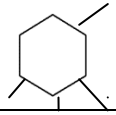
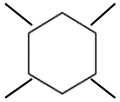
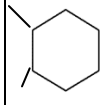
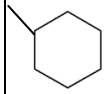
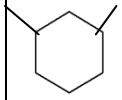
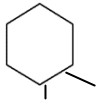
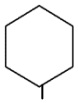
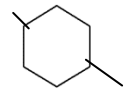
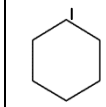
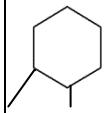
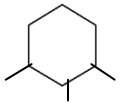
Pe 15					-						-	-
Pe 16											-	-
Pe 17											-	-
Pe 19	-	-			-				-	-		
Pe 22		-		-	-		-			-		-
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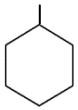
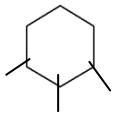
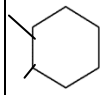
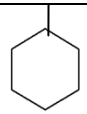
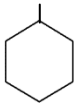
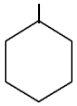
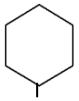
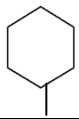
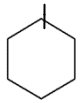
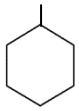
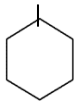
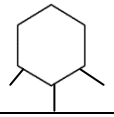
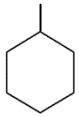
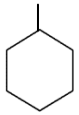
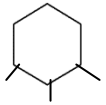
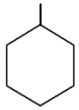
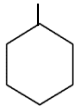
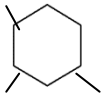
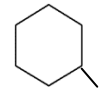
Pe 30	-	-			-		-				-	-
Pe 31	-	-			-		-				-	-
Pe 37	-		-		-	-	-	-	-		-	
Pe 38	-		-		-	-	-	-	-		-	
Pe 40	-		-		-	-	-	-	-		-	

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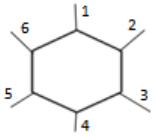
4/5-Young and mature archegonia, 6- Sporophyte 

CONCLUSION

On the basis of the observations, it can be concluded that there is lot of variation in phenology in different populations. Variations could be on the account of various environmental factors like habitat, temperature, availability of water, nutrients available etc. which need futher investigations.

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RESEARCH ARTICLE

LIVELIHOOD SECURITY OF FARMERS IN EASTERN UTTAR PRADESH: AN ECONOMIC ANALYSIS

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Abstract: The present study was conducted to investigate and find out the livelihood security status of the farmers in eastern Uttar Pradesh.Varanasi and Sonbhadradistricts were purposively selected because these districts are having differences with respect to irrigated and rainfedfarming systems respectively. Pindrablockof Varanasi district and Ghorawalblock of Sonbhadra district were selected based on highest net sown area of food crops and to represent various farming systems.Primary and secondary data were used in the study.To address the objectives set forth for the study, primary data were collected from 200 randomly selected farmers for the period 2016-17. Six different livelihood security indicators were constructed based on the prevailing condition of farmers' households in the study area. The index score of indicator ranged from 0 to 1. Higher value of the indicator implies households are better off and more secured in terms of their livelihood.Economic security and habitat security status are in highly vulnerable situation for rain-fed farmers compare to irrigated farmers. This confirmed that around 53 % of the irrigated farmers and around 62 % of the rain-fed farmers were in livelihood insecurity status in the study area.

Keywords: Farming System, Livelihood security, Livelihood security index, Social Security

INTRODUCTION

Agriculture is the main income generating source for small and marginal farmers and they also depend on livestock enterprise for their household income.The income from farming alone in small and marginal farms is barely sufficient to meet the basic needs. With gradual decline in farm size due to explosion of population, it has become increasingly difficult to produce enough food and other farm products for the family. National Commission on Farmers proposed the introduction of appropriate farming systems toachieve better growth in agriculture and livelihood. In recent years, farming systems approach gave a scientific touch to the existing practices and found ways and means to make them sustainable in changing the global scenario. Drinkwater and McEwan (1992)has defined household livelihood security asadequate and sustainable access to income and resources to meet basic needs (includingadequate access to food, potable water, health facilities, educational opportunities,housing, time for community participation and social integration).Livelihoods can be made up of a range of on-farm and off-farm activities whichtogether provide a variety of procurement strategies for food and cash. Thus, eachhousehold can have several possible sources of entitlements which constitute itslivelihood.

METHODOLOGY

Study area

The study was carried out in Varanasi and Sonbhadra districts of Uttar Pradesh.Both districtsVaranasi and Sonbhadra were selectedpurposively because these districts are having differences with respect to irrigated and rainfedfarming systems respectively.There are total 8 blocks in each district.Pindrablockof Varanasi district and Ghorawalblock of Sonbhadra district were selected based on highest net sown area of food crops and to represent various farming systems.

Data Collection

Primary and secondary data were used in the present study. To address the objectives set forth for the study, primary data were collected from 200 randomly selected farmers for the period 2016-17. Multistage random sampling procedure was used for the selection of respondents, on the first stage two blocks was selected and in second stage based on the reconnaissance survey 5 villages in each block was considered for selecting the farmers practicing farming systems. In the third stage from each selected village, 20 farmers were randomly selected who are practicing farming systems. The data pertaining to socio-economic parameters, consumption pattern, health, habitat, educational, social network security, rural development schemes, constraints and others were obtained from the sample households through personal interviews.

Analytical tool

To analyze the objective, five-point scale method was used to construct livelihood security Indexes. Indicators are assumed that each indicator has equal weight to the overall household livelihood security index. Household's livelihood security index consisted of six livelihood outcomes and were measured based on accessibility, quality and status. Household livelihood indexes such as Economic,

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Education, Health, Habitat, Food and Social Security were obtained by aggregating the scores of indicators. Each indicator was measured in a different scale. It was first necessary to standardize each indicator as an index for relevant indicator.The standardized indicators of a household will be prepared using the method adopted to calculate Human Development Index (UNDP, 2007), and used by SaravanamutthuJeyarajah (2016). For any component of the HDI, the individual indices can be computed according to the general formula

$$Z_{index} = \frac{Actual\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

Each index thus ranges from 0 to 1. If the actual value of the variable is the minimum, the index is zero. If the actual value is equal to the maximum value, the index is one.Higher value of the indicator implies households are better off and more secured in terms of their livelihood.Household Livelihood Security Index (HLSI) will be calculated by averaging the standardized indicators by using formula

$$HLSI = \frac{\sum_{j=1}^{J} Z_{index}}{J}$$

J = no. of indicators

RESULT AND DISCUSSION

The livelihood security index is very important to determine whether the livelihood is successful in following their livelihood strategies. Livelihood security Indices such as food, economic, health, education, habitat and social security will be computed by aggregating all the scores of the selected indicators. Livelihood indices were calculated using standardized value of indicators of the relevant variable. The indicators chosen for this study were based on the literature review of previous researches

Economic Security

Economic security is the condition of having stable income or other resources to support a standard of living now and in the future.Economic security index of the irrigated farmers was 0.34and 0.21 of the rain-fed farmers in the study area. The average annual income offarmer was more under irrigated situation (Rs. 261566.79) compared to rain-fed situation (Rs. 231295.6). This implies that the irrigated farmers'households are economically better off and more secured than rain-fedfarmers' household.

Food Security

Food security indicator like monthly food consumption expenditurewas selected in the present study.The index of the food security scored a value of 0.45in irrigated area farmers and 0.38 in rain-fed area farmers. The average monthly food consumption expenditureoffarmer was more under irrigated situation (Rs. 8320) compared to rain-fed situation (Rs. 5173). It highlights that food security had a relatively better position among the irrigated farmersthan rain-fed area farmers in the present research.

Health Security

The definition of health security is the capacity of individuals to identify, prevent and manage significant risks to their health. In the present research, indicator like access to primary health care services was used to measure the health security of farmers in the study area.

Table 1. Accessibility to Primary Health Services in the study area

No. of Farmers

Accessibility (Distance in km)	Irrigated (n=100)	Rain-fed (n=100)
0-2	20	14
2-4	44	20
4-6	36	32
6-8	-	26
8-10	-	8
10&above	-	-
Health Security Index	**0.768**	**0.612**

Source: *Computed from field survey 2016-17*

The index of the health security scored a value of 0.77in irrigated area farmers and 0.61 in rain-fed area farmers. The present study confirmed that the health security was significantly higher for irrigated and rain-fed area farmers in eastern Uttar Pradesh. This might be due to the better investment on health sector at the national level.It should be noted that both values gained the value above the mid-point. This indicated less vulnerabilityto the health security of the farmers in eastern Uttar Pradesh. However, small percentage of farmers needs health facilities for their better living.

Habitat Security

Habitat of the farm households is also one of the factors which influence the livelihood of household. Shyamalie and Saini (2010) defined as the access of

individuals to an adequate shelter and its related resource to ensure that they have a healthy and sanitary environment, protection from detrimental elements to enable safe and secure livelihoods. The index of the habitat security scored a value of 0.25 in irrigated area farmers and 0.21 in rain-fed area farmers.The average value of farmers' house was more under irrigated situation (Rs. 522750) compared to rain-fed situation (Rs. 391200). Due to higher annual income under irrigated situation, the number of farmers with pucca houses, toilet facility and cooking gas were more compared to those under rainfed situation. In general, farm households under irrigated situation are more secured in terms of habitat.

Educational Security

Education is the important necessity of life. Level of education at the individual as well as household level, availability and accessibility of educational institutes and monthly expenditure on education are the major determinants of educational security of households.

Table 2. Education Level of Farmers

No. of Farmers

Level of education	Irrigated (n=100)	Rain-fed (n=100)
Illiterate	26	29
Primary school	4	9
Middle school	16	11
High school	20	7
12^{th} standard	18	12
Graduate & above	16	32
Total	100	100
Educational Security Index	**0.496**	**0.52**

Source: *Computed from field survey 2016-17*

In the study area, based on the educational level of the farmers, an educational index was calculated. It was found to be more under rain-fed situation (0.52 which means 32 farmers had education up to university level) compared to irrigated situation (0.50 which means 16 farmers had education up to university level). Not all the sample farmers have access to primary school, high school and college. Further, irrigated area farmers are having better accessibility to educational institutions than the rain-fed farmers is due to the fact that, irrigated area farmers haveresources to send their children to private schools and colleges. But majority of the rain-fed area farmers send their children to Government schoolsand colleges which are relatively faroff.

Social Security

The social security refers to the capacity of the individuals to maintain and participated in the social networks that enable them to pursue sustainable livelihood by reducing risks, accessing resources and information. Social network is nothing but the level of participation by the farmers in organizations like Panchayat, Co-operatives, Self Help Groups and other organizations. Access to support from friends/neighborhood and access to social network elements like phone and television is another factor which determines the social network status of households.

Table 3. Social Security Status of farmers

Particulars	Irrigated (n=100)	Rain-fed (n=100)
Access to support from friends/ neighborhood	6	12
Access to phone	55	64
Access to TV	32	20
Member at village level/block level	7	4
Social Security Index	**0.466**	**0.386**

Source: *Computed from field survey 2016-17*

The analysis of social network status of farmers revealed that, participation in gram panchayat elections was higher under irrigated situation compared to rain-fed situation. And also 7 per cent of the irrigated area farmers were members at village level/block level than 4 per cent of rain-fed area farmers.55 per cent of the farm households under irrigated and 65 per cent under rainfed situations were having phone. 32 cent of the farm households under irrigated situation had access to televisions and about 20 per cent of the farm households under rain-fed situation had access to television. Based on the level of participation in social organizations and access to social media like television and phone, an index of social network status was worked out the index was more in irrigated situation (0.47 which means that most of the households participated in/had access to more than two of the social networks) than rain-fed situation (0.39 which means that most of the households participated in/ had access to more than one of the social networks).

Household Livelihood Security Index

Household livelihood security index includes six livelihood security domains such as economic security, Food Security, Health security, Habitat security, educational security and social security. The composite overall Livelihood Security Index (LSI) for the household was calculated.

Table 4. Household Livelihood Security

Indicators	Indices	
	Irrigated	**Rain-fed**
Economic Security	0.34	0.21
Food Security	0.45	0.38
Health Security	0.77	0.61
Habitat Security	0.25	0.21
Educational Security	0.52	0.50
Social Security	0.47	0.39
Household Livelihood Security Index	**0.47**	**0.38**

Source: *Computed from field survey 2016-17*

In the present research, the overall livelihood security index of irrigated farmers was 0.47 and livelihood security index of rain-fed farmers was 0.38.

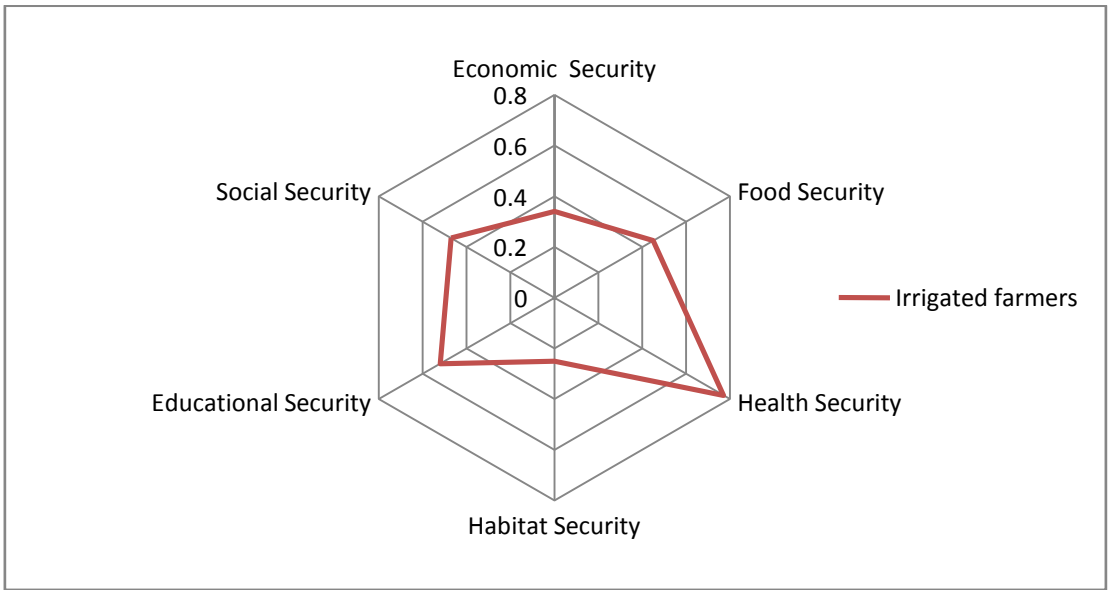

Figure 1. Livelihood Security Status of irrigated farmers

The results of livelihood Security Status of irrigated farmers are summarized in Fig:1. The livelihood security index spider diagram ranges between 0 and 0.8. It shows the significant difference among the six livelihood indices. Habitat Security of irrigated farmers is stood in a comparatively very lower position followed by economic security. Food and Social security scored relatively same value and moderate level. Health security and Educational Security scored a higher value and confirmed a higher level of security. Among these livelihood security index health security was indicated best level in the study area.

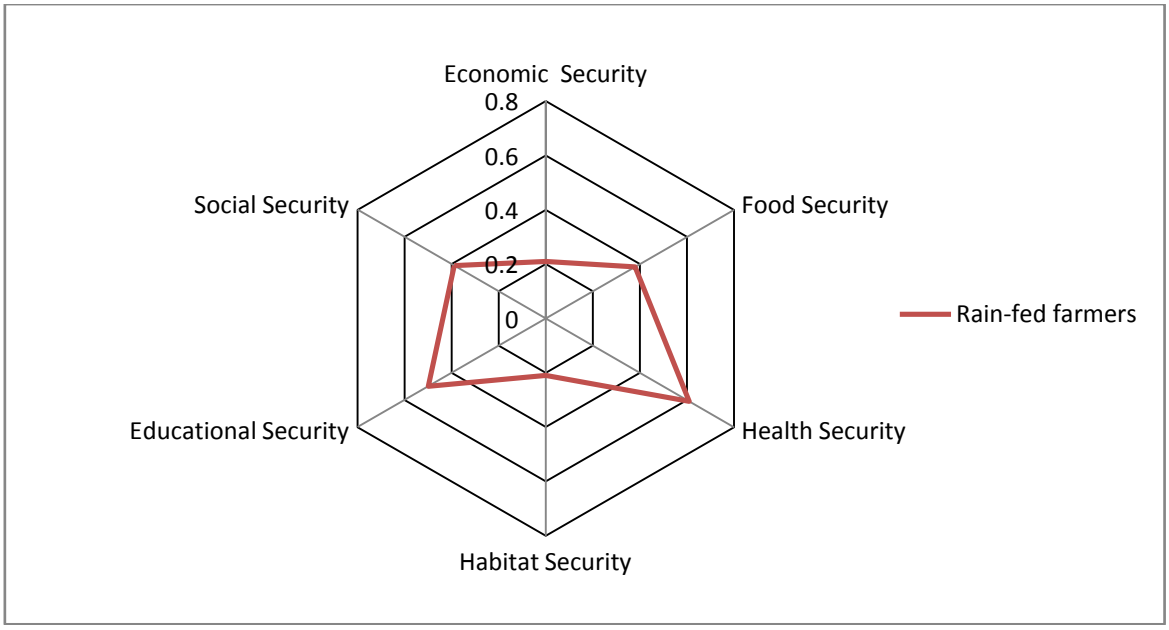

Figure 2. Livelihood Security Status of rain-fed farmers

The results of livelihood Security Status of rain-fed farmers are summarized in Fig:2. The livelihood security index spider diagram ranges between 0 and 0.7. It shows the significant difference among the six livelihood indices. Habitat Security and Economic Security of irrigated farmers is stood in a comparatively very lower position. Food and Social security scored relatively same value and moderate level. Health security and Educational Security scored a higher value and confirmed a higher level of security. Among these livelihood security index health security was indicated best level in the study area.

CONCLUSION AND RECOMMENDATION

The study was set out to explore the livelihood security of farmers in the Varanasi and Sonbhadra district of Uttar Pradesh. The socio-economic status of the farmers and their livelihood status were a vulnerable situation in both the district. Particularly, economic security and habitat security status are in highly vulnerable situation for rain-fed farmers compare to irrigated farmers. This confirmed that around 53 % of the irrigated farmers and around 62 % of the rain-fed farmers were in livelihood insecurity status in the study area.Livelihood diversification is one of the ways to enhance the livelihood security of farmers. Lack of understanding about well-established patterns of livelihood and lack of diversified livelihoods were reported by the majority of farmers in the study area. Government can organize training on diversified livelihood activities.

