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Contents

FIELD PERFORMANCE OF *SWIETENIA MACROPHYLLA* KING. SAPLING IN MUNICIPAL GARBAGE AS THE POTTING MEDIA FOR REFORESTATION IN THE TROPICS

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Abstract : The term 'garbage' used internationally to describe waste materials arising from domestic, trade, commercial, industrial, agricultural and other related activities and from public services. It has created a real threat not only to the living environment but also for the cultivation of crops as well as afforestation. The present investigation was conducted to study the influence of two weeks decayed or stored waste materials as component potting media on the growth and vigour of *Swietenia macrophylla* (Mahogany) seedlings. The survival rate was ranged from 96 per cent to 99 per cent among various treatments studied. Mixture of soil, partially decayed tea waste and sand was recorded the maximum height in nursery and T1 (Control - Soil: Sand: cow dung) recorded maximum collar diameter (9.35 mm). With regards to height (155.62 cm) and diameter (14.2 mm), the maximum performance was registered in potting media containing soil and partially decayed Municipal waste (T2) in sapling level. Height and diameter increment at nursery level after eighth month showed the maximum increase was in T7 (28.32 per cent) and -3.53 per cent as compared to the control (T1) in seedling level and maximum increment per cent in the plantation was recorded in T2 (45.28) and T4 (49.55) for height and diameter respectively. The combined use of soil with garbage result in the production high quality planting material and the effect of plantation development were very less.

Keywords: *Swietenia macrophylla*, potting media, survival rate, diameter, height, increment percentage

INTRODUCTION

Swietenia mcrophylla (Meliaceae) is the promising spices in the round wood. It is able to tolerate a very wide range of environmental conditions and is found naturally in both tropical dry and wet forest types. The economic importance of timber may due to the attractive light reddish colour and high durability. During the past few years the demand for mahogany was tremendously increased. It has special attention due to the wood quality, workability and less insect attack. In the recent times Mahogany gained a wide acceptance among the tree growers in Kerala. In Kerala, despite the favorable agroclimatic and edaphic conditions and the concomitant production potential, the forest plantations contribute marginally to meet the state wood demand (less than 25%) reported by Krishnankutty, (1990). Establishing forest plantations to meet the ever-increasing demand for tree products have been a long standing tradition in the tropics (Evans, 1990). Apart from alleviating the pressure on the primary forest, plantations offer continuous production of wood materials through intensive management practices. Besides the direct economic benefits the ecological dimensions, plantation forestry have attained greater importance in the recent times in view of the invaluable contribution they provide in regulating atmospheric CO2 emission and there by playing a dominant role in mitigating climatic change (IPCC, 2007). The natural regeneration and establishment were only scarce. So the production of quality material was a challenging topic and that is the reason for the selection of this species.

Municipal solid waste is a heterogeneous mass of discarded waste material of industrial and commercial activities of human being. They are normally non-flowing materials such as plastic, paper metal, glass, kitchen wastes and market wastes (Sharma, 2002). Spooner (1971) has reported that solid waste comprise countless different materials like dust, food waste, packaging in the form of paper, metals, plastic, glass pieces, discarded clothing and furnishings, garden waste and hazardous and radioactive wastes. With the looming urbanization and changes in lifestyle and food habits, municipal solid waste has been proliferating rapidly and its composition keeps changing periodically (Umpathy, 2003). Solid waste management is the effort of removing and disposing all the unwanted material through a carefully, planned and judicious use of means. Shah, (2000) reiterated the planning, financing, construction and operation of facilities for the collection, transportation, recycling and final disposition of solid waste. It is based on principles such as engineering, economics, public health, conservation, aesthetics, environmental considera-tions and social and ethical issues.

The research studies conducted elsewhere revealed that the waste materials like municipal garbage could be used for cultivation of vegetables and ornamentals particularly when supplemented with some nutrients. But information regarding the effect of these solid wastes on the growth and vigour of tree seedlings either in the nursery or in the plantation are very scanty. Scientific information on the influence of municipal garbage on growth behavior of seedlings will be extremely useful for the production of healthy seedlings in the nursery at low cost, same time

paving a way for the easy disposal of these waste materials.

Hence, the present investigations were carried out in the College of Forestry, Kerala Agricultural University, Vellanikkara. The overall objective of this study was to determine the effects of two weeks decayed or stored waste materials as component potting media on the survival, growth and vigour of Mahogany seedlings in the nursery and media influence on field. We addressed three specific questions: (1) Did municipal garbage as potting media affect survival and growth of *Swietenia macrophylla* seedlings? (2) Did municipal garbage as potting media affect growth in plantation level of *Swietenia macrophylla*?