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RESEARCH ARTICLE

STUDIES ON YIELD AND QUALITY OF FRENCH BEAN *(PHASEOLUS VULGARIS* L.) GENOTYPES, UNDER NET- HOUSE CONDITIONS

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Abstract: French bean is an important legume crop which is grown for its dry grain and tender pods in North-Western India. This off-season crop can be successfully raised in Punjab during winter season which fetches higher price in the market and economical to the farmers when there is no availability of green pods from high altitude. Hence, there is a great scope of cultivation of French bean under net-house conditions in Punjab. The present investigations were carried out in Department of Vegetable Science, PAU Ludhiana with the sole objective to indentify French bean genotypes suitable for cultivation under net-house conditions. Twenty genotypes were selected for green pod yield per plant, number of pods per plant, average pod weight (g). Based on the two year studies, the genotypes Falguni (350.19 g), Cosmo (329.86 g) and IIHR-909 (240.22 g) performed better under net-house conditions for total green pod yield per plant. Maximum number of pods per plant was recorded in genotype Falguni (52.33), Seville (50.83) and IIHR-909 (49.50) while maximum pod weight was elicited by genotypes Falguni (6.96g), Cosmo (6.11g) and DWP-FB-57 (5.78g) respectively.

Keywords: French bean, Green pod yield, Pod weight, Net-house

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belongs to the family Fabaceae and it is native of South America. It is domesticated in Mexico, Peru and Colombia about 8000 years ago. French bean has evolved from wild growing vine distributed in the high lands of Middle-America and Andes. These two domestications, led to two groups of cultivars with contrasting agronomic characteristics. During this evolution, some marked changes has affected this plant from climbing to dwarf type which has taken place both in the middle American and Andean domestication centres as reported by (Schoonhoven and Vosyest, 1991). It is widely cultivated in tropics, sub tropics and temperate regions. In India and most of the tropical Asia, it is a major vegetable crop where indigenous pulses are also preferred (Adams, 1985).

French bean commonly known as kidney bean or snap been or fine bean is one of the important vegetable crop among legumes. It is grown for tender green pods for fresh consumption as well as for dry seeds which are used as pulse. The dried beans are rich in protein and closely compare with meat. In India, it is mostly grown for tender green pods, while in the USA it is grown for processing in large quantities. This vegetable not only plays a vital role in nourishment of human population, but also improves soil fertility to a greater extent by virtue of being highly nitrogen fixing crop. 100 g green pods contain 1.7 g protein, 0.1 g fat, 4.5 g carbohydrate, 1.8 g fibre and are also rich in minerals and vitamins. It has some medicinal properties in control of diabetes, cardiac problems and natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhea as reported by Duke, 1981.

In India, it is mainly grown in Himachal Pradesh, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. In India, pulses account for about one fifth of the total area under food grains and contribute to about one fifth of the total food grain production with the total area under pulses being 23.85 million ha and production of 14.60 metric tones (Anon., 2008). Among the pulses, raj mash is one of the high potential pulse crops with a yielding potential of 18 to 20 q per ha. French bean fetches premium price in market as compared to other vegetables and is a popular vegetable grown under irrigated conditions almost throughout the year. It is gaining lot of importance due to its short duration and high production potential as well as its high nutritive value. French bean is a tender warm season vegetable which cannot tolerate frost, high temperature and rainfall. Its seeds do not germinate below 15°C and a most favorable soil temperature for its seed germination ranged from 18-24°C. A mean air temperature of 20-25°C is optimum for its growth and high pod yield. Extreme high temperature interferes with pod filling. When sowing of French bean is done in September-October under open field conditions in Punjab there is a severe mortality of plants due to fusarium wilt at germination stage. Moreover occurrence of frost coupled with low temperature during the month of December-January causes mortality of plant. Hence extreme low and high temperature are the limiting factors for successful cultivation of French bean

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under open field conditions in Punjab.

To overcome these environment factor, protected cultivation particularly net-house cultivation is the best alternative which offers distinct advantages of earliness, high productivity, better quality and pesticide residue free produce besides higher returns to growers. Singh *et al* (2004) while studying the cultivation of capsicum in net-house reported that fruits are more uniform, larger in size and mature one month earlier to conventional cultivation. So, net-house cultivation of *capsicum*, tomato and brinjal in net-house has been recommended by Punjab Agricultural University, Ludhiana.

MATERIAL AND METHOD

Twenty genotypes of French bean were collected from different sources (Public sector and private sector) were collected. These varieties were evaluated at Vegetable Research Farm, Department of Vegetable Crops, Punjab Agricultural University, Ludhiana from October to March in the net-house and in the open field conditions during the year 2008-09 and 2009-10. The experiment was laid out in a Randomized Complete Block Design with three replications. Genetically pure seeds of each genotype were sown in a 2.5 m long row at 30 cm spacing between paired rows on a 90 cm raised bed (45 cm bed top and 45 cm furrow). The plant to plant spacing was kept 10 cm and recommended cultural practices were followed to raise a uniform healthy crop. Pooled mean value of the parameters in each replication was statistically analysed.. The table formulated by Fisher and Yates (1963) were consulted for the purpose of comparison of 'F' values and for determination of critical differences (C.D. values) at the probability of 0.05.

RESULT AND DISCUSSION

Days to 50% germination

The germination of the seed depicts the yield of the crop. The data presented in Table 1, showed that 50% germination of the seeds of different varieties took10.00 to 13.00 days during 2008-09 and 9.00 to 14.00 days during 2009-10 recording non significant differences among various cultivars for germination. Likewise the pooled mean for 50% germination, the days taken were between 9.50 to 13.17 which also showed that all the cultivars were statistically at par for germination. The varieties which showed relatively higher germination percentage were Mohanpur Local (95.5) Badsah (92.45%), Arka Suvidha (86.53%), Shillong Local-3 (84.22%). Seedling root length measured at 9day of germination was highest for Shillong Local-3(14.83 cm) whereas it was obtained as lowest for Falguni (8.90 cm), (Das *et al.* 2014)

Plant height (cm)

The present study revealed that among the various genotypes (Table-1), it was noticed that most of the genotypes were shorter than the cultivar Contender except genotype 504-64C and FB-17 where average height of two years was 85.53 and 71.20 cm, respectively. It was further seen from the data that genotype 'Seville' was the most dwarf one in nature recording the height of 35.70 cm and 34.00 cm, respectively during 2008-09 and 2009-10. The plant of genotypes FB-6, Cosmo, DWP FB-57, IIHR-909 and Aperna were also shorter statured and were statistically at par among themselves where those recorded an average height of 42.27 cm, 45.00 cm, 46.67 cm, 48.00 cm and 47.07 cm respectively during 2008-09 and 40.33 cm, 45.00 cm, 44.67 cm, 43.33 cm and 43.67 cm during 2009-10. Rest of the cultivars recorded intermediate heights. These genotypes were DW FB-53, FB-4, Falguni, FB-16, DWP-FB-1, FB-18 where average height ranged between 50.00 cm to 59.70cm. The differential height of various genotypes is due to genetic constitution of various cultivars as a result of which the cultivars had variation in height.With respect to plant height the highest value was highest value was obtained in case of genotypes Badsah (47.53 cm) and lowest for the genotypes Abhay (25.67 cm), (Das *et al* 2014).

Days to 50% flowering

Days to 50 % flowering are an index for earliness in any crop. The present study depicted the significant variation in 50% flowering during the first year of the study where it took between 51.00 days to 61.67 days during 2008-09, (Table 1). But during the year 2009-10 the non-significant differences were recorded among the various genotypes. It was noticed that during 2008-09, the cultivar 'Falguni' was the earliest to flower where it took 51.00 days as compared to 57.67 days in Contender. Likewise Falguni was the earliest to flower during 2009-10 also where Falguni flowered in 55.33 days while Contender took 60.00 days. It showed that Falguni was the earliest to flowering by 5-7 days than the check cultivar Contender.The data further showed that FB-17, DWP FB-53 and FB-3 were the most late cultivar to flower during both the years. However, rest of the genotypes was intermediary in their response to 50% flowering where it ranged between 52.67 days to 59.33 days during 2008-09. It shows that the selection among various genotypes can be done for earliness to flowering. However, narrow range in flowering is most probably due to the aerial temperature conducive for flower formation.Similar finding with respect to days taken to pod set from 50 % flowering in common bean has been reported by Kamaluddin and Shaahid- Ahmed (2011). Khyad (1996) reported minimum number of days to 50% flowering in 'Arka Komal' (33.83) and 'Burpee's Stringless' (34.00).

Table 1. Mean values of genotypes character days to 50% germination, plant height (cm) and days to 50% flowering

S. N.	Genotypes	Days to 50% germination			Plant height (cm)			Days to 50% flowering		
		2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean
1.	Falguni	10.00	11.67	10.83	55.73	54.00	54.87	51.00	55.33	53.17
2.	Seville	11.33	11.33	11.33	35.70	34.00	34.85	52.67	60.67	56.67
3.	Aperna	10.67	12.67	11.67	47.07	43.67	45.37	57.67	65.00	61.33
4.	504-64C	12.33	14.00	13.17	86.40	84.67	85.53	55.33	63.67	59.50
5.	Cosmo	11.00	12.67	11.83	45.00	44.00	44.50	60.67	64.00	62.33
6.	DPP-BSS-1	13.00	13.33	13.17	51.33	47.33	49.33	57.67	58.67	58.17
7.	DWP-FB-1	13.00	12.33	12.67	56.33	54.00	55.17	59.00	63.67	61.33
8.	DWP-FB-53	10.67	12.00	11.33	51.33	48.67	50.00	61.00	60.33	60.67
9.	DWP-FB-57	12.00	12.67	12.33	46.67	44.67	45.67	55.00	55.33	55.17
10.	IIHR-909	12.67	11.00	11.83	48.00	43.33	45.67	56.67	61.00	58.83
11.	FB-3	10.00	9.00	9.50	62.33	60.33	61.33	60.67	61.33	61.00
12.	FB-4	10.00	12.67	11.33	55.27	52.67	53.97	58.33	62.00	60.17
13.	FB-5	11.33	11.33	11.33	49.13	47.33	48.23	59.33	57.00	58.17
14.	FB-6	13.00	10.67	11.83	42.27	40.33	41.30	60.00	64.33	62.17
15.	FB-16	12.67	9.67	11.17	54.13	52.00	53.07	58.00	60.67	59.33
16.	FB-17	10.00	12.00	11.00	72.40	70.00	71.20	61.67	58.00	59.83
17.	FB-18	10.67	10.00	10.33	61.07	58.33	59.70	56.67	59.33	58.00
18.	FB-19	12.00	9.67	10.83	58.00	55.33	56.67	59.67	63.00	61.33
19.	FB-20	12.33	10.33	11.33	49.67	46.67	48.17	53.67	57.67	55.67
20.	Contender (C)	13.33	11.00	12.17	65.67	64.00	64.83	57.67	60.00	58.83
	Mean	11.60	11.50	11.55	54.67	52.27	53.47	57.62	60.55	59.08
	Range	10 .00–13.00	9.00 - 14.00	9.50–13.17	35.70 - 86.40	34.00 - 84.67	34.85 – 85.53	51.00 – 61.67	55.33– 65.00	53. 17 – 62.33
	CD (5%)	NS	NS	1.88	6.47	5.94	4.32	5.81	NS	4.49
	CV	13.10	15.24	14.20	7.17	6.87	7.03	6.1	7.04	6.61

Table 2. Mean values of genotypes character, days to first harvest, number of pods per/ plant and average pod weight (g).

S. N.	Genotypes	Days to first harvest			Number of pods per/ plant			Average pod weight (g)		
		2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean
1.	Falguni	78.00	80.00	79.00	54.67	50.00	52.33	7.16	6.76	6.96
2.	Seville	84.33	82.00	83.17	53.00	48.66	50.83	4.53	4.26	4.39
3.	Aperna	89.33	88.00	88.67	40.00	44.66	42.33	5.76	5.66	5.71
4.	504-64C	92.67	90.33	91.50	44.00	40.66	42.33	5.16	5.00	5.08
5.	Cosmo	81.67	84.33	83.00	46.67	40.54	43.605	6.26	5.96	6.11
6.	DPP-BSS-1	87.67	84.00	85.83	48.00	21.88	34.94	4.86	4.50	4.68
7.	DWP-FB-1	86.33	83.67	85.00	27.33	16.33	21.83	4.16	4.33	4.24
8.	DWP-FB-53	88.67	79.00	83.83	35.00	35.67	35.34	4.10	3.90	4.00
9.	DWP-FB-57	82.00	80.00	81.00	38.00	38.00	38.00	5.90	5.66	5.78
10.	IIHR-909	77.00	78.00	77.50	50.67	48.33	49.50	5.20	5.00	5.10
11.	FB-3	84.33	84.67	84.50	33.33	34.00	33.67	4.50	4.30	4.4
12.	FB-4	87.67	86.33	87.00	36.00	36.67	36.34	4.60	4.33	4.46
13.	FB-5	84.67	82.67	83.67	35.33	33.67	34.50	4.10	3.86	3.98
14.	FB-6	91.67	89.33	90.50	37.33	36.33	36.83	4.56	4.36	4.46
15.	FB-16	84.00	82.00	83.00	31.00	32.67	31.84	4.16	3.90	4.03
16.	FB-17	87.67	78.00	82.83	30.33	31.33	30.83	4.60	4.33	4.46
17.	FB-18	82.33	80.67	81.50	34.33	35.00	34.67	4.33	4.10	4.21
18.	FB-19	85.67	83.33	84.50	35.00	33.67	34.34	4.26	4.06	4.16
19.	FB-20	83.33	78.00	80.67	32.00	33.00	32.50	3.76	3.56	3.66
20.	Contender (C)	82.00	84.67	83.33	37.33	40.33	38.83	4.90	4.63	4.76
	Mean	85.05	82.95	84	38.97	35.42	37.19	4.84	4.61	4.72
	Range	77.00 – 92.67	78 .00 – 90.33	77.5 – 91.50	27.33 – 54.67	16.33 – 50.00	21.83 – 52.33	3.76– 7.16	3.56- 6.76	3.66– 6.96
	CD (5%)	NS	NS	6.24	4.81	7.47	4.37	1.09	1.10	0.76
	CV	6.18	6.72	6.45	7.47	11.72	9.81	13.67	14.47	14.06

Days to first harvest

The data present in Table-2, revealed that various genotypes do not differ significantly for days to first picking during both the years of investigation, however on pooled mean basis it was noticed that among them, Falguni was the cultivar which took minimum days to reach the stage of first harvest. Falguni took 79.00 days to give first harvest which was statistically at par with Contender (check) which gave first harvest in 83.33 days. Among rest of the cultivars, 504-64 C, FB-6 and FB-4 took maximum number of days to first picking. Being statistically at par among themselves those took 91.00, 90.50 and 87.00 days respectively. The rest of the cultivars

were at par with Contender for first picking where those counted between 77.50 days (IIHR-909) to 86.33 days (FB-4).

Number of pods per plant

The present study conducted in year 2008-09 and 2009-10 (Table-2) revealed that the number of pods per plant in 2008– 09 varied from 27.33 – 54.67 among the various genotypes. Maximum number of pods was observed in genotype Falguni (54.67), which was statistically at par with genotypes Seviile and IIHR-909 where numbers of pods were 53.00 and 50.67, respectively. Minimum number of pods were observed in genotypes DWP-FB-1 (27.33), FB-16 (31.00)., FB-20 (32.00), Contender (37.33) and FB-18 (34).Number of pods per plant in 2009-10 varied from 16.33-50.00 among various genotypes. Maximum pods were observed in genotype Falguni (50.00),whichwas statistically at par with genotypes Seville, IIHR-909 and Aperna, where number of pods were 48.66, 48.33, 44.66, respectively. Minimum number of pods were harvested in genotypes DWP-FB-1 (16.33) and DPP BSS-1 (21.88).In the pooled data for two years the maximum pod number were observed in genotype Falguni (52.33) which was statistically at par with genotypes Seville (50.83) and IIHR-909 (49.50). Ram Krishna (1999) reported (11.10) and (10.23) number of pods per plant in Arka Komal and Burpee's stringless, respectively.

Average pod weight (g)

Average pod weight (Table-2) was observed during 2008- 2009 ranged from 3.76-7.16 g. The maximum pod weight was observed in genotype Falguni (7.16 g) which was statistically at par with genotype Cosmo (6.26 g) followed by DWP-FB-57, Aperna, 504-64C where it was recorded (5.90g), (5.76g) and (5.16g), respectively. The minimum pod weight was observed in genotypes FB-20,FB-5,DWP-FB-53, FB-16 and DWP-FB-1, where it weighted (3.76g),(4.10 g),(4.10g),(4.16g) and (4.16g), respectively. During 2009-10 average pod weight was observed 3.56-6.76 g, the maximum pod weight was observed in genotype Falguni (6.76 g) , which was statistically at par with genotypes Cosmo, Aperna and DWP-FB-57 where it weighted (5.96g), (5.66g) and (5.66g), respectively followed by IIHR-909 (5.00g) and Contender (4.63g). The minimum pod weight was observed in genotypes FB-20, FB-16, DWP-FB-53 and FB-18, where it weighted (3.56g), (3.90g), (3.90g) and (4.10 g), respectively. In the pooled data for two years, pod weight ranged from 3.66-6.96 g. There were significant differences in average pod weight per plant in different French bean genotypes. The maximum pod weight was observed in genotype Falguni (6.96g) followed by genotypes Cosmo, DWP-FB-57, Aperna, 504-64-C, where it weighted (6.11 g), (5.78g), (5.71g) and (5.08g), respectively. The minimum pod weight was observed in genotypes FB-20 (3.66g), FB-5 (3.98g), DWP-FB-53 (4.00g), FB-16 (4.03g) . Ram Krishna (1999) reported green pod weight of Arka Komal and Burpee's stringless as 31.12g and 29.82g, respectively.

Pod length (cm)

During 2008-09 (Table 3) the maximum pod length was observed in genotypes FB-4 (18.00 cm) which was statistically at par with genotypes Cosmo (17.00 cm) and FB-18 (15.33 cm) .The minimum pod length was observed in genotypes FB-3 (9.67 cm), IIHR-909 (10.00 cm), DWP-FB-53 (10.00 cm), DWP-FB-57 (11.00 cm), FB-6 (11.33 cm) and Aperana (11.33 cm). During 200 –10,the maximum pod length was observed in FB-4 (17.00cm) which was statistically at par with Cosmo (14.33cm), FB-5 (14.00 cm) and check Contender (15.30cm). The minimum pod length was observed in genotypes DWP-FB-57 (9.33 cm), FB-3 (9.33 cm) DWP-FB-53 (9.67 cm), FB-6 (10.00 cm), Aperna (10.33 cm) and IIHR-909 (10.67 cm), respectively. In the pooled data for two years, there were a significant difference in pod length per plant in different French bean genotypes. It was observed that maximum pod length was observed in genotypes FB-4 (17.50 cm) which was statistically at par with genotypes Cosmo (15.67 cm) and minimum pod length was observed in genotypes FB-3 (9.50 cm), DWP-FB-57 (9.83 cm), DWP-FB-57 (10.17 cm) and IIHR-909 (10.33 cm). Ramakrishna (1999) reported green pod length 13.24 cm in 'Arka Komal' and 13.03 cm in 'Burpee's stringless'.

Pod width (cm)

The pod width (Table-3) of French bean recorded in 2008-09 varied from 0.69-1.08 cm. The maximum pod width was observed in genotype FB-3 (1.08cm) which was statistically at par with genotypes Falguni (1.04 cm),Seville (1.02 cm), FB-17 (0.98 cm), FB-19 (0.98 cm) and FB-20 (0.96 cm). Minimum pod width was observed in genotypes Aperna (0.69 cm), FB-5(0.73 cm), DWP-FB-1 (0.75cm) and DWP-FB-53 (0.78 cm). During 2009-2010, pod width varied from 0.68-1.03 cm. The maximum pod width was observed in genotype FB-4 (1.03 cm) which was statistically at par with genotypes FB-3(1.00 cm), Falguni (0.99 cm), seville (0.98 cm), FB-20 (0.93 cm), FB-16 (0.93 cm), FB-16 (0.92 cm), FB-17 (0.92 cm) and FB-18 (0.90 cm). Minimum pod width was observed in genotypes Aperna (0.68 cm),DWP-FB-1 (0.70 cm), DWP-FB-53 (0.72 cm) and FB-5 (0.72 cm). In pooled mean for two years, there were significant differences of pod width in different French bean genotypes and it varied from 0.68 to 1.04 cm. Pods of genotype FB-3 and FB-4 had maximum pod width (1.04 cm) which was statistically at par with genotypes Seville (0.99 cm), FB-19 (0.97 cm),), FB-19 (0.97 cm), FB-17 (0.95 cm), contender (0.94 cm) and 504-64c (0.91 cm), respectively. Minimum pod width was observed in genotypes Aperna (0.68 cm), FB-5 (0.72 cm), DWP-FB-1 (0.73 cm) and DWP-FB-53 (0.75 cm). Roy and

Parthasarathy (1999) reported 0.78 cm green pod width in Tender Crop, 0.77 cm in stringless cluster, 0.78 cm in Canadian Wonder, 0.74 cm in Meghalaya Pole, 0.77 cm in Maghalya Dwarf and 0.71 cm in Manipur.

Table 4. Mean values of genotypes for pod length (cm), pod width (cm) and green pod yield per plant (g)

S. No.	Genotypes	Pod length (cm)			Pod width (cm)			Green pod yield per plant (g)		
		2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean	2008-09	2009-10	Pooled mean
1.	Falguni	14.00	12.67	13.33	1.04	0.99	1.02	381.16	319.22	350.19
2.	Seville	13.33	12.00	12.67	1.00	0.98	0.99	208.60	185.50	197.05
3.	Aperna	11.33	10.33	10.83	0.69	0.68	0.68	200.67	233.37	217.02
4.	504-64C	12.67	11.00	11.83	0.93	0.89	0.91	194.67	181.00	187.84
5.	Cosmo	17.00	14.33	15.67	0.93	0.88	0.90	373.11	286.60	329.86
6.	DPP-BSS-1	11.67	13.00	12.33	0.91	0.86	0.89	203.60	186.00	194.80
7.	DWP-FB-1	13.00	11.33	12.17	0.75	0.70	0.73	115.10	97.80	106.45
8.	DWP-FB-53	10.00	9.67	9.83	0.78	0.72	0.75	143.50	140.30	141.90
9.	DWP-FB-57	11.00	9.33	10.17	0.91	0.84	0.87	225.53	218.00	221.77
10.	IIHR-909	10.00	10.67	10.33	0.80	0.85	0.83	234.10	246.33	240.22
11.	FB-3	9.67	9.33	9.50	1.08	1.00	1.04	151.23	144.33	147.78
12.	FB-4	18.00	17.00	17.50	1.05	1.03	1.04	165.60	158.00	161.80
13.	FB-5	12.67	14.00	13.33	0.73	0.72	0.72	144.93	131.80	138.37
14.	FB-6	11.33	10.00	10.67	0.80	0.79	0.79	170.90	160.56	165.73
15.	FB-16	12.67	11.33	12.00	1.01	0.93	0.97	129.03	129.30	129.17
16.	FB-17	12.33	10.67	11.50	0.98	0.92	0.95	140.83	139.50	140.17
17.	FB-18	15.33	13.33	14.33	0.91	0.90	0.90	150.13	147.20	148.67
18.	FB-19	13.67	11.67	12.67	0.98	0.95	0.97	148.40	133.13	140.77
19.	FB-20	14.67	13.00	13.83	0.96	0.93	0.95	121.23	120.70	120.97
20.	Contender (C)	14.5	15.30	14.90	0.96	0.93	0.94	183.90	182.90	183.40
	Mean	13.10	12.05	12.57	0.91	0.87	0.89	189.31	177.08	183.19
	Range	9.67 – 17.00	9.33 – 17.00	9.50 – 17.50	0.69 – 1.08	0.68 – 1.00	0.68 – 1.04	115.10 – 381.16	97.8 – 319.22	106.45 – 350.19
	CD (5%)	3.14	3.05	2.15	0.12	0.13	0.92	44.85	62.29	37.96
	CV	14.51	15.34	14.91	8.07	9.45	8.76	14.33	21.05	18.02

Green pod yield per plant (g)

Green pod yield (Table-3) in 2008-09 varied from 115.10 - 381.16 g per plant so lot of variation was present among the studied genotypes. Falguni yielded all the genotypes for green pod yield per plant where it showed a yield record of 381.16 g per plant, which was statistically at par with genotype Cosmo (373.11g) per plant. Other high yielding genotypes were DWP-FB-57 (225.53 g), Seville (208.60 g) and DPP-BSS-1 (203.60g) per plant. The lowest yield was recorded from DWP-FB-1, FB-20, FB-16 and FB-5, which yielded 115.10, 121.23, 129.03 and 144.93 g per plant, respectively.

During 2009-10, green pod yield varied from 97.8-319.22 g per plant, the maximum pod yield was observed in genotypes Falguni (319.22 g) per plant which was statistically at par with genotype Cosmo (286.60 g) per plant. Other high yielding genotypes were IIHR-909 (246.33g), Aperna (233.37g) and DWP-FB-57(218.00g) per plant. The lowest yield was recorded in genotypes DWP-FB-1 (97.80 g), FB-20 (120.70 g), FB-16(129.30 g) and FB-5(131.80 g) per plant. In pooled data for two years, green pod yield varied from 106.45 to 350.19 g per plant and there were significant differences in green pod yield per plant in different French bean genotype. Falguni out yielded in all the genotypes as it showed a yield record of 350.19 g per plant, which was statistically at par with genotype Cosmo (329.86g) per plant followed by other high yielding genotypes viz. IIHR – 909 (240.22 g), DWP-FB-57 (221.77 g) and Aperna (217.02 g) per plant. The lowest yield was recorded from plants of DWP-FB-1 which yielded only (106.45 g) per plant followed byFB-20, FB-16, FB-5, FB-17, FB-19, and DWP-FB-53 which yielded 120.97, 129.17, 138.37, 140.17, 140.77 and 141.90 g per plant, however, all these were at par with each other. Ramakrishna (1999) reported green pod yield as 22.09 q/ac and 17.07 q/ac of two genotypes Arka Komal and Burpee's stringless, respectively.

CONCLUSION

The analysis of variance revealed that all the genotypes were significantly different in treatments for all the characters in 2008-09 and 2009-10. Twenty genotypes of French bean were evaluated along with the variety Contender (check) for nineteen characters. On the basic of pooled mean, Falguni and Cosmo out yielded all the genotypes in the net –house. These genotypes yielded more due to more number of pods per plant, pod length, pod width and pod weight. Maximum average pod weight was found in Falguni and Cosmo and more number of pods were found in Falguni, Seville and IIHR-909. Pod length was maximum in FB-4 followed by Cosmo and Contender where as pod width was maximum in FB-3 and Falguni. IIHR-909 and Falguni took minimum number of days to first harvest as compared to other genotypes and maximum numbers of pods were recorded in

Falguni, Seville and IIHR-909 where as average pod weight was maximum in Falguni and Cosmo. On basic of pod shape and colour Falguni, Cosmo, Seville and IIHR-909 were found best having round, straight and dark green/green coloured pods as compared to other genotypes.

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RESEARCH ARTICLE

FEEDING POTENTIAL OF *CHRYSOPERLA ZASTROWI* SILLEMI ON SOLENOPSIS MEALY BUG, *PHENACOCCUS SOLENOPSIS* TINSLEY INFESTING COTTON

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Abstract: The feeding potential of *Chrysoperla zastrowi sillemi* (Esben-Peterson) on eggs (ovisac), nymphs and female adults of mealy bug (*Phenacoccus solenopsis*) were studied at Bio-control Laboratory, Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari during September to October 2014. In no choice feeding against cotton mealy bugs, the feeding potential of larvae of *C. zastrowi sillemi* was found more on eggs (ovisac) and nymphs than female adults (freshly formed). On eggs of mealy bug, the feeding potential of larvae of *C. zastrowi sillemi* was 1778 to 2035 (Av. 1886.60 ± 74.88) eggs with consumption rate of 177.80 to 203.50 (188.6± 7.49) eggs per day whereas on nymphs of mealy bug, it was 812 to 899 (Av. 845.50 ± 23.44) nymphs with consumption rate of 81.20 to 89.90 (Av. 84.76 ± 2.21) nymphs. When fed exclusively on female adults, it was 119 to 141 (Av. 132.15 ± 6.37) female adults with consumption rate of 13.20 to 16.90 (14.87 ±0.89) adults per day. The larvae of *C. zastrowi sillemi* developed little bit faster when fed on female adults of mealy bug than fed on eggs and nymphs. In free choice feeding of mixed stages of mealy bug, the feeding potential was found to be 886 to 998 (Av. 938.65 ± 35.09) mealy bug exhibited preference to eggs and nymphs of mealy bug more as indicated by proportion of 408 to 477 (440.90 ± 18.93) eggs, 364 to 422 (395.70 ± 15.82) nymphs and 94 to 113 (102.05 ± 4.72) female adults in mixed stages offered. The consumption rate was 88.6 to 107.2 (94.93± 5.27) mixed stages of mealy bug per day in its developmental durations of 9 to 10 (Av. 9.75 ± 0.44) days.

Keywords: *Chrysoperla zastrowi sillemi*, Feeding potential, *Phenacoccus solenopsis*

INTRODUCTION

Cotton mealy bug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is a small, soft bodied sap sucking introduced species that cause severe damage to cotton and other field, fruit and vegetable crops (Arif *et al*., 2009; Nagrare *et al*., 2009). It was described originally from USA in 1898 (Tinsley, 1898) and regarded as an invasive pest in Asia. It was first recorded damaging cotton crop in Pakistan during 2005, since then it has become the most serious pest in Asia (Ben Dov *et al*., 2010; Wang *et al*., 2010). The reduction in seed cotton yield was estimated to be 25.02 per cent due to mealy bug infestation in south Gujarat (Pawar *et al*., 2011). Various insecticides have been recommended for the management of mealybug (Dhawan *et al*., 2008; Nikam *et al*., 2010; Patel *et al*, 2010 and Rashid *et al*., 2011), but it is difficult to achieve proper control of mealy bug with insecticides due to waxy coating on the body of adult females (Rao and David, 1958; Dean *et al*., 1971). Besides, growing environmental and economic concerns involved in the use of pesticides, there is dire need to develop alternate measures for the management of sucking pests. Pesticides lead to many serious problems like pollution, health hazards, biodiversity threat, pest resurgence, pest resistance and secondary pest out-breaks in ecosystem (Bellows, 2001). Biological control is an effective means of achieving insect control (Pedigo and Rice, 2000). In natural ecosystem, the common green lacewing, *Chrysoperla carnea* (Stephens) has been recorded as an effective predator of aphids, including *Aphis gossypii* Glover (Burke and Martin,1956; Yuksel and Gocmen, 1992; Balasubramani and Swamiappan, 1994; Zaki *et al*., 1999) and has potential against cotton mealy bug (Sattar *et al*., 2007; Tanwar *et al*., 2007; Gautam *et al*., 2010; Ram and Saini, 2010; Rashid *et al*., 2012; Hameed *et al*., 2013), especially under pesticides free environment. The green lacewing, *Chrysoperla zastrowi sillemi* (Esben-Peterson) in the field preferred to oviposit on cotton followed by okra and it laid eggs on stalks on lower surface of leaves for oviposition followed by stem (Chakraborty *et al*., 2011) especially under pesticides free environment. The common green lacewing, *Chrysoperla zastrowi sillemi* seems to be a good candidate in IPM programme, as it is a voracious feeder (Balasubramani and Swamiappan, 1994), display a relative broad range of acceptable preys (Hydron and Whitecomb, 1979), easy to mass produced (Morrison, 1985 and El-Arnaouty, 1991) and is tolerant to some groups of pesticides (Hassan *et al*., 1989; Bigler and Waldburger, 1994 and Chen and Liu, 2002). The occurrence of *C. zastrowi sillemi* along with its prey insects in cotton ecosystem of south Gujarat necessities to evaluate the feeding potential of larvae of *C. zastrowi sillemi* as biological control agents to different stages of mealybug [eggs (ovisac), nymphs and female adults] with no choice and free choice feeding under laboratory condition.

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MATERIAL AND METHOD

The study of feeding potential of *C. zastrowi sillemi* on mealy bug was carried out in the Bio-control Laboratory, Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari during September to October 2014 at average room temperature of 24.03 ± 1.75 °C and relative humidity of 73.08 ± 2.86 per cent.

Maintenance of aphid and *Chrysoperla* culture

The initial cultures of mealy bug were collected from the cotton fields of Research farm, Main Cotton Research Station, Navsari Agricultural University, Surat during June to August 2014. For the purpose, mealy bug infested apical shoot were plucked and collected in perforated plastic bags, separately. The well matured adult female so obtained were released on 60 days old cotton plants raised in pots (45 CM height × 18.5 cm diamter) in the wire netting inventory of Bio-control Laboratory, Department of Agricultural Entomology, Navsari Agricultural University, Navsari for establishment. The culture so established within one and half month was utilized as prey for study the feeding potential of *C. zastrowi sillemi.* The laboratory culture of *C. zastrowi sillemi* was obtained from *Chrysoperla* Rearing Unit, Bio-control Laboratory, Department of Agricultural Entomology, N.A.U., Navsari. The pupae of *C. zastrowi sillemi* were placed in glass vial separately for adult emergence. Freshly emerged adults were released in rectangular oviposition cage of size 50 × 30 × 17 cm (Length x Width x Height) covered with a black muslin cloth inside the lid of the cage to facilitate egg laying. Semi solid paste of artificial diet (composed of 4 g of each ingredients of honey, proteinex powder, glucose, fructose, yeast powder, milk powder in equal quantity of distilled water with dispersible vitamin E capsule along with castor pollens) were placed on cotton swab in small plastic container at inside of the bottom of the oviposition cage for nutrition of adults. Eggs laid by the female on the under surface of lid of the cage on black muslin cloth which were removed individually with the help of a soft sponge pad for removing the stalk of eggs and kept individually with the help of fine camel hair brush and placed in separate plastic vials (5 x 2.5 cm) for further rearing and to avoid cannibalism. A special care was also taken to avoid mechanical injury to the eggs during detaching it from the stalk. On hatching, the larval instar of *Chrysoperla* was reared on laboratory host (eggs of rice grain moth, *Corcyra cephalonica* (Stainton) till pupae formation and again the eggs were collected as described above. Neonate larvae of *C. zastrowi sillemi* obtained through mass rearing as above were utilized for the study.

Assessment of feeding potential , consumption rate and developmental duration

The predatory potential of the larval instars of *C. zastrowi sillemi* against eggs (ovisac), nymphs and female adult (freshly formed) stage of mealy bug was studied in no choice and free choice feeding trials separately under laboratory conditions.

No choice feeding experiment: Twenty neonate larvae of *C. zastrowi sillemi* were kept individually in the plastic vial (5 × 2.5 cm). Three such sets of 20 larvae under plastic vials were prepared. One set was utilized for studying predatory potential against ovisac of mealy bug; second set for nymphs and third set for female adults were provided as prey insect stages throughout the total larval development. In all the three set, known number of prey insect was offered as food and the record was maintained on rate of consumption daily. On next day, again counted number of prey stage was offered as food and the consumption of prey insect was calculated. Predatory insect was observed daily in the morning and evening for change of instar. Number of prey consumed by the predatory larvae in each instar was calculated for each individual and the total consumption during total larval stage was worked out. The total larval duration of *C. zastrowi sillemi* was also estimated for ovisac, nymph and adult stage of mealy bug, separately and per day consumption of each stage of the prey was also calculated.

Free choice feeding experiment : Twenty neonate larvae of *C. zastrowi sillemi* were kept individually in the plastic vial (5 × 2.5 cm). The set of 20 larvae under plastic vials were prepared. The set was utilized for studying predatory potential against mixed stages of mealy bug (ovisac, nymph and adult) as prey. In the set, known number of mixed stages was offered as food and the record was maintained separately on rate of consumption daily. On next day, again counted number of mixed stages was offered as food and the consumption of prey insect was calculated. Predatory insect was observed daily in the morning and evening for change of instar. Number of prey consumed by the predatory larvae in each prey stage and in each instar was calculated for each individual and the total consumption during total larval stage was worked out. The total larval duration of *C. zastrowi sillemi* was also estimated and per day consumption of prey stages was also calculated.

RESULT

No choice feeding

Under no choice feeding experiment exclusively with eggs (ovisac) of mealy bug as food source, grubs of *C. zastrowi sillemi* consumed 163.65 ± 65.38, 511.70 ± 70.83 and 1211.25 ± 116.13 eggs (ovisac) of mealy bug in developmental durations of 2.55 ± 0.51, 3.05 ± 0.22 and 4.40 ± 0.50 days of first, second and third larval instars, respectively (Figure 1 and Table 1). The predator, *C. zastrowi sillemi* consumed 1778 to 2035 (Av. 1886.60 ± 74.88) eggs of mealy bug during developmental duration of 10 days. The prey consumption rate varied from 43.00 to 91.67 (Av. 61.69 ± 14.16), 137.67 to 191.00 (Av. 167.72 ±

19.43) and 256.50 to 314.00 (Av. 279.85 ± 17.44) eggs of mealy bug per day during first, second and third instars of *C. zastrowi sillemi*, respectively. During entire larval period prey consumption rate varied from 177.80 to 203.50 (Av. 188.66 ± 7.49) nymphs. When exclusively fed on nymphs of mealy bug, larva captured the nymph in between two sickle shaped mandibles and suck the inner body fluid by leaving behind the shrunken body skeleton. Grubs of *C. zastrowi sillemi* consumed 130.90 ± 23.51, 295.35 ± 40.35 and 419.25 ± 41.44 nymphs of mealy bug in developmental duration of 2.85 ± 0.37, 3.00 ± 0.46 and 4.15 ± 0.37 days of first, second and third larval instars, respectively. The grub of *C. zastrowi sillemi* consumed 812 to 899 (Av. 845.50 ± 23.44) nymphs of mealy bug during developmental durations of 9.5 to 10 (Av. 9.98 ± 0.11) days. The prey consumption rate varied from 36.00 to 51.33 (Av. 45.62 ± 3.72), 84.00 to 105.00 (Av. 98.75 ± 5.65) and 92.25 to 114.75 (Av. 101.06 ± 5.49) nymphs of mealy bug per day during first, second and third instars of *C. zastrowi sillemi*, respectively. During entire larval period prey consumption rate varied from 81.20 to 89.90 (Av. 84.76 ± 2.21) nymphs per day. Grubs of *C. zastrowi sillemi* consumed 25.70 ± 5.72, 57.05 ± 7.65 and 49.40 ± 5.05 female adults of mealy bug in developmental duration of 2.70 ± 0.47, 3.30 ± 0.47 and 2.90 ± 0.31 days of first, second and third larval instars, respectively. The grub of *C. zastrowi sillemi* consumed 119 to 141 (Av. 132.15 ± 6.37) female adults of mealy bug during developmental durations of 9.50 to 10.00 (Av. 9.98 ± 0.11) days. The prey consumption rate varied from 8.00 to 11.33 (Av. 9.47 ± 0.90), 15.33 to 19.00 (Av. 17.33 ± 1.04) and 14.00 to 19.67 (Av. 16.47 ± 1.68) female adults of mealy bug per day during first, second and third instars of *C. zastrowi sillemi*, respectively. During entire larval period prey consumption rate varied from 13.20 to 16.90 (Av. 14.87 ± 0.89) female adults.