MATERIAL AND METHOD

In the present investigation, it is proposed to study the effect of two weeks decayed or stored waste materials as component potting media on the survival rate and field performance of Mahogany seedlings. The experiment was conducted at College of Forestry, Kerala Agricultural University and Vellanikara during the period 2009-2012. The nursery area is located at 40 meters above mean sea level at $10^0$32'N latitude and $76^0$26'E longitude. The area experiences a warm and humid climate with distinct rainy season. Mature mahogany seeds were collected from Mananthavady, Wayanad district. The seeds/pods were brought to the college nursery and dried under partial shade. Seeds/pods were extracted for the study. Seeds were sown in standard nursery beds. Uniform vigorous seedlings were transplanted in polythene bags of 10"x5" size filled with different treatment media and arranged in separate rows in the green house. Watering was done regularly.

The following 7 potting media were prepared by thoroughly mixing the components.

T1 - Soil: Sand: cow dung (1:1:1 ratio- control treatment)
T2- Soil: partially decayed Municipal waste (1:1)
T3 - Soil: partially decayed Coir waste (1:1)
T4- Soil: partially decayed Tea waste (1:1)
T5 - Soil: partially decayed Municipal waste: Sand (1:1:1)
T6 - Soil: partially decayed Coir waste: Sand (1:1:1)
T7 - Soil: partially decayed Tea waste: Sand (1:1:1)

The experiment was laid out in Complete Randomized Block Design (CBD) with three replications. A total of one thousand and fifty seedlings were kept for conducting growth studies. The seedlings after transplanting to the polybags were kept under green house conditions. Necessary plant protection measures were also adopted.

Initial establishment after one week of planting and final survival rate were recorded. The seedlings were kept in 50% shade house about eight months for its proper care and protection from seedling mortality. The height and collar diameter at monthly intervals were collected using scale and digital vernier caliper respectively. An experimental plot was established to study the growth performance of Mahogany seedlings in the field. Field observations were undertaken 70 seedlings planted in Randomized block design at a spacement of 2 x 2 m. Growth in height and diameter of seedlings was taken in the field at monthly intervals up to one year after planting in the field.

Statistical Analysis

Complete Randomized Block experimental design was used for all analyses performed in the experiment. All treatments were replicated four times. Data were analyzed using SPSS (version 20.0, SPSS Institute, Chicago, IL, USA). The shoot height and collar diameter were statistically analyzed using one-way ANOVA with LSD test for multiple comparisons (a=0.05).

RESULT

The observations on the initial survival rate after one week of planting and final survival rate after eight months of planting of the seedlings of mahogany are given below in Fig 1. The survival rate was ranged from 96 per cent to 99 per cent among various treatments studied. Treatment T4 [Soil: partially decayed tea waste (1:1)] and T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] showed 2 to 4 per cent mortality. However, T3 [Soil: partially decayed Coir waste (1:1)] and T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] showed relatively low rate of mortality. Leaf fall and yellowing were more prominent in T4 and T7.

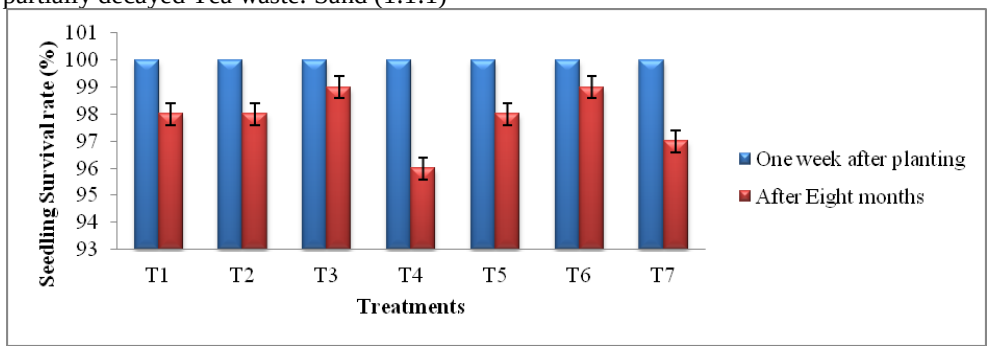

Fig 1. Survival rates of seedlings in different intervals under various treatments of *Swietenia macrophylla* seedlings

Significant variation was observed among various treatments with regard to height of seedlings. However, it was not conspicuous at different intervals up to the end of the study. Treatment T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] recorded the maximum height of 56.10 cm, which was immediately followed by T5 [Soil: partially decayed Municipal waste: Sand (1:1:1)], and T2 [Soil: partially decayed Municipal waste (1:1)]. Whereas treatment T3 [Soil: partially decayed Coir waste (1:1)] showed the lowest value (36.73 cm). It indicated that the influence of potting media on height growth.