Free choice feeding

Under free choice feeding with mixed stages of eggs, nymphs and female adults of mealy bug, the grubs of *C. zastrowi sillemi* consumed 96.55 ± 25.33, 313.65 ± 22.92 and 528.45 ± 19.23 mixed stages of mealy bug (eggs, nymphs and adult) in developmental durations of 2.90 ± 0.31, 3.1 ± 0.31 and 3.9 ± 0.31 days of first, second and third larval instars, respectively (Figure 1 and Table 2). The *C. zastrowi sillemi* consumed 886 to 998 (Av. 938.65 ± 35.09) numbers of mealy bugs (mixed stages) during developmental durations of 9 to 10 (Av. 9.75 ± 0.44) days. In free choice feeding, grub of *C. zastrowi sillemi* preferred eggs and nymphs of mealy bug more compared to female adult stage of mealy bug as indicated by consumption of 440.90 ± 18.93 eggs, 395.70 ± 15.82 nymphs and 102.05 ± 4.72 female adults out of 938.65 ± 35.09 number of mealy bug (mixed stages). The prey consumption rate varied from 23.50 to 43.00 (Av. 33.91 ± 5.49), 84.3 to 108.70 (Av. 98.70 ± 6.89) and 124.80 to 179.00 (Av. 136.57 ± 15.01) number of mealy bug (mixed stages) per day during first, second and third instars of *C. zastrowi sillemi*, respectively. During entire larval period prey consumption rate varied from 88.60 to 107.20 (Av. 94.93 ± 5.27) numbers of mealy bug (mixed stages) per day.

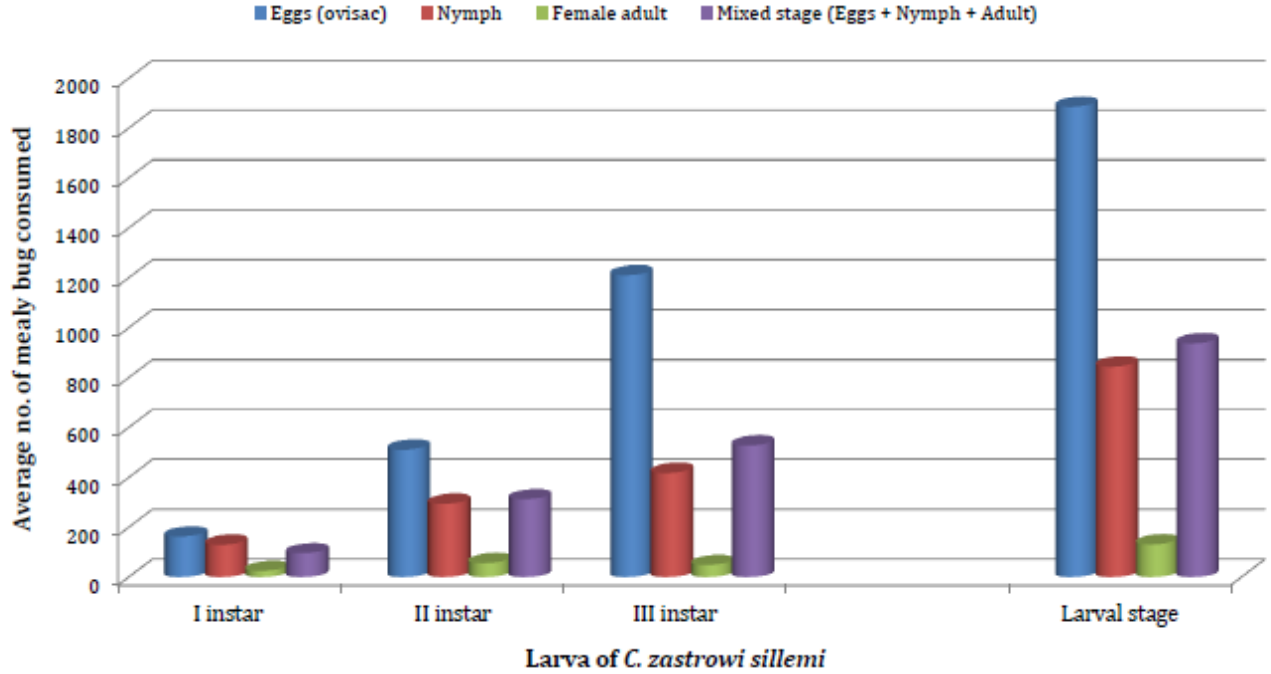

Fig 1. Feeding potential of *C. zastrowi sillemi* on eggs (ovisac), nymphs and adults (No choice feeding) and mixed stages (Free choice feeding) of mealy bug, *P. solenopsis*

Table 1. Feeding potential of *C. zastrowi sillemi* on different stages of *P. solenopsis* (no choice feeding)

Larval stages of *C. zastrowi sillemi*	No. of larvae exposed	No. of mealy bug consumed			Rate of consumption/day			Developmental duration (Days)		
		Min.	Max.	Av. ± S. D.	Min.	Max.	Av. ± S. D.	Min.	Max.	Av. ± S. D.
Eggs of Mealy bug as prey										
I instar	20	86	275	163.65 ±65.38	43.00	91.67	61.69 ±14.16	2	3	2.55 ±0.51
II instar	20	413	683	511.70 ±70.83	137.67	191.00	167.72 ±19.43	3	4	3.05 ±0.22
III instar	20	1044	1492	1211.25 ±116.13	256.50	314.00	279.85 ±17.44	4	5	4.40 ±0.50
Total	**60**	**1778**	**2035**	**1886.60 ±74.88**	**177.80**	**203.50**	**188.66 ±7.49**	**10**	**10**	**10.00 ±0**
Nymphs of Mealy bug as prey										
I instar	20	72	154	130.90 ±23.51	36.00	51.33	45.62 ±3.72	2	3	2.85 ±0.37
II instar	20	196	358	295.35 ±40.35	84.00	105.00	98.75 ±5.65	2	4	3.00 ±0.46
III instar	20	369	515	419.25 ±41.44	92.25	114.75	101.06 ±5.49	4	5	4.15 ±0.37
Total	**60**	**812**	**899**	**845.50 ±23.44**	**81.20**	**89.90**	**84.76 ±2.21**	**9.5**	**10.0**	**9.98 ±0.11**
Female adults of Mealy bug as prey										
I instar	20	17	33	25.70 ±5.72	8.00	11.00	9.47 ±0.90	2	3	2.70 ±0.47
II instar	20	46	75	57.05 ±7.65	15.33	19.00	17.33 ±1.04	3	4	3.30 ±0.47
III instar	20	42	59	49.40 ±5.05	14.00	19.67	16.47 ±1.68	2	3	2.90 ±0.31
Total	**60**	**119**	**141**	**132.15 ±6.37**	**13.20**	**16.90**	**14.87 ±0.89**	**9.50**	**10.00**	**9.98 ±0.11**

Table 2. Feeding potential of larva of *C. zastrowi sillemi on P. solenopsis* (free choice method)

Larval stages of *C. zastrowi sillemi*	Mathematical functions	No. of mixed stages of mealy bug consumed				Rate of consumption (No./day)				Duration in days
		Eggs	Nymphs	Adults	Total	Eggs	Nymphs	Adults	Total	
I instar	Min.	32	12	0	47	16.0	6.00	0.00	23.5	2
	Max.	82	37.00	12	129	27.33	12.33	4.00	43.0	3
	Av ± S. D.	63.65 ± 16.60	26.80 ± 7.98	6.05 ± 3.71	96.55 ± 25.33	22.43 ± 3.47	9.43 ± 2.04	2.02 ± 1.24	33.91± 5.49	2.9 ± 0.31
II instar	Min.	137	111	26	276	42.25	33.00	8.25	84.3	3
	Max.	181	150	43	369	51.33	46.00	12.67	108.7	4
	Av ± S. D.	151.25 ± 12.75	129.35 ± 9.35	33.05 ± 3.94	313.65± 22.92	47.52 ± 2.64	40.77 ± 3.69	10.41 ±1.32	98.7 ± 6.89	3.1 ± 0.31
III instar	Min.	206	225	59	499	51.50	56.25	14.75	124.8	3
	Max.	244	267	68	576	76.00	66.75	22.00	179.0	4
	Av ± S. D.	226.00 ± 10.62	239.50 ± 10.02	62.95 ± 2.98	528.45± 19.23	58.4 ± 6.53	59.88 ± 2.50	16.28 ± 1.98	136.57 ± 15.01	3.9 ± 0.31
Total	Min.	408	364	94	886	40.8	36.40	9.4	88.6	9
	Max.	477	422	113	998	50.2	46.10	11.4	107.2	10
	Av ± S. D.	440.90 ± 18.93	395.70 ± 15.82	102.05 ± 4.72	938.65± 35.09	44.59 ± 2.65	40.02 ± 2.35	10.32 ± 0.57	94.93 ± 5.27	9.75 ± 0.44

DISCUSSION

Under no choice feeding, the second and third instar grub of *C. zastrowi sillemi* fed more number of eggs than first instar and were voracious feeder. This might be due to more nutrition required for growth and development in subsequent instars. The first instar larvae of *C. zastrowi sillemi* had difficulty to open the full face of ovisac and feed on the eggs inside thread like cottony mass whereas bigger larvae fed easily by making rooms to fed eggs inside white cottony ovisac. The larvae of *C. zastrowi sillemi* developed little bit faster when fed on female adults of mealy bug than fed on nymphs and consumed less number of female adults than nymphs of aphids. This might be due to force feeding of nutritive diets in form of female adults of mealy bug. Under free choice feeding, the larvae of *C. zastrowi sillemi* preferred nymphs more comapared to eggs and female adults of mealybug owing to soft body, stationery behavour and small size of younger stages of mealy bug favoring the easy capture while there was diificulty of early instar larvae to open the full face of ovisac and feed the eggs and disliking of waxy coating on body of female adult stage of mealy bug. Further, there was not much variation in development duration of larvae of *C. zastrowi sillemi* when fed on mixed stages (eggs, nymphs and female adults) in free choice feeding then fed on nymphs and female adults of mealy bug in no choice feeding conditions. However, larvae of *C. zastrowi sillemi* developed little bit slower when fed exceptionally on eggs of mealy bug in no choice feeding conditions. Thus, in the present study, the larvae of *C. zastrowi sillemi* preferred eggs (ovisac) and nymphs of mealy bug as compared to freshly formed adult mealy bug as prey in free choice feeding condition. Different workers *viz.*, Sattar *et al*. (2007), Rashid *et al*. (2012) and Hameed *et al*. (2013) found that first instar nymphs of mealy bug was the most preferred food amongst three nymphal instars of mealy bug of *P. solenopsis*. In the present study, the first, second and third instar larvae of *C. zastrowi sillemi* consumed 72 to 154 (130.90 ± 23.51), 196 to 358 (295.35 ± 40.35) and 369 to 515 (419.25 ± 41.44) medium sized nymphs of *P. solenopsis*. In respective larval instars of *C. zastrowi sillemi*, Sattar *et al*. (2007) reported that the consumption of 125.8, 510.8 and 967.4 first instar nymphs of mealy bug while Rashid *et al*. (2012) found that the consumption of 406.0 ± 1.15, 426.3 ± 2.18 and 645.9 ± 2.45 and Hameed *et al*. (2013) reported that the consumption of 736.3, 3163.3 and 9131.7 first instar nymphs. These reports are more or less in support to the the present findings. Further, in present study, the larvae of *C. zastrowi sillemi* consumed 1178 to 2035 (1886.60 ± 74.88) eggs (ovisac), 812 to 899 (845.50 ± 23.44) nymphs (medium sized) and 119 to 141 (132.15 ± 6.37) female adult (freshly formed) during its development in no choice feeding condition. Earlier, Rabinder *et al*. (2008) reported that the larvae consumed 617.45 crawlers of *P. solenopsis* at the consumption rate of 30.79 crawlers per day in developmental period of 22.15 days and Aggarwal and Neetan (2014) reported that the single larva of *C. zastrowi sillemi* consumed 700.46, 245.00, 30.53 and 8.56 of first, second, third instar nymphs and female adults of cotton mealy bug, respectively during its entire life span.

Thus, the grub of *C. zastrowi sillemi* showed good potential against the younger stages of mealy bugs and can be taken advantage in Integrated Management of mealybug in cotton ecosystem.

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RESEARCH ARTICLE

IMPACT OF KRISHI VIGYAN KENDRA'S TRAINING ON ADOPTION OF IMPROVED RICE PRODUCTION TECHNOLOGY IN REWA DISTRICT. (M.P.)

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Abstract: In rural india by raising the level of farm productivity, income and employment with application of agricultural innovations, an innovative extension education institution Krishi Vigyan Kendra (KVK) was introduced by ICAR. In context with Rewa district of M.P. rice is the most prominent crop of the district as occupying 115.7 thousand ha. area with the productivity of 1416 kg/ha (Source – District Land Record Rewa). Krishi Vigyan Kendra Rewa has been conducting a number of training programmes on location specific technological aspects of rice crop. The main purpose of the training programme is to accelerate the adoption and diffusion rate of improved rice production technologies. The study was carried out to assess the adoption of improved rice production technology of paddy growers. It was found that the majority of the respondent (45.84%) had medium adoption. of improved rice production technologies. Mean adoption score was highest in improved variety (1.65) followed by seed rate (1.61), seed treatment (1.60), management of organic manure (0.69).and lowest mean score was application of manure (0.62). The study also revealed that the major constraints faced by farmers required technological inputs were not available at local level (71.66%) followed by lack of trials and demonstration related to low cost technology (66.66), no planning of the out side exposure visit (63.33), low market price of agricultural product(58.33) and lack of infrastructural facilities for using the technological skill on occupational basis at the village level (57.50),

Keywords: Agricultural innovation, Krishi Vigyan Kendra, Rice

INTRODUCTION

In rural india to raise the level of farm productivity, income and employment with application of agricultural innovations, an innovative extension education institution Krishi Vigyan Kendra (KVK) was introduced by ICAR. In rural india by raising the level of farm productivity, income and employment with application of agricultural innovations, an innovative extension education institution Krishi Vigyan Kendra (KVK) was introduced by ICAR. In context with Rewa district of M.P. rice is the most prominent crop of the district as occupying 115.7 thousand ha. area with the productivity of 1416 kg/ha (Source – District Land Record Rewa). Krishi Vigyan Kendra Rewa has been conducting a number of training programmes on location specific technological aspects of rice crop. The main purpose of the training programme is to accelerate the adoption and diffusion rate of improved rice production technologies.

Objective

To assess the impact of training in terms of adoption of improved rice production technology.

To identify the constraints perceived by the respondents concerned with the training programmes and suggest measures to overcome them.

METHODOLOGY

The present study was conducted in Rewa district of M.P. The district has nine blocks namely Rewa, Raipur, Sirmour, Teohthar, Jawa, Gangeo, Mauganj, Hanumana and Naigardi. Rewa block was selected purposively because in this block the number of trained farmers under KVK trainings is maximum during the last 5 years. Five villages on the basis of large number of trainees under rice training programme was selected for the present study, A village wise list of traniees who attended rice training programmes on rice crop was prepared. From this list the trainees was selected from each village through proportionate random sampling method to make a sample of 120 respondents. Finaly the sample were consisted of 120 respondents.

Table 1. List of selected villages and number of respondents selected from each village

S. No.	Name of village	Number of trainees farmer	No. of selected respondents	
			Trained farmers	Untrained farmers
1.	Rithi	90	26	26

*Corresponding Author

2.	Johri	85	24	24
3.	Kothi	82	23	23
4.	Khokam	80	23	23
5.	Devra	85	24	24
	Total	422	120	120

RESULT AND DISCUSSION

1. Impact of training in term of adoption of improved rice production technology

Table 2. Mean score of the selected trained farmers and their adoption of improved rice production technology.

S. No.	Technological practices	Extent of Adoption			Total score	Mean score	Rank
		complete	Partial	Not			
1	Improved varieties	88	22	10	198	1.65	I
2	Nursery management	75	29	18	179	1.49	VI
3	Sowing methods	78	25	17	181	1.50	V
4	Seed rate	85	24	11	194	1.61	II
5	Seed treatment	82	28	10	192	1.60	III
6	Spacing	60	48	12	168	1.40	VIII
7.	Weed management	80	26	14	186	1.55	IV
8.	Water management	73	30	17	176	1.46	VII
9	Management of organic manures	23	37	60	83	0.69	XIV
10	Bio fertilizer management	43	49	28	135	1.12	X
11	Chemical fertilizer management	38	44	38	120	1.00	XI
12	Insect & pest management	32	38	50	102	0.85	XII
13	Disease management	27	32	61	86	0.71	XIII
14	Grain storage	46	51	23	143	1.19	IX
15	Application of manure	20	35	65	75	0.62	XV

Table 2 it was observed that the mean adoption score was highest in improved variety (1.65) followed by seed rate (1.61), seed treatment (1.60), weed management (1.55), sowing method (1.50), nursery management (1.49), water management (1.46), spacing (1.40), grain storage (1.19), bio fertilizer management (1.12), fertilizer management (1.0), insect and pest management (0.85), disease management (0.71), management of organic manure (0.69).and lowest mean score was application of manure (0.62).

Table 3. (a) Distribution of the respondents according to level of adoption in regards to recommended practices of rice

S. No.	**Level of Adoption**	**Trained farmers**		**Untrained farmers**	
		No.	**%**	**No.**	**%**
1	**Low**	39	32.50	69	57.50
2.	**Medium**	55	45.84	34	28.34
3	**High**	26	21.67	17	14.16
Total		**120**	100	**120**	100

The data in the Table 3 show that out of 120 respondents 45.84 percent had medium adoption level followed by 32.50 percent low adoption level and only 21.67 percent had high adoption level regarding recommended practices of rice. The table also revealed that out of 120 untrained farmers, higher percentage of the respondents majority of i.e., 57.50 percent belonged to low adoption level category.

(b) t ratio for the mean adoption scores of the trainees and non trainees

S. No.	N	Mean	Standard Deviation	t	P
Non trainees	120	11.5	1.1		
Trainees	120	20.8	1.4	11.3	0.01

The value of the t ratio in the above table is significant. On the basis of this result it may be inferred that the mean adoption scores of trainees and non trainees exhibited significant difference. The mean adoption score obtained by trainees is higher than the mean adoption score obtained by the non trainees. This improvement in adoption may be attributed to the training imparted by the KVKs.

2. Distribution of respondents according to the constraints perceived by them in adoption of improved rice production technology

With a view to locate the reasons for non adoption of recommended package of practices of rice, the respondents were asked to express the major constraints faced by them in adoption of improved rice production technologies disseminated through farmers training programmes. Out of many constraints faced by them the major constraints on the basis of rank order have been presented in the table 4.

Table 4. Constraints faced by the farmers in relation to adoption of technologies disseminated through farmers training programmes

S.N.	Constraints	No. of Respondents	Percentage	Rank
1.	Lack of good quality product (Bio-fertilizer, Bio-pesticide, Bio-agent)	56	46.66	8
2.	Lack of close contact of the trainees with the trainers / scientists after completion of the training.	25	20.83	14
3	Non avability of appropriate hybrid varieties	27	22.5	13
4	Lack of trials and demonstration related to low cost technology	80	66.66	2
5	Lack of infrastructural facilities for using the technological skill on occupational basis at the village level.	69	57.5	5
6	The required technological inputs were not available at local level.	86	71.66	1
7	Information about resource availability, marketing and credit orientation were not given.	29	24.16	12
8	Small size of land holding and low socio-economic status.	31	25.83	11
9	Lack of coordination with allied departments	51	42.50	9
10	Unavailability of skilled labour for SRI	61	50.83	7
11	Low market price of agricultural product	70	58.33	4
12	Improved higher cost of seed of varieties	48	40.00	10
13	Lack of incentives and recognition to the scientists and farmers	68	56.66	6
14	No planning of the out side exposure visit	76	63.33	3

The major constraints experienced by the trained farmers in knowledge and skill acquisition were arranged in descending order on the basis of rank order as the required technological inputs were not available at local level (71.66%) followed by lack of trials and demonstration related to low cost

technology (66.66), no planning of the out side exposure visit (63.33), low market price of agricultural product(58.33), lack of infrastructural facilities for using the technological skill on occupational basis at the village level (57.50), lack of incentives and recognition to the scientists and farmers (56.66), unavailability of skilled labour for SRI (50.83), lack of good quality product (Bio-fertilizer, Bio-pesticide, Bio-agent) (46.66), lack of coordination with allied departments (42.5), Improved higher cost of seed of varieties (40.00), small size of land holding and low socio-economic status(25.83), information about resource availability, marketing and credit orientation were not given (24.16), non arability of hybrid seed (22.5) and lack of close contact of the trainees with the trainers / scientists after completion of the training (20.83) relation to adoption of technologies disseminated through farmers training programme

Table 5. Suggestions for enhancement of the adoption of improved rice production technology.

S.No.	Suggestions	No. Of respondents	Percentage	Rank
1	Availability of good quality seed at seasonable rate.	84	70.00	III
2	Trials and demonstration should be organized on adoption of low cost technologies.	89	74.15	II
3	Knowledge & skill oriented training should be imparted at village level	78	65.00	VI
4	Procurement of produce should be made at reasonable price by society	94	78.33	I
5	Implementation of effective crop insurance policies	54	45.00	X
6	Improved farm machineries should be available at reasonable rate	79	65.83	V
7	Conducting research and seed programme on crop varieties suitable in conditions	55	45.83	IX
8	Agricultural scientist/extension personal should visit one in week at village level	66	55.50	VII
9	The price of hybrid rice seeds should be reduced	64	53.33	VIII
10	Demontration & trails on IPM &organic farming	82	68.33	IV

The results in Table 5 indicated that the majority of the respondents suggested as creating the people towards rice production technology procurement of produce should be made at reasonable price by society (78.33%), trials and demonstration should be organized on adoption of low cost technologies. (74.15%), availability of good quality seed at seasonable rate (70.00%), demontration & trails on

IPM &organic farming (68.33) improved farm machineries should be available at reasonable rate (65.83%), knowledge & skill oriented training should be imparted at village level (65.00%), agricultural scientist/extension personal should visit one in week at village level (55.50%) , the price of hybrid rice seeds should be reduced (53.33%), conducting research and seed programme on crop varieties suitable in conditions (45.83%), and Implementation of effective crop insurance policies (45.00%) respectively.

CONCLUSION

Majority of the respondent (45.84%) had medium adoption. of improved rice production technologies. Mean adoption score was highest in improved variety (1.65) followed by seed rate (1.61), seed treatment (1.60), management of organic manure (0.69).and lowest mean score was application of manure (0.62). The study also revealed that the major constraints faced by farmers required technological inputs were not available at local level (71.66%) followed by lack of trials and demonstration related to low cost technology (66.66), no planning of the out side exposure visit (63.33), low market price of agricultural product(58.33) and lack of infrastructural facilities for using the technological skill on occupational basis at the village level (57.50), adoption of improved rice production technologies.

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RESEARCH ARTICLE

EFFECT OF BALANCED NUTRITION AND BIO-INOCULANTS ON FLOWER YIELD AND QUALITY ATTRIBUTES OF CHRYSANTHEMUM *(DENDRANTHEMA GRANDIFLORA* TZVELEV)

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Abstract: A field experiment was conducted to know the response of Chrysanthemum (*Dendranthema grandiflora Tzvelev*) to balanced nutrition with bio-inoculants at the, College of Horticulture, Mudigere during 2015-16. Plants treated with (T_{22}) *Bacillus megaterium* + *Bacillus mucilaginosus*+ $MgSO_4$ +Micronutrient mixture recorded significantly maximum flowers per plant (100), flower yield per plant (627.20 g), flower yield per plot (61.46 kg), flower yield (30.73 t/ha) and individual flower weight (6.27 g),flower diameter (7.25 cm),number of petals per flower (136.50),shelf life (15.25 days),vase life(22 days) followed by *Azotobacter* + *Bacillus mucilaginosus*+ $MgSO_4$ + Micronutrient mixture and *Azotobacter* + *Bacillus megaterium*+ $MgSO_4$ +Micronutrient mixture over the control(RDF) respectively.

Keywords: Chrysanthemum, Bio-inoculants, $MgSO_4$, Micronutrient mixture, RDF

INTRODUCTION

Chrysanthemum *(Dendranthema grandiflora Tzvelev)* belongs to the family compositae (2n=18).It occupies a prominent place in ornamental horticulture, as it is one of the commercially exploited traditional and modern flower crops. It is a short duration crop which produces wide spectrum of flowers, eye-catching color, shape, size and keeping quality and attracted the attention of flower growers.

It is used both as cut as well as traditional flower; in the preparation of garlands and vase decorations, also has great demand as potted plant in the International market. The indiscriminate and continuous use of chemical fertilizers in chrysanthemum has led to imbalance nutrient in soil. Therefore this study has been conducted to ensure the effectiveness of microbial bio-inoculants along with the balanced use of chemical fertilizers which helps to improve physic-chemical and biological properties of the soil, besides improving the efficiency of applied fertilizers for optimum yield and quality of mums.

MATERIAL AND METHOD

An experiment was conducted under outdoor condition during 2015-16 at College of Horticulture, Mudigere, Chikkamagaluru, and Karnataka. Rooted terminal cuttings - mum *var*. Kolar local. Planting method is ridges and furrows, plot size is 5m x 4m and spacing is about 45 x 45cm (98 plants/plot).The experiment was laid out with RCBD. There were 22 treatments viz.,T_1 – Control (RDF), T_2 – $MgSO_4$, T_3 – Micronutrient mixture, T_4 –$MgSO_4$ + Micronutrient mixture, T_5 – *Azotobacter* ,T_6 –*Bacillus megaterium*, T_7 –*Bacillus mucilaginosus*,T_8 –$MgSO_4$ + *Azotobacter* ,T_9 – $MgSO_4$ + *Bacillus megaterium* ,T_{10} – $MgSO_4$+*Bacillus mucilaginosus* ,T_{11}–Micronutrient mixture+ *Azotobacter* ,T_{12} – Micronutrient mixture + *Bacillus megaterium* ,T_{13} – Micronutrient mixture + *Bacillus mucilaginosus*, T_{14}–*Azotobacter* + *Bacillus megaterium* + $MgSO_4$, T_{15} – *Azotobacter* + *Bacillus mucilaginosus*+ $MgSO_4$, T_{16} – *Bacillus megaterium* +*Bacillus mucilaginosus*+ $MgSO_4$,T_{17} – *Azotobacter* + *Bacillus megaterium*,+ Micronutrient mixture ,T_{18} – *Azotobacter* + *Bacillus mucilaginosus*+ Micronutrient mixture ,T_{19} – *Bacillus megaterium* + *Bacillus mucilaginosus*+ Micronutrient mixture ,T_{20} – *Azotobacter* + *Bacillus megaterium*,+ $MgSO_4$ +Micronutrient mixture ,T_{21}– *Azotobacter* + *Bacillus mucilaginosus*+ $MgSO_4$ + Micronutrient mixture ,T_{22}– *Bacillus megaterium* + *Bacillus mucilaginosus*+ $MgSO_4$ +Micronutrient mixture and replicated twice.

These bioinoculants were applied along with secondary nutrient ($MgSO_4$), Micronutrient mixture with RDF. At the time of transplanting the rooted cuttings were dipped in bioinoculant solution according to treatments and after 30 DAP bioinoulants with $MgSO_4$, Micronutrient mixture, were applied, and the observations on flower yield and quality parameters were recorded and the data were analyzed scientifically and interpreted the results and discussed as below.

RESULT AND DISCUSSION

The different bioinoculants with $MgSO_4$ and Micronutrient mixture treatments had a significant effect on number of flowers per plant (100), flower yield per plant (627.20 g), flower yield per plot (61.46 kg), flower yield (30.73 t/ha) followed by T_{21}, T_{20} and T_{19}, respectively and these treatments were found on par with each other. However, T_1 with un-inoculated control (RDF) recorded minimum alone (Table 1) .The other treatments were also found

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statistically significant over the control for all the parameter. The possible reason for better performance of yield attributes and higher yield could be due to the regular supply of nutrients leads to more vegetative growth leading to increase in photosynthetic area, which in turn resulted in more synthesis and accumulation of dry matter in the flower Bosali et al. [1]. Moreover, presence of growth promoting substances such as auxin, gibberllins and cytokinin due to presence of biofertilizers would have also contributed in development and accumulation of sink resulting in better growth and subsequently higher number of flowers per plant and higher flower yield per hectare. The results are in agreement with the earlier findings of Thumhar et al. [2] and Jadhav et al. [3] in marigold, Patanwar et al. [4] in chrysanthemum, Kirar et al . [5] in china aster and Sheergojri et al. [6] in gladiolus. And (T_{22}) *Bacillus megaterium* + *Bacillus mucilaginosus*+ $MgSO_4$ +Micronutrient mixture showed the highest individual flower weight (6.27 g), flower diameter (7.25 cm), number of petals per flower (136.50) followed by $T_{21,}$ T_{20} and T_{19}, respectively and these treatments were found on par with each other. However, T_1 with un-inoculated control (RDF) recorded minimum (Table 2). The other treatments were also found statistically significant over the control for all the parameter. This might be due to better physical condition of soil and increased population of microflora, thereby enhanced availability of nutrients through mineralization process. Moreover, biofertilizers produce the growth stimulating substances *viz*., auxin, gibberellins and cytokinins which contribute towards vigorous growth of the plant. This in turn increases photosynthesis and enhances food accumulation and also diversion of photosynthates towards sink resulting in better quality flowers. The earlier study of Panchal et al. [7] and Swaroop [8] also confirms these findings in marigold. And (T_{22}) *Bacillus megaterium* + *Bacillus mucilaginosus*+ $MgSO_4$ +Micronutrient mixture showed the maximum shelf life (15.25 days) and vase life(22 days) followed by $T_{21,}$ T_{20} and T_{19}, respectively and these treatments were found on par with each other. However, T_1 with un-inoculated control (RDF) recorded minimum (Table 3). The other treatments were also found statistically significant over the control for all the parameter. It might be due to overall food nutrient status of flowers under this treatment. Application of balanced nutrition and bio inoculants influences flower longevity due to the increased nutrient uptake by plants and greater of water conducting tissue. It might also be due to the presence of ethylene inhibitors or due to the presence of cytokinins which delay senescence of flowers. These findings are matching with those of Bhatia and Gupta [9] in gerbera.

Table 1. Effect of balanced nutrition and bioinoculants on flower yield parameters of chrysanthemum

	Treatment	No. of flowers/ plant	Flower yield/ plant (g)	Flower yield (kg/plot)	Flower yield (t/ha)
T_1	RDF (control)	62.50	331.25	32.46	16.23
T_2	$MgSO_4$	70.85	393.21	38.53	19.26
T_3	Micronutrient mixture	74.25	404.66	39.65	19.82
T_4	$MgSO_4$ + Micronutrient mixture	76.25	438.43	42.96	21.48
T_5	*Azotobacter*	78.50	412.12	40.38	20.19
T_6	*B. megaterium*	80.15	428.80	42.02	21.01
T_7	*B. mucilaginous*	82.15	435.39	42.66	21.33
T_8	$MgSO_4$ + *Azotobacter*	79.10	446.91	43.79	21.89
T_9	$MgSO_4$ + *B. megaterium*	85.35	465.15	45.58	22.79
T_{10}	$MgSO_4$ + *B. mucilaginous*	93.55	458.39	44.92	22.60
T_{11}	M. mixture + *Azotobacter*	94.50	477.22	46.76	23.38
T_{12}	M. mixture + *B. megaterium*	89.15	450.20	44.11	22.05
T_{13}	M. mixture + *B. mucilaginous*	90.05	477.26	46.77	23.38
T_{14}	*Azotobacter* + *B. megaterium* + $MgSO_4$	91.05	509.88	49.96	24.98
T_{15}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$	92.15	525.55	51.50	25.75
T_{16}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$	93.05	539.69	52.88	26.44
T_{17}	*Azotobacter* + *B. megaterium* + M. mixture	93.65	561.90	55.06	27.53
T_{18}	*Azotobacter* + *B. mucilaginous* + M. mixture	94.10	555.19	54.40	27.20
T_{19}	*B. megaterium* + *B. mucilaginous* + M. mixture	95.75	555.35	54.42	27.21
T_{20}	*Azotobacter* + *B. megaterium* + $MgSO_4$ + M. mixture	96.55	593.78	58.19	29.09
T_{21}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$+ M. mixture	98.05	614.77	60.24	30.12

T_{22}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$+ M. mixture	100.00	627.20	61.46	30.73
S. Em ±		**0.86**	**11.00**	**0.22**	**0.58**
C D @ 5 %		**2.53**	**31.88**	**0.65**	**1.72**

Note: *RDF is constant for all the treatments. **B=Bacillus*, M=Micronutrient

Table 2. Effect of balanced nutrition and bioinoculants on flower quality parameters of chrysanthemum

	Treatment	Flower Weight (g/flower)	Flower diameter (cm)	Number of petals per flower
T_1	RDF (control)	5.30	3.95	89.25
T_2	$MgSO_4$	5.55	4.20	94.25
T_3	Micronutrient mixture	5.45	4.40	99.75
T_4	$MgSO_4$ + Micronutrient mixture	5.75	4.55	100.75
T_5	*Azotobacter*	5.25	5.10	105.25
T_6	*B. megaterium*	5.35	4.96	102.75
T_7	*B. mucilaginous*	5.30	4.95	104.90
T_8	$MgSO_4$ + *Azotobacter*	5.65	5.25	106.75
T_9	$MgSO_4$ + *B. megaterium*	5.45	5.45	109.50
T_{10}	$MgSO_4$ + *B. mucilaginous*	4.90	5.65	111.05
T_{11}	M. mixture + *Azotobacter*	5.05	5.00	113.25
T_{12}	M. mixture + *B. megaterium*	5.05	5.35	109.00
T_{13}	M. mixture + *B. mucilaginous*	5.30	5.84	110.25
T_{14}	*Azotobacter* + *B. megaterium* + $MgSO_4$	5.60	6.10	112.15
T_{15}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$	5.70	5.75	117.00
T_{16}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$	5.80	5.33	119.15
T_{17}	*Azotobacter* + *B. megaterium* + M. mixture	6.00	6.10	121.00
T_{18}	*Azotobacter* + *B. mucilaginous* + M. mixture	5.90	6.35	122.50
T_{19}	*B. megaterium* + *B. mucilaginous* + M. mixture	5.80	6.45	129.80
T_{20}	*Azotobacter* + *B. megaterium* + $MgSO_4$ + M. mixture	6.15	6.60	130.00
T_{21}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$+ M. mixture	6.27	6.90	131.00
T_{22}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$+ M. mixture	6.27	7.25	136.50
S. Em ±		**0.04**	**0.13**	**0.79**
C D @ 5 %		**0.12**	**0.38**	**2.33**

Note: *RDF is constant for all the treatments. **B=Bacillus*, M=Micronutrient

Table 3. Effect of balanced nutrition and bioinoculants on flower shelf and vase life of chrysanthemum

	Treatment	Shelf life (days)	Vase life (days)
T_1	RDF (control)	6.00	7.25
T_2	$MgSO_4$	6.25	8.30
T_3	Micronutrient mixture	6.75	9.10
T_4	$MgSO_4$ + Micronutrient mixture	7.30	10.05
T_5	*Azotobacter*	7.90	12.00
T_6	*B. megaterium*	8.18	10.00
T_7	*B. mucilaginous*	8.40	9.25
T_8	$MgSO_4$ + *Azotobacter*	7.60	11.25
T_9	$MgSO_4$ + *B. megaterium*	7.85	10.95
T_{10}	$MgSO_4$ + *B. mucilaginous*	8.70	12.15
T_{11}	M. mixture + *Azotobacter*	8.90	12.70
T_{12}	M. mixture + *B. megaterium*	9.20	13.20
T_{13}	M. mixture + *B. mucilaginous*	8.10	14.00
T_{14}	*Azotobacter* + *B. megaterium* + $MgSO_4$	9.40	12.75
T_{15}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$	9.65	13.45
T_{16}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$	10.15	14.25
T_{17}	*Azotobacter* + *B. megaterium* + M. mixture	10.75	15.00
T_{18}	*Azotobacter* + *B. mucilaginous* + M. mixture	11.65	16.00
T_{19}	*B. megaterium* + *B. mucilaginous* + M. mixture	12.80	17.00
T_{20}	*Azotobacter* + *B. megaterium* + $MgSO_4$ + M. mixture	13.75	18.25

T_{21}	*Azotobacter* + *B. mucilaginous* + $MgSO_4$+ M. mixture	14.40	20.05
T_{22}	*B. megaterium* + *B. mucilaginous* + $MgSO_4$+ M. mixture	15.25	22.00
S. Em ±		**0.18**	**0.38**
C D @ 5 %		**0.53**	**1.12**

Note: *RDF is constant for all the treatments. **B=Bacillus*, M=Micronutrient

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RESEARCH ARTICLE

EFFECT OF ACCELERATED AND NATURAL AGEING ON TOTAL SOLUBLE SEED PROTEIN PROFILE OF WHEAT (*TRITICUM AESTIVUM*)

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Abstract: Study was conducted to compare fresh, natural and accelerated seed lots of wheat with germination and vigour index varied from 98.67 to 44.00 and 2960 to 524.92 respectively. Germination loss became more evident in accelerated ageing as compared to fresh and natural aged lot. Total soluble seed protein banding pattern of different aged seed was revealed that there was decline in band intensity, band numbers or disappearance of some bands with ageing. It is more in accelerated aged lot as compared to natural aged seed lot. Thus, seed lot with slight variation in germination or vigor could also be used for varietal characterization by SDS-PAGE to differentiate the cultivars or even for genetic purity testing, but not the seed lots which were severely aged that lost threshold limit of 50 per cent.

Keywords: Accelerated ageing, Protein profiles, SDS-PAGE, Wheat seed

INTRODUCTION

Recent findings in biochemistry and molecular biology have enabled seed scientists to utilize new techniques for cultivar identification to augment existing traditional methods (Grow-Out-Test). Proteins are direct products of structural genes and are independent of environmental factors; these markers have been used to characterize varieties and to test the hybrid purity of many important crops (Tanksely, S.D. and Jones R.A. 1981; Cooke, R.J. 1998; Meng, X.D, Wei Y.Y., Zhang M. H. & Li J.R. 1998; Lucchese,C., DinelliG.,.Miggiano A & Lovato 1999; Vishwanath K., Prasanna K.P.R., Gowda R., Rajendra Prasad S., Narayanaswammy S. and Pallavi H.M. 2007). Seed is the best material to extract protein because examination can be carried out immediately after or even before harvest.

It is very essential to know the effect of ageing on seed protein profile so that an appropriate age of seed can be considered for electrophoretic analysis of seed proteins to characterize and differentiate the cultivars. Hence, an attempt was made to find out threshold limit for seed ageing, up to which these can be used for electrophoretic analysis proteins.

MATERIAL AND METHOD

Seed material comprised of six varieties of wheat *Viz*. C-306, PBW-502, WH-542, WH-711, WH-283 and RAJ-3765 having germination above minimum seed certification standard (MSCS) i.e.85% was collected at the time of sowing and stored in ambient conditions and present research work was carried out in the laboratory of Department of Seed Science and Technology CCS Haryana Agricultural University, Hisar from 2006 to 2010. For defining the variables for artificial ageing, seed of all six varieties were artificially aged (40±1ºC/72 hrs.) and observations were recorded after ageing. In case of natural ageing, observations were recorded quarterly on the stored wheat seeds in cotton bags in ambient conditions up to one year till germination was fall below as compared to fresh seed lot. Aged as well as non aged seed lots were evaluated for germination as per ISTA (1996) and seed vigor index (Abdul-Baki & Anderson (1973). Further, SDS-PAGE of total soluble proteins of all the seed lots was carried out by using 12 per cent acrylamide gel according to the methods prescribed by Dadlani and Varier (1993) with slight modifications. 0.1 gm seed powder was taken in eppendorf's tube to which 0.5 ml of extraction buffer (Tris-Glycine buffer, pH 8.3) was added. The contents were thoroughly mixed and kept overnight in refrigerator. The eppendorf's tubes were taken out, mixed the contents well and subjected to centrifugation at 10,000 rpm for 10 minutes. The supernatant was decanted and from this supernatant 0.1 ml was taken into a separate eppendorf's tube to which 0.3 ml of working solution (0.06 M Tris-Hcl, pH 6.8, 2% SDS, 10% glycerol, 0.025% bromophenol blue) was added and incubated at 60-70ºC for 10 minutes on dry bath, cooled immediately for 5 minutes and finally it was used as protein source for electrophoresis. The comb and tygon tubes were carefully removed after polymerization. The gel cassette was fixed into the electrophoresis apparatus. Then the wells were properly washed with running buffer. In each well 10-15µl sample was loaded. Electrophoresis was carried out at 1.5 mA per well till the sample migrated to the resolving gel. Later 2 mA per well was applied until the tracking dye reached the bottom of the gel.

RESULT AND DISCUSSION

Seed attain maximum quality at physiological maturity. Starting from this point, there is a series of

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degenerative events that reduce the survival capacity of seeds and lead to loss of vigor and germination Anderson, (1973). Main sites of ageing at cellular level are mitochondria, ribosome and membranes. Ageing process is mainly due to reduction in enzymatic activity; increased respiration and macromolecule synthesis, which are associated with initial deterioration of membrane system. A considerable amount of work has been done on the change in protein content (Roberts and Osborn ,1973 Bedi *et al* ,2006; Singh *et al* ,2002; Abdul baki and Anderson ,1972). and changes in activity of proteolytic enzymes (Galleschi et al,1988;Cheng and Kao,1984;Freitas et al,2006 and Krishnasamy and Yugasandhya,2002) related to seed deterioration. However, there is a need to know whether the protein profiles, the qualitative aspect of protein is going to alter due to ageing that would help to select the right age of seed lot for varietal characterization since protein profiles are being used to identify the off type at seed level.

In present study, natural as well as accelerated ageing affects germination and vigour of seeds. Germination loss became more accentuated in accelerated ageing and in natural ageing it progressively increased with time of ageing [Table 1&2], It varied from 98.67 to 44.00 from fresh to aged seed lots, accordingly vigor index also varied from 2960 to 524.92.

Table 1. Effect of natural and artificial ageing on Germination of wheat

Varieties	**Ageing**			
	Fresh	Natural	Accelerated	Mean
C-306	98.67	71.33	47.00	75.33
PBW-502	97.67	79.00	55.00	77.22
WH-542	98.00	74.33	49.33	73.88
WH-711	97.33	77.67	50.00	75.00
WH-283	95.33	74.00	52.67	74.00
RAJ-3765	98.00	71.33	44.00	68.11
Mean	**97.50**	**74.61**	**49.67**	

Factors	**C.D.(5%)**	**SE(d)**	**SE(m)**
Treatment (A)	1.361	0.668	0.472
Varieties (B)	1.924	0.945	0.668
Factor(A X B)	3.333	1.637	1.157

Table 2. Effect of natural and artificial ageing on vigor index- I of wheat

Varieties	**Ageing**			
	Fresh	**Natural**	**Accelerated**	**Mean**
C-306	2960.00	939.41	612.41	1403.94
PBW-502	2740.87	1072.03	742.50	1518.46
WH-542	2678.67	1003.45	659.54	1447.22
WH-711	2563.33	978.64	636.50	1392.82
WH-283	2637.67	976.80	675.75	1430.07
RAJ-3765	2482.67	891.62	524.92	1299.73
Mean	**2668.86**	**976.99**	**550.27**	

Factors	**C.D.(5%)**	**SE(d)**	**SE(m)**
Treatment (A)	62.960	30.918	21.862
Varieties (B)	89.039	43.725	30.918
Factor(A X B)	154.219	75.733	53.551

When the total soluble seed protein banding pattern of different aged seed lots were compared, in general there was decline in band intensity, band numbers or disappearance of some band as period of ageing advanced and it is observed higher in accelerated aged lot as compared to natural aged lot. This is due to degradation of protein in aged seed lots resulting in reduction of band intensity. Several researchers also reported such degradation of proteins in term of reduction in number and intensity of bands with

increased ageing [Sammour, 1989; Coello and Romos, 1996].

Table 3. Protein profile of total seed soluble Proteins by SDS-PAGE after of fresh, natural and accelerated aged seed lots of Wheat

Varieties	**Number of bands in fresh lot**	**Number of bands in natural aged lot**	**Number of bands in accelerated aged lot**
C-306	16	14	13
PBW-502	19	17	15
WH-542	16	14	14
WH-711	16	16	14
WH-283	16	14	13
RAJ-3765	14	13	13

Table 4. Band map of protein of fresh, natural and accelerated aged seed lots of Wheat based on RM values.

S.No.	RM Values	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	$+L_9$	L_{10}	L_{11}	L_{12}	L_{13}	L_{14}	L_{15}	L_{16}	L_{17}	L_{18}
1	0.130	-	+	+	+	+	-	-	+	-	+	-	-	-	-	-	-	-	-
2	0.182	-	+	+	+	+	+	-	+	-	+	+	-	-	-	-	+	+	+
3	0.222	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4	0.305	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
5	0.342	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	-	-	-
6	0.360	-	+	-	-	-	-	-	+	-	-	-	+	-	+	-	-	+	+
7	0.441	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-
8	0.472	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-
9	0.494	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10	0.510	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	0.584	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
12	0.652	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
13	0.678	+	+	+	+	-	+	+	+	+	+	-	+	+	+	+	+	-	+
14	0.750	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15	0.778	+	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-
16	0.820	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	0.842	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18	0.905	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19	0.940	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

L_1-L_6:- Fresh seed lot, L_7-L_{12}:- Natural aged seed lot, L_{13}-L_{18}:- Accelerated aged seed lot,

The seed protein profile of seed lots of wheat genotypes resulted in 19 bands with relative mobility ranging from 0.13 to 0.94 with molecular weight ranging from 165 to 470 kilodaltons (Table 4). In our study, there was decrease band intensity or total disappearance of a particular band in case of natural and accelerated aged seed lots in all the six varieties. However, no such variation was observed in band no 3,9,10,11,12,14,17,18&19 in all the seed lots over it is concluded thus these bands are stable band and do not disappear after ageing. Here as we compared all six varieties in term of ageing maximum expand of bands (19) were observed in fresh seed lot of variety PBW-502 which were decreased 17 in case of natural aged and 15 in accelerated aged lot (Table 2). Among all the varieties WH-711 was observed much stable because no change was observed in banding pattern after natural ageing of variety (Table 2). Although Krishnasamy and Yugasadhya (2002) also did not notice any difference in protein profiles of aged and none aged seed of maize. However, in this study, it was not clear how this particular protein was degraded. Hence, there is need to study the mechanism of degradation of this protein. Thus, seed lots with slight variation either in germination or vigor could be used for varietal characterization by SDS-PAGE to differentiate the cultivars or even for genetic purity testing but not the seed lots which are more aged that have lost threshold limit of 50 per cent.

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RESEARCH ARTICLE

ANALYSIS OF MICROBIAL CONTAMINATION OF DRINKING WATER AT MEERUT DISTRICT, NORTHEN INDIA

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Abstract: Water is one of the most important natural resource on earth. The safety of drinking water is important for the human health. The safety of drinking water is affected by various contaminants specially bacteria. Coliform can cause serious health problems. The analyses of drinking water quality at Meerut District, Uttar Pradesh, India, were done. The experimental procedures were set according to the international drinking water standards set by World Health Organization. Bacteriological examination of water samples collected from different sources showed that the water of bore wells were not potable and found across the maximum permissible limit of contamination for drinking water guidelines, while in 2016, only two water samples were found to be safe for drinking purpose.

Keyword: Drinking water, Coliforms, Health probems, World Health Organization, Contamination

INTRODUCTION

Water quality is a critical factor affecting human health and welfare. The World Health Organization estimated that up to 80% of diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water (Daunders and Warford, 1976; WHO, 1997). Other studies also showed that approximately 3.1% of deaths and 3.7% of disability-adjusted-life-years worldwide are attributable to unsafe water, hygiene and poor sanitation system (WHO, 2004; Werkneh *et al*., 2015). World Bank provided the evidence that incidence of certain water borne, water washed, water based and water sanitation associated diseases are related to the quality and quantity of water and sanitation available to the water users (Abebe, 1986; Kalbermatten, 1990). More than 15 million deaths worldwide result annually from waterborne infections (Atlas and Bertha, 1997). The surface water sources, in general, are not acceptable for drinking purpose as these are often loaded by different organic, inorganic and biological constituents (Dahiya and Kaur, 1999). Naturally, ground water contains mineral ions. These ions slowly dissolved from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and aquifer. Good quality of water resources depends on a large number of physico-chemical parameters and biological characteristics. To asses that monitoring of these parameters is essential to identify magnitude and source of any pollution load (Werkneh *et al*., 2015). The problem is the lack of socio-economic development resulting in one of the lowest standard of living, poor environmental conditions and low level of social services (WHO, 2004; Reza and Singh, 2009). The safety of drinking water can be monitored in a number of ways because the constituents of drinking water (such as chemicals and microbes) which can compromise human health can be measured directly (Battu and Reddy, 2009). The functioning of an aquatic ecosystem and its stability to support life forms depend to a great extent, on the physicochemical characteristics of its water. Physico-chemical parameters are highly important with respect to the occurrence and abundance of species. Ground water is by far more abundant than surface water and its quality is as important quantity. Water meant for drinking must therefore meet quality standards and it is essentially determined by its physico-chemical (WHO, 2004) and microbial characteristics. The reason for monitoring drinking water quality is to determine whether the water supply system is being operated correctly, implying that the water is safe for drinking or not. Indicator microorganisms survive better and longer than the pathogens with a uniform and stable properties and may easily be detected by standard laboratory techniques. The present study was designed to detect the coliforms and to assess the quality of ground water available for drinking purpose.

MATERIAL AND METHOD

Collection of Water Samples

A total of twenty four water samples (in replicates) were collected in polystyrene bottles (250 ml) from bore wells in two successive years 2015 and 2016 from all the twelve developmental blocks (Daurala, Jani, Rohta, Sarurpur, Meerut, Sardhana, Kharkhoda, Machhra, Rajpura, Mawana, Parikshitgarh, Hastinapur) of study area (District Meerut, Uttar Pradesh, India). The water samples were collected through simple random sampling without replacement technique from all the selected sites as per the procedure recommended by American Public Health Association (APHA, 2012). The water

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samples containers immediately covered tightly after collection of water samples and brought to the laboratory within 6 hours. The samples were immediately placed in a lightproof insulated box containing melting ice or ice-packs with water to ensure rapid cooling. The cool box used to carry the samples, cleaned and disinfected after each use to avoid contaminating the surfaces of the bottles and the sampler's hands. Primary examination of coliformic organisms and microbiological studies were followed as per the methods given by Bonde (1977), Fresenives *et al.* (1988), WHO (1996), Patralekh (1991) and APHA (1998).

RESULT AND DISCUSSION

Water quality for drinking purpose poses a serious concern worldwide. Safe drinking water is the most essential factor for maintenance of good health. Ground water (which is less polluted and considered safe for drinking purpose) is most important source of drinking water in Meerut District. There are different causes of water pollution such as lack of sanitation, lack of water source protection, improper waste disposal, open faecal disposal system, faulty well construction increase ground water contamination. More than 80 percent diseases such as typhoid, cholera, dysentery, gastroenteritis, infectious hepatitis, skin and eye infections is due to water pollution caused by poor sanitation. Under normal circumstances, water intended for human consumption should not contain any chemical or microorganism known to be pathogenic or any bacteria whose presence indicates the faecal pollution. Water can be perfectly clear, odour and tasteless and yet unsafe for drinking (WHO, 2003, 2008; Shekha, 2013). Based on the World Health Organization (WHO) guidelines, water used for drinking purpose should not contain even a single coliform bacterium per 100ml of water and contaminated water is not fit for human consumption. In the same way, water used for washing and bathing should not contain more than 50 coliform bacteria per 100ml of water (Bartram *et al.*, 2003)**.** The results of this present study showed that the colony forming unit (cfu/ ml) of coliform in case of water sample collected from bore well water was estimated to be very high and not found suitable for drinking purpose (Table 1).

In 2015, highest coliform was determined in the water samples collected from bore wells of Meerut City development block area (234) and followed by Jani development block area (216), Rajpura development block area (84), Mawana development block area (55), Kharkhoda development block area (54), Daurala development block area (49), Rohta development block area (9), Parikshitgarh development block area (2) and Machhra development block area (1). There is no coliform found in three (Sarurpur, Sardhana and Hastinapur) development block area (Table 1, Figure 1). In 2016, highest coliform was found again in the water samples collected from bore wells of Meerut City development block area (234) and followed by Jani development block area (225), Mawana development block area (137), Daurala development block area (87), Kharkhoda development block area (86), Rajpura development block area (65), Rohta development block area (22), Sardhana development block area (5), Sarurpur development block area (4) and Parikshitgarh development block area (2). There is no coliform found in two (Machhra and Hastinapur) development block area. Overall, there is a steep increase was observed in bacterial contamination in all the collected samples except Machhra development block area (Table 1). *Total Coliforms* indicates degree of pollution and their higher density portrays the differences between pure and polluted water (Rai and Hill, 1978). Coliformic bacteria are reliable indicator of contamination of water since they indicate the possibility of simultaneous occurrence of human pathogens (Clark and Pogel, 1977). *Fecal Coliforms* should be used as the indicator organism for evaluating the microbiological suitability of recreation water (Douglas *et al.*, 2015).

Table 1. Distribution of Total Coliform bacteria in Borewell water in Meerut District

Location	**Total Coliform Population (CFU/ml)**	
	2015	**2016**
Daurala	49	87
Jani	216	225
Rohta	9	22
Sarurpur	Nil	4
Meerut	234	467
Sardhana	Nil	5
Kharkhoda	54	86

Machhra	1	Nil
Rajpura	84	65
Mawana	55	137
Parikshitgarh	2	2
Hastinapur	Nil	Nil

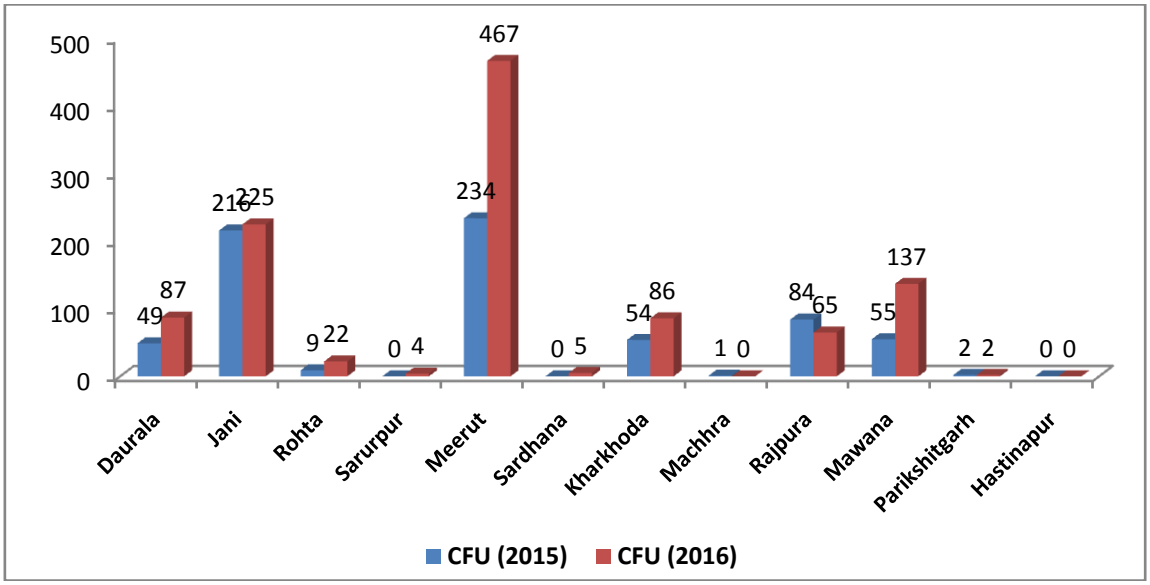

Fig. 1 Distribution of Total Coliform bacteria in Borewell water in Meerut District

Biochemical characteristics of the isolated bacteria clearly showed the maximum presence of *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* in the water samples collected from the different sites of Meerut District. According to Central Pollution Control Board (New Delhi India), total coliforms organism MPN/100 ml shall be 50 or less in drinking water. The consumption of drinking water contaminated with pathogenic bacteria (*E. coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*) of faecal origin is significant risk to human health in the developing countries, especially in industrial (Davies-Colley *et al.*, 2001) and urban areas (Bartram *et al.*, 2003). Over 3 million deaths per year is attributed to water-borne diarrhoeal diseases, especially among infants and young children in poor communities in the world (Werkneh *et al.*, 2015; Daud *et al.*, 2017). Microbial contamination is the most critical hazard due to its direct impact on human health (Chaturvedi and Shukla, 2008). Increase in total coliform counts in bore well water samples showed poor hygienic zones and indicated the lack of proper hygienic practices followed by the users (Raju *et al.*, 2011). The results of the present investigation suggested that there is a need to monitor the water quality from time to time to detect the actual source of contamination and also to pass the water through a form of treatment to prevent epidemic outbreak, since the values obtained are far above the WHO guidelines for water intended for domestic use. There is also need for pretreatment before use for domestic purposes. It is concluded that the proper sanitary survey, design and implementation of water and or/ sanitation projects, regular disinfections, maintenances and supervisions of water sources, and regular coliformic bacteriological assessment of all water sources for drinking should be planned and conducted.

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RESEARCH ARTICLE

MANAGEMENT OF PREVALENCE OF NATURAL ENEMY, *EUBLEMA AMABILIS* (MOORE) BY NOVEL INSECTICIDES AT KORBA DISTRICT OF CHHATTISGARH

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Abstract: Management of prevalence of natural enemy, *Eublema amabilis* (Moore) was studied during year 2014-15 and 2015-16 at Korba District of Chhattisgarh. Overall impact of insecticidal application, emamectin benzoate @ 0.002 per cent was found very much effective in suppression the population of lac predator, *E. amabilis* (Moore) over control with minimum 1.11 and 0.88 insect/30 cm of lac stick at first spray 30 day after BLI and second spray 60 day after BLI, respectively and relatively suffer or less toxic for lac cultivation fallowed by indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, indoxacarb @ 0.005 per cent, fipronil @ 0.005 per cent, fipronil @ 0.02 per cent, spinosad @ 0.005 per cent, spinosad @ 0.0025 per cent, fipronil @ 0.0025 per cent growers practice ethofenprox @ 0.02 per cent and indoxacarb @ 0.003 per cent accept fipronil 0.02 per cent.

Keywords: Natural enemy, *Eublema amabilis* (Moore), Novel insecticides

INTRODUCTION

Production and trade of lac in India dates back to the *Vedic* period as it finds a mention in the *Atharaveda* and *Mahabharat*. There are some findings that lac production and trade in China is almost 4000 years and developed along with silk (Singh, 2006). Lac is a natural, biodegradable, non-toxic, odourless, tasteless, hard resin and non-injurious to health. Lac is one of the most valuable gifts of nature and only resin of animal origin secreted by a tiny scale insect, *Kerria lacca* (Kerr.) belonging to the family Lacciferidae (Kerriidae), superfamily Coccoidea and order Hemiptera (Pal, 2009 and Mohanta *et al.*, 2012). Lac is an export oriented commodity, cultivated in the states of Jharkhand, Chhattisgarh, West Bengal, Madhya Pradesh, Odisha, Maharashtra, parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region. Majority of the tribal households of lac growing regions carry out lac cultivation as a subsidiary occupation to agriculture. Lac cultivation generates employment opportunities, particularly in the off agricultural season (Pal *et al*., 2012). The better lac production depends on suitable host plant, cultivation techniques and management of bio-agent timely during cultivation. It has been estimated that on an average, up to 30-35% of the lac cells are destroyed by natural enemies of lac crop. At times, the enemy attack can be so serious as to result in crop failures. The lac insect is prone to attack by insect predators and parasitoids. Among them, two Lepidopteron predators, *Eublemma amabilis* Moore (Lepidoptera: Noctuidae) are key pests causing a loss of around 30-40% to lac production (Glover, 1937, Narayanan, 1962, Jaiswal *et al.*, 2008). Chhattisgarh is of one the major lac cultivated area in India. It would be better to take precautions for management of lac insect fauna.Korba is the major lac cultivated area in Chhattisgarh. The total area of the district is 7, 14, 544 sqkms out of this 2, 83,457 sq kms area is under forests or notifies as 'forest' (chote/bade jhaadke jungle).So we need to have identified lac associated fauna and take precaution for management of lac insect fauna. Keeping this in view management of prevalence natural enemies associated with lac insect *Kerria lacca* Kerr. was studied at Korba District of Chhattisgarh.

MATERIAL AND METHOD

For the management of natural enemies of lac insect with insecticides which comparatively safer to lac insect was studied during year 2014-15 and 2015-16 at Korba District of Chhattisgarh.. Different concentrations of insecticides were applied on first and second instar larvae (30 and 60 days after BLI) of lac insect in both the years in *Rangeeni Baisakhi* (summer) season. The experiment was laid in randomized block design (RBD) with twelve treatments including untreated control, replicated three times. The quantity of each insecticide was determined for a plant size. Before and after spraying of insecticides, sprayer and measuring cylinder was thoroughly washed with clean water. 10 days after spray the observations were recorded from each tree on number of live and dead cell to see the effect of insecticides on lac insect. At maturity the 30 cm length matured lac encrustation was recorded along with density of major predators to see the impact of spraying on lac insect and survival of lac insect and natural enemies.

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RESULT AND DISCUSSION

Observation on *Eublema amabilis (*Moore) incidence was recorded from randomly selected 30 cm lac sticks of each treatment. The insecticidal treatments were applied two times, first at 30 days of brood lac inoculation (BLI) and second 60 days of brood lac inoculation (BLI). After first spray among the treatments, emamectin benzoate @ 0.002 per cent was recorded statistically significant over control with the minimum *E. amabilis* population 1.00 insect/30 cm of lac stick which was at par with indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, fipronil @ 0.02 per cent, growers practice ethofenprox @ 0.02 per cent and fipronil @ 0.005 per cent with 1.33, 1.44, 1.66, 2.00 and 2.00 insect/30 cm of lac stick in 2014-15, respectively. The maximum population of *E. amabilis* was found under the untreated control i.e. 7.00 insect/30 cm of lac stick (Table 1).

Regarding per cent reduction of the population of *E. amabilis* in different doses of insecticides, it varied from 47.71 to 85.71 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 85.71 per cent. Other treatments were superior as compared to control but less effective than best one during the year 2014-15.

Similarly, during 2015-16 emamectin benzoate @ 0.002 per cent was recorded statistically significant over control with the minimum *E. amabilis* population 1.22 insect/30 cm of lac stick which was at par with indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, fipronil @ 0.02 per cent, growers practice ethofenprox @ 0.02 per cent, spinosad @ 0.005 per cent and fipronil @ 0.005 per cent with 1.33, 1.66, 2.00, 2.00, 2.33 and 2.33 insect/30 cm of lac stick, respectively. The maximum population of *E. amabilis* was found under the untreated control i.e. 7.33 insect/30 cm of lac stick. The per cent reduction of the population of *E. amabilis* in different doses of insecticides, it varied from 45.43 to 83.36 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 83.36 per cent. Other treatments were superior as compared to control but less effective than best one the year 2015-16.

On the basis of pooled mean, emamectin benzoate @ 0.002 per cent was found superior 1.11 insect/30 cm of lac stick as compared all of the treatments. The population of *E. amabilis* was varied from 1.11 to 7.16 insect/30 cm of lac stick. The per cent reduction of the population of *E. amabilis* in different doses of insecticides, it varied from 46.57 to 84.54 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 84.54 per cent.

After second spray among the treatments, emamectin benzoate @ 0.002 per cent was recorded statistically significant over control with the minimum *E. amabilis* population 0.88 insect/30 cm of lac stick which was at par with indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, fipronil @ 0.02 per cent, growers practice ethofenprox @ 0.02 per cent and fipronil @ 0.005 per cent with 0.89, 1.00, 1.00, 1.11 and 1.67 insect/30 cm of lac stick in 2014-15, respectively. The maximum population of *E. amabilis* was found under the untreated control i.e. 7.66 insect/30 cm of lac stick. Regarding per cent reduction of the population of *E. amabilis*in different doses of insecticides, it varied from 56.53 to 88.51 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 88.51 per cent. Other treatments were superior as compared to control but less effective than best one during the year 2014-15.

Similarly, during 2015-16 emamectin benzoate @ 0.002 per cent was recorded statistically significant over control with the minimum *E. amabilis* population 0.88 insect/30 cm of lac stick which was at par with indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, fipronil @ 0.02 per cent, growers practice ethofenprox @ 0.02 per cent, spinosad @ 0.005 per cent and fipronil @ 0.005 per cent with 0.99, 1.00, 1.22, 1.66, 2.00 and 2.00 insect/30 cm of lac stick, respectively. The maximum population of *E. amabilis* was found under the untreated control i.e. 8.00 insect/30 cm of lac stick.

The per cent reduction of the population of *E. amabilis* in different doses of insecticides, it varied from 58.38 to 89.00 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 89.00 per cent. Other treatments were superior as compared to control but less effective than best one the year 2015-16.

On the basis of pooled mean, emamectin benzoate @ 0.002 per cent was found superior 0.88 insect/30 cm of lac stick as compared all of the treatments. The population of *E. amabilis* was varied from 0.88 to 7.83 insect/30 cm of lac stick. The per cent reduction of the population of *E. amabilis* in different doses of insecticides, it varied from 57.46 to 88.76 per cent over control. Among the treatment, emamectin benzoate @ 0.002 per cent was the best treatment with maximum reduction 88.76 per cent.

On the basis of overall impact of insecticidal application, emamectin benzoate @ 0.002 per cent was found very much effective in suppression the population of lac predators viz. *E. amabilis* (Moore) and *Pseudohypatopa puverea* (Mayrick) and parasitoid, *Tachardiaephagous tachardiae* (How) and relatively suffer or less toxic for lac cultivation fallowed by indoxacarb @ 0.02 per cent, spinosad @ 0.02 per cent, fipronil @ 0.02 per cent, indoxacarb @ 0.005 per cent, fipronil @ 0.005 per cent, spinosad @ 0.005 per cent, spinosad @ 0.0025 per cent, fipronil @ 0.0025 per cent growers practice ethofenprox @ 0.02 per cent and indoxacarb @ 0.003 per cent.

There were number of published document found regarding the effectiveness of emamectin benzoate, indoxacarb, spinosad and fipronil against harmful biotic fauna associated with lac insect in *rangeeni* strain.

The present study evidenced by Jaiswal *et al*., (2017) evaluated the safety of emamectin benzoate against lac insect *K. lacca* Kerr and bioefficacy against associated lepidopteran predators in lac culture. Seven concentrations of emamectin benzoate (5% SG) ranging from 0.00025 % *a.i.* (0.05 g/L) to 0.0030 % *a.i.* (0.6 g/L) were evaluated by dipping of brood lac (functional seed of lac culture) in insecticidal formulation for 5, 10 and 15 min durations. Various treatments and control on survival of settled second instar larvae and adult female lac insect clearly indicated the safety of insecticide on lac insect. Treatment of brood lac in insecticidal formulations (0.00025, 0.0005, 0.0010, 0.0015, 0.0020, 0.0025 and 0.0030 % *a.i.*) for 5, 10 and 15 min durations exerted significant reduction in the population of both key lepidopteran predators, *E. amabilis* Moore and *P.pulverea*Meyr harboring brood lac. The treatment of *rangeeni* brood lac with 0.00025 % a.i. emamectin benzoate for 10-15 min and *kusmi* brood lac with 0.0005 % a.i. for 5-10 min duration provides effective tool for the management of both major lepidopteran predators of lac insects. This novel insecticide can be safely and effectively integrated in IPM programme of lac production system.

Table 1. Bio-efficacy of insecticide for the management of *Eublema amabilis* as major predator of lac during year 2014-15 and 2015-16

SN.	Insecticide	Dose	First spray					Pooled	Second spray					Pooled
			(Number of insect /30 cm lac sticks)			Reduction %			(Number of insect /30 cm lac sticks)			Reduction %		
			30 DABLI		Pooled				60 DABLI		Pooled			
			2014-15	2015-16		2014-15	2015-16		2014-15	2015-16		2014-15	2015-16	
1	Indoxacarb (14.5% SC)	0.003%	3.66 (2.14)	4.00 (2.22)	3.83 (2.18)	47.71	45.43	46.57	3.33 (2.07)	3.33 (2.06)	3.33 (2.07)	56.53	58.38	57.46
2	Indoxacarb (14.5% SC)	0.005%	3.33 (2.07)	3.00 (1.98)	3.17 (2.02)	52.43	59.07	55.75	3.00 (1.98)	2.66 (1.91)	2.83 (1.95)	60.84	66.75	63.80
3	Indoxacarb (14.5% SC)	0.020%	1.33 (1.51)	1.33 (1.52)	1.33 (1.51)	81.00	81.86	81.43	0.89 (1.37)	0.99 (1.40)	0.94 (1.39)	88.38	87.63	88.01
4	Spinosad (2.5%SC)	0.0025%	3.00 (1.98)	3.67 (2.15)	3.33 (2.06)	57.14	49.93	53.54	2.66 (1.90)	3.00 (1.98)	2.83 (1.95)	65.27	62.50	63.89
5	Spinosad (2.5%SC)	0.005%	2.33 (1.81)	2.33 (1.80)	2.33 (1.80)	66.71	68.21	67.46	2.00 (1.71)	2.00 (1.71)	2.00 (1.72)	73.89	75.00	74.45
6	Spinosad (2.5%SC)	0.020%	1.44 (1.56)	1.66 (1.61)	1.55 (1.58)	79.43	77.35	78.39	1.00 (1.41)	1.00 (1.39)	1.00 (1.41)	86.95	87.50	87.23
7	Fipronil (5% SC)	0.0025%	2.55 (1.87)	3.33 (2.07)	2.94 (1.97)	63.57	54.57	59.07	2.33 (1.82)	2.66 (1.91)	2.50 (1.87)	69.58	66.75	68.17
8	Fipronil (5% SC)	0.005%	2.00 (1.72)	2.33 (1.81)	2.16 (1.76)	71.43	68.21	69.82	1.67 (1.62)	2.00 (1.71)	1.83 (1.67)	78.20	75.00	76.60
9	Fipronil (5% SC)	0.020%	1.66 (1.63)	2.00 (1.72)	1.83 (1.67)	76.29	72.71	74.50	1.00 (1.41)	1.22 (1.47)	1.11 (1.45)	86.95	84.75	85.85
10	Emamectin benzoate (5 SG)	0.002%	1.00 (1.39)	1.22 (1.48)	1.11 (1.43)	85.71	83.36	84.54	0.88 (1.36)	0.88 (1.36)	0.88 (1.37)	88.51	89.00	88.76
11	Growers practice (Ethofenprox 10% EC)	0.020%	2.00 (1.71)	2.00 (1.71)	2.00 (1.71)	71.43	72.71	72.07	1.11 (1.43)	1.66 (1.63)	1.39 (1.53)	85.51	79.25	82.38
12	Untreated control	Water	7.00 (2.81)	7.33 (2.88)	7.16 (2.84)	0.00	0.00	0.00	7.66 (2.94)	8.00 (2.99)	7.83 2.97)	0.00	0.00	0.00
SEm±			**0.13**	**0.13**					**0.10**	**0.13**				
CD (P= 0.005)			**0.39**	**0.38**					**0.31**	**0.39**				

Note: Figures in parentheses are root square transformed value, DABLI= Day after brood lac inoculation.

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RESEARCH ARTICLE

EMPOWERMENT OF RURAL WOMEN THROUGH NATIONAL RURAL LIVELIHOOD MISSION IN REWA BLOCK OF REWA DISTRICT (M.P.)

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Abstract: Rural women empowerment is a multi-dimensional process, which enables rural women or group of women to realize their full identity and power in all spheres of life. The present study was carried out in Rewa district M.P. National Rural Livelihood Mission project has been running in the district since 2015 for improving the livelihood of rural women beneficiaries and their empowerment. The study was planned to assess the empowerment of the women among beneficiaries of NRLM. It was found that the aspect social empowerment (1.40) had highest mean empowerment score followed by psychological empowerment (1.19), economic empowerment (1.12), cultural empowerment (1.08). Mean empowerment score was lowest in case of political empowerment (0.64). The study also revealed that the characteristics namely, education, size of family, annual income, longevity of SHG's, cosmopoliteness, source of information, mass media participation, training participation, risk orientation, economic motivation, decision making and achievement motivation had significant relationship with empowerment at 5% level of significance of their empowerment of the rural women beneficiaries of NRLM.

Keywords: Empowerment, Livelihood, Rural women, Rewa block

INTRODUCTION

In the present century the terms women empowerment, women welfare, gender justice have come to light in the social, economic and political development perspective of both developed and developing nation. Empowerment is a process, which helps people to gain control of their lives through raising awareness, taking action and working in order to exercise greater control. Empowerment is the feeling that actives the psychological energy to accomplish ones goals (Indiresan 1999). Despite these challenges, millions and millions of women in India are breaking old barriers and charting their own destiny. Empowerment is a multi-dimensional process, which should enable women or group of women to realize their full identity and power in all spheres of life. It consists of greater access to knowledge and resources, greater authority in decision making to enable them to have greater ability to plan their lives, or to have greater control over the circumstances that influence their lives and free from shocks imposed on them by custom, belief and practice. Keeping this in view the present study entitled as "Empowerment of rural women through National Rural livelihood mission in Rewa Block of Rewa District (M.P.)" was undertaken with the following objectives:-

1. To study the empowerment of the women beneficiaries of NRLM.
2. To find out relationship between independent and dependent variable.

MATERIAL AND METHOD

The present study was conducted in Rewa district M.P.since the National Rural Livelihood Mission project has been running in the district since 2015 for improving the livelihood of women beneficiaries under NRLM project. Out of these blocks Rewa block was selected on the basis of higher number of rural women beneficiaries under NRLM project . A cluster of villages consisting five villages viz, Kitvariya, Karhiya, Bisar, Bhitwa, Mandhi of Rewa block was selected due to higher concentration of SHGs members.In Rewa block, the majority of the SHGs have been found to be involved in income generating activities viz, vegetable production, masala processing, making agarbatti, tailoring, kirana stores, vermiculture, goatry and dairy enterprise for their livelihood. From this block the five villages were selected for the study on the basis of higher number of rural women SHGs members. From these selected villages a village wise list of SHGs members under NRLM was prepared. Out of this list members of rural women SHGs were selected through proportionate random sampling method to make a sample of 120 respondents. Hence finally the sampling was consisted of 120 respondents.

RESULT AND DISCUSSION

Empowerment of the women among beneficiaries of NRLM

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Table 1. Distribution of respondents of each of the sub items In women- empowerment

S. no.	Aspects	Total empowerment score	Mean score
A	**Psychological empowerment**		
1	Self confidence	164	1.36
2	Courage	135	1.12
3	Self reliance	148	1.23
4	Career ambition	141	1.17
5	Self image	130	1.08
	Average mean score	**1.19**	
B	**Cultural empowerment**		
1	Freedom to interact with male outside family	172	1.43
2	Freedom for performing festival ceremonies	181	1.50
3	Freedom for wearing a kind of dress	120	1.00
4	Freedom for attending common place/ TUG office	111	0.92
5	Freedom for deciding (food) menu	105	0.87
6	Liberty for attending marriage ceremony	98	0.81
	Average mean score	**1.08**	
C	**Social empowerment**		
1	Self education	187	1.55
2	Freedom to work outside family	170	1.41
3	Freedom for adopting practices for maintaining health	155	1.29
4	Participation in decision about family planning	168	1.40
5	Participation in community action	177	1.47
6	Feeling of social security	181	1.50
7	Participation in decision about education of children	188	1.56
8	Participation in decision about girls marriage	144	1.20
9	Access to modern technology	156	1.30
	Average mean score	**1.40**	
D	**Economic empowerment**		
1	Freedom for selection job	164	1.36
2	Personal saving in form of fixed deposit	169	1.40
3	Operating personal account in bank	122	1.01
4	Participation in decision about adoption of modern technology in home/enterprise	138	1.15
5	Participation in decision about purchasing building/house	179	1.49
6	Participation in purchase of input for family enterprise	94	0.78
7	Authority to employ laborers	114	0.95
8	Participation in decision about marketing of produce	99	0.82
	Average mean score	**1.12**	
E	**Political empowerment**		
1	Holding political position at present	56	0.46
2	Freedom for participation in active politics	98	0.81
3	Awareness of human rights	105	0.87
4	Awareness of legislation for women	81	0.67
5	Awareness of political institution	49	0.40
	Average mean score	**0.64**	

In case of psychological aspect it was observed that the women empowerment index was highest in self confidence (1.36) followed by self reliance (1.17), courage (1.23), career ambition (1.17) and self image (1.08).

Regarding the cultural aspect women empowerment index was highest in freedom for performing festival ceremonies (1.50) followed by freedom to interact with male outside family (1.43), freedom for wearing a kind of dress (1.00), freedom for attending pilgrim/ religious place (0.92), freedom for deciding (food) menu(0.87) and liberty for attending marriage ceremony (0.81).

As far as social aspect was concerned women empowerment index arranged in descending order as decision about girls education of children (1.56) followed by self education (1.55), feeling of social security (1.50), participation in community action

(1.47), freedom to work outside family (1.41), participation in decision about family planning (1.40), access to modern technology (1.30), freedom for adopting practices for maintain health (1.29) and participation in decision about girls marriage (1.20).
Regarding economical aspect women empowerment index was maximum in relation to participation in decision about purchasing building/house (1.49) followed by personal saving in form of fixed deposit (1.40), freedom for selection of job (1.36), participation in decision about adoption of modern technology in home/ enterprise (1.15), operating personal account in bank (1.01), participation in purchase of input for family enterprise (0.95), authority to employ laborers (0.82) and participation in decision about marketing of produce (0.78).
Regarding the political aspect women empowerment index was highest in awareness of human rights (0.87) followed by freedom for participation in active politics (0.81), awareness of legislation for women (0.67), holding a political position at present (0.46) and awareness of political institution (0.40).

Table 2. Association between profile of the respondents and their empowerment about IGA.

S. No.	Characteristics	X^2 value	d.f.	C	Degree of association
1.	Age	8.66	4	0.21	Negligible
2.	Education	14.70*	6	0.33	Fair
3.	Size of family	4.25	4	0.33	Negligible
4.	Longevity of SHG's membership	15.90*	4	0.34	Fair
5.	Caste	8.84	4	0.22	Negligible
6.	Social participation	3.42	4	0.21	Negligible
7.	Annual income	9.85*	4	0.30	Fair
8.	Cosmopoliteness	17.24*	4	0.31	Fair
9.	Source of information	10.37*	4	0.36	Fair
10.	Training participation	9.82*	4	0.35	Fair
11	Mass media participation	13.47*		0.30	Fair
12.	Risk orientation	10.52*	4	0.37	Fair
13.	Economic motivation	9.82*	4	0.40	Fair
14.	Achievement motivation	15.30*	4	0.42	Fair
15.	Decision making	9.62*	4	0.39	Fair

Significant at 5% level of probability

Relationship between profile of the respondents with their empowerment. The characteristics namely, education, size of family, annual income, longevity of SHG's, cosmopoliteness, source of information, mass media participation, training participation, risk orientation, economic motivation, decision making and achievement motivation had significant relationship of empowerment at 5% level of significance. The result also depict that age, caste, size of family and social participation of the women did not establish significant relationship with their empowerment of the rural women beneficiaries of NRLM .

CONCLUSION

The study was planned to assess the empowerment of the women among beneficiaries of NRLM. It was found that the aspect social empowerment (1.40) had highest mean empowerment score followed by psychological empowerment (1.19), economic empowerment (1.12), cultural empowerment (1.08). Mean empowerment score was lowest in case of political empowerment (0.64). The study also revealed that the characteristics namely, education, size of family, annual income, longevity of SHG's, cosmopoliteness, source of information, mass media participation, training participation, risk orientation, economic motivation, decision making and achievement motivation had significant relationship with empowerment at 5% level of significance of their empowerment of the rural women beneficiaries of NRLM.

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SHORT COMMUNICATION

USE OF INK FOR STAINING AM STRUCTURES IN HEPATICS

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Abstract: Commonly available inks were used to stain AM fungal structures in rhizoids of three liverwort species so as to find a suitable replacement for carcinogenic stains like trypan blue. None of the inks were found to be suitable.

Keywords: Ink, Stain, Chemicals, AM fungi

INTRODUCTION

Staining is an essential step in studying various AM fungal structures in roots. Philips and Hayman (1970) developed a method of staining by using trypan blue. Trypan blue is listed by the International Agency for Research on Cancer as a possible carcinogen (International Agency for Research on Cancer, 1975.). Such hazardous chemicals may cause skin irritation (Arena, 1986) and their vapours may irritate the eyes, nose,throat, and lungs thus, use of such chemicals should be reduced for health and safety reasons. In an attempt to replace the use of these hazardous chemicals, literature was surveyed so as to search for some substitutes. Vierheilig *et al.,* 1998 has developed a technique to replace the use of trypan blue with ink and vinegar to study AM associations of three fungal species (*G. mosseae*, *G. intraradices*, and *G. margarita*) in families having different root characteristics (bean [*Phaseolus vulgaris* L.], soybean [*Glycine max* L.], cucumber [*Cucumis sativus* L.], maize [*Zea mays* L.], wheat [*Tritium aestivum* L.], barley [*Hordeum vulgare* L.], and ryegrass [*Lolium perenne* L.]) and found out that staining of all three AM fungi by the black ink-vinegar solutions gave excellent results. Another worker, (Walker, 2005) replaced the use of vinegar by dilute HCl. Cao *et al.,* (2013) found only blue ink to be suitable for staining roots of *Citrus*. He got a bad color contrast in the roots stained by black and red ink-acetic acid solution. Therefore, he suggested the use of blue ink-acetic acid solution to stain mycorrhiza in *Citrus* roots. He pointed out that staining time is vital for the staining procedure. Chhetri and Maharjan (2012) tested two locally available inks in Nepal (Chelpark permanent black and Chelpark washable royal blue) for staining arbuscular mycorrhiza and found both of them suitable for staining the fungal structures (arbuscules, vesicles and internal hyphae).

Our objective was to determine whether this technique can be adapted for staining of AM fungi in hepatic rhizoids or not, thus replacing these harmful chemicals with non-toxic yet equally effective products.

MATERIAL AND METHOD

For staining process, rhizoids were detached from the thallus and boiled in 0.01% Potassium hydroxide (KOH) for 2-3 hours and then kept at room temperature for 1 hour followed by 3-4 washings in order to remove KOH. These rhizoids were then stained in ink-vinegar solution for 5 minutes so as to assess the effectiveness of the both. After destaining in water, rhizoids were mounted in glycerine.

Rhizoids of three liverwort species *Plagiochasma appendiculatum, Marchantia paleacea* and *Marchantia papillata* were used for testing the effectiveness of the staining process.

RESULT AND DISCUSSION

Results obtained were quite different from those obtained on higher plants (Table 1). After destaining in water, red and blue inks gave totally zero result (Figs. 1a & b) . Black ink was able to stain fungal hyphae but the results were not upto the mark (Fig. c). Moreover, the contrast developed was also very poor.

Vierheilig *et al.,* 1998 found that not all inks of different colours were effective in staining. Purple and green ink gave zero result whereas one of the blue and red ink gave good contrast. Black inks of four different companies gave good results of which black ink of Schaffer make gave excellent results.

CONCLUSION

None of the inks included in the present study were suitable for studying AM associations in rhizoids of liverworts. Some more inks of different brands need to be tested so as to find suitable substitutes for hazardous stains like trypan blue

Table 1. Comparison of different inks for staining of AM fungi in roots.

Color of the ink	Company	Staining time	Staining result	Comments
Red	Camlin	5 min	Fungus not stained	Not suitable

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	Chelpark	”	Fungus not stained	”
Blue	Camlin	”	Fungus not stained	”
	Chelpark	”	Fungus not stained	”
	Parker	”		
Black	Camlin	”	Fungus stained	”
	Chelpark	”	Fungus stained	”

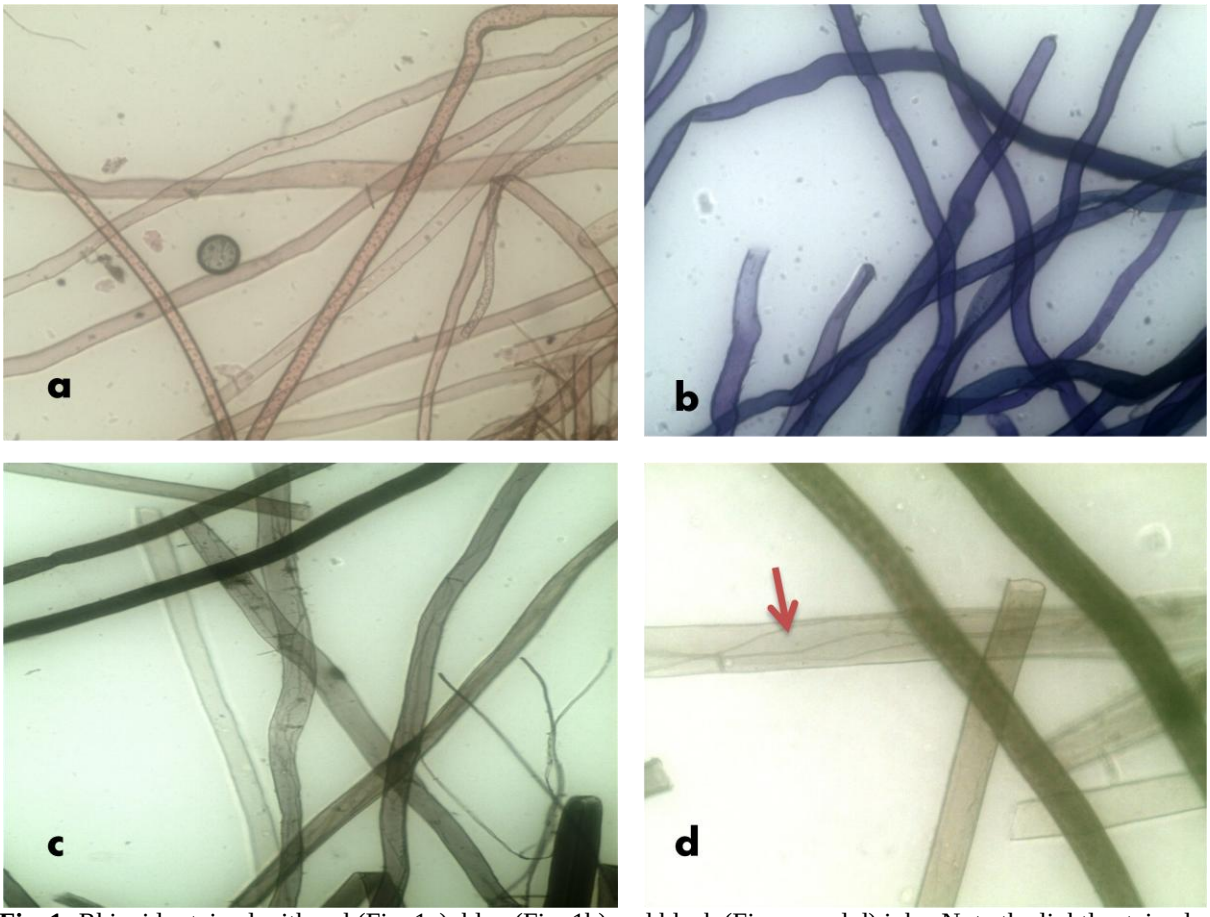

Fig. 1: Rhizoids stained with red (Fig. 1a), blue (Fig. 1b) and black (Figs. c and d) inks. Note the lightly stained fungal hyphae (arrow).

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SHORT COMMUNICATION

EFFECT OF SEED RATES AND SEED WATER SOAKING ON WHEAT UNDER DELAYED CONDITION

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Abstract: The effect of seed rate and seed water soaking level on the performance of wheat was studied. The main plot treatment was seed rate (100,125&150 kg ha^{-1}), sub plot treatment was (Without seed soaking and overnight soaking in water) and sub-sub plot treatment was covering the rows with FYM @2t $ha^{-1}$and covering the rows without FYM. Six irrigation should be provided at different critical stages. The only higher seed rate 150 kg/ ha gave significantly higher yield (27.11 q/ha and 25.82 q/ha first and second respectively). The average yield was 26.0 q/ha. Higher yield were also obtained under seeds soaking and covering the furrows with FYM but the differences were not significant.

Keywords: Wheat, Seed rate, Water, Treatment, Production

INTRODUCTION

Wheat is grown in *rabi* season when maximum land is occupied by *boro* rice. The water requirement for boro rice is much higher than that of wheat. The water requirement of wheat is only 25-33% of boro rice(BARI, 1990). The production cost of wheat is also less than that of boro rice. Therefore, wheat has much potentiality to replace boro rice in terms of its economic production and nutritional quality. In *rabi* season, most of the land, especially in North-Western part of the country remains fallow due to lack of irrigation facilities which could easily be brought under wheat cultivation. The climate and soil of Bangladesh are quite favorable for the cultivation of wheat during this period .Wheat yield in farmers field is very low i.e. only 2 t ha-1 but in the research stations it is about 4 t ha-1(BARI, 1990). This might be due to the use of improper production technology by the farmers. To get maximum yield it is necessary to use quality seed and improved agronomic techniques such as optimum seed rate, time of seeding, irrigation, fertilizer application, weeding, water management, time of harvest etc. There is a need to increase the yield of wheat per unit area in Bangladesh to provide the ever-increasing food requirement of the country, as the cultivable area is very limited and there is little scope to expand the area for production of wheat.

Seed rate plays a vital role for optimum plant densities which is a pre-requisite for increased seed yield. It influences the yield and yield attributes of wheat (Singh and Singh, 1987). Seed rate depends on seeding method. The broadcasting method requires more seeds than line sowing. Higher seed rate produces more plants in unit area resulting in less intra-crop competition hereby affecting the yield and production cost. On the other hand, lower seed rate may reduce the yield drastically.

MATERIAL AND METHOD

The research was carried out at the Research cum Instructional Farm, RMDCARS, Ambikapur (C.G.) during *Rabi*season. Ambikapur is situated in northen hills region of Chhattisgarh state and lies at $23^0$12' North Latitude and $83^0$2' East Longitude. The soil of experimental field was sandy loam in texture and neutral in reactions. It is deep and hence, has good water holding capacity. It was neutral in reaction, low in nitrogen, medium in available phosphorus and medium exchangeable potassium. The crop received about 1100-1400 mm rains during the growth periods. The experiment was laid out in Split plot Design with 3 replications. The main plot treatment was seed rate (100,125&150 kg ha^{-1}), sub plot treatment was (Without seed soaking and overnight soaking in water) and sub-sub plot treatment was covering the rows with FYM @2t $ha^{-1}$and covering the rows without FYM. Six Irrigation should be provided at different critical stages.The recommended fertilizer rates of 64 kg Nha^{-1},50 kg $P_2O_5ha^{-1}$and K_2O 40 $kgha^{-1}$ were applied at the time of planting while the remaining 36$kgha^{-1}$ N was applied at mid tillering stage.

RESULT AND DISCUSSION

During both years amongst the techniques such as higher seed rate, soaking seed in water over night and speeding a thin covering of FYM soon after sowing to reduce the losses caused by delayed sowing revealed that only higher seed rate 150 $kgha^{-1}$ gave significantly higher yield(27.11 qha^{-1} and 25.82 qha^{-1} first and second respectively). The average yield was 26.0qha^{-1}. Higher yield were also obtained under seeds soaking and covering the furrows with FYM but the differences were not significant. The highest number of effective tiller (64.48 & 57.16) was produced by the seed rate of 150 kg ha^{-1} and the

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shortest spike (7.10 cm), shortest number of effective tiller (61.29& 55.87) was found from the seed rate of 100 kg ha^{-1}. Talukder *et al.,* (2004) obtained similar results. The longest panicle length(5.6 & 5.2 cm) was recorded from the seed rate of 150 kg ha^{-1} and the lowest (5.5 & 5.3 cm) was recorded from the seed rate of 100 kg ha^{-1}. Numerically the highest 100 seed weight (5.49g & 5.31g) was obtained from the seed rate of 150 kg ha^{-1}.

Table 1. Effect of seed rates on different growth parameters and yield attributes.

Treatment	**Plant ht.(cm)**		**Effective tiller (1m row length)**		**100 seed weight (gm)**		**Panicle length (cm)**		**Grain yield (q ha^{-1})**	
Seed rate(Kg ha^{-1})	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
100	70.95	57.70	61.29	55.87	5.52	5.34	5.5	5.3	25.64	23.54
125	71.60	57.83	62.47	56.19	5.44	5.33	5.5	5.3	26.26	24.18
150	71.25	58.27	64.48	57.16	5.49	5.31	5.6	5.2	27.11	25.82
SEm±	0.37	0.93	0.93	0.51	0.09	0.03	0.11	0.04	0.13	0.34
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.54	1.18
Seed treatment										
Soaking with water	71.33	58.03	62.82	56.73	5.52	5.34	5.6	5.3	26.93	24.54
Without soaking	71.20	57.84	62.68	56.07	5.45	5.30	5.4	5.2	25.75	24.25
SEm±	0.61	0.56	0.46	0.35	0.06	0.03	0.09	0.04	0.31	0.31
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Covering the seed rows										
With FYM @2tha^{-1}	71.81	58.15	63.45	56.63	5.46	5.38	5.4	5.4	26.48	24.83
Without FYM	70.72	57.71	62.04	56.44	5.50	5.27	5.7	5.1	26.20	23.96
SEm±	0.64	0.57	1.61	0.23	0.08	0.02	0.12	0.06	0.46	0.39
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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