Table 1. Height (cm) under different treatments of *Swietenia macrophylla* at monthly intervals in nursery

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	18.42^{b}	16.69^{d}	12.50^{f}	17.44^{c}	16.65^{d}	15.21^{e}	21.90^{a}
Aug	24.75^{d}	25.41^{c}	18.54^{g}	21.82^{e}	26.23^{b}	19.59^{f}	27.13^{a}
Sept	29.46^{d}	32.55^{c}	20.80^{f}	29.52^{d}	34.71^{b}	22.46^{e}	35.86^{a}
Oct	30.92^{e}	37.26^{c}	22.30^{g}	32.79^{d}	38.89^{b}	25.45^{f}	44.57^{a}
Nov	32.80^{e}	38.94^{c}	23.27^{g}	34.07^{d}	42.79^{b}	26.74^{f}	46.02^{a}
Dec	36.98^{d}	41.61^{c}	24.29^{f}	36.61^{d}	46.77^{b}	29.59^{e}	48.00^{a}
Jan	40.24^{d}	46.35^{c}	27.86^{f}	39.60^{d}	49.58^{b}	34.45^{e}	52.74^{a}
Feb	43.72^{d}	48.78^{c}	31.05^{g}	41.87^{e}	52.02^{b}	36.73^{f}	56.10^{a}

** Significant at 0.01 levels
Means with same letter as superscript are homogeneous

Significant variation was also observed among various treatments with regard to collar diameter of seedlings at various months (Table 2). Treatment T1 [Soil: Sand: cow dung (1:1:1)] recorded maximum collar diameter (9.35 mm) at the end of the study. Treatment T4 [Soil: partially decayed Tea waste (1:1)] was on par with treatment T5 [Soil: partially decayed Municipal waste: Sand (1:1:1)]. Treatment T3 [Soil: partially decayed Coir waste (1:1)] recorded lowest value (5.97 mm) in collar diameter. With regards to the advancing intervals, significant variation was observed among treatments at the end of the study period when compared to the initial phase.

Table 2. Mean diameter (mm) under different treatments of *Swietenia macrophylla* at monthly intervals in nursery

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	2.38^{d}	2.61^{b}	2.01^{e}	2.41^{d}	2.47^{c}	2.40^{d}	2.68^{a}
Aug	3.68^{b}	3.73^{b}	2.70^{e}	3.88^{a}	2.93^{d}	2.80^{de}	3.48^{c}
Sept	5.01^{b}	5.86^{a}	3.85^{f}	4.14^{e}	5.89^{a}	3.39^{d}	4.64^{c}
Oct	6.00^{b}	6.13^{a}	4.27^{d}	5.59^{c}	6.13^{a}	4.16e	6.10^{ab}
Nov	6.27^{b}	6.63^{a}	4.74^{c}	6.12^{b}	6.72^{a}	4.65^{c}	6.65^{a}
Dec	6.69^{c}	7.40^{a}	5.34^{e}	7.07^{b}	7.50^{ab}	5.65^{d}	7.28^{a}
Jan	8.36^{b}	7.88^{c}	5.85^{e}	8.15^{bc}	8.13^{bc}	6.39^{d}	8.69^{a}
Feb	9.35^{a}	8.20^{b}	5.97^{d}	8.33^{b}	8.46^{b}	6.77^{c}	9.02^{a}

** Significant at 0.01 levels
Means with same letter as superscript are homogeneous

Performance of sapling planted in field revealed significant difference in height due to the effect of various potting media. The availability of nutrients in growing substrate greatly affects the growth of seedlings. With regards to height, the maximum performance (155.62 cm) was registered in T2 [Soil: partially decayed Municipal waste (1:1)] at the end of study period (Table 3) and the least (59.75 cm) height occurred in T6 [Soil: partially decayed Coir waste: Sand (1:1:1)]. With regards to the height of the seedlings in the field, it increased from 75.59 (T3) to 155.61 (T2) at the end of the study. In the case of height, the treatment with maximum height in the beginning did not show the maximum height at the end of the study. In general increase in height at different intervals was not significant up to the end of the study i.e. 12 months.

Table 3. Height (cm) under different treatments of *Swietenia macrophylla* at monthly intervals in plantation

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	60.38^{bc}	60.17^{bc}	47.39^{a}	64.17^{c}	62.17^{bc}	51.67^{ab}	70.63^{c}

May	66.83^{b}	64.67^{b}	48.99^{a}	69.42^{b}	64.33^{b}	52.00^{a}	69.42^{b}
June	68.86^{b}	76.32^{b}	50.37^{a}	73.12^{b}	65.92^{b}	52.50^{a}	72.92^{b}
Jul	74.03^{bc}	84.24^{c}	52.63^{a}	78.43^{bc}	67.50^{b}	53.17^{a}	73.72^{bc}
Aug	77.77^{bc}	92.49^{c}	53.67^{a}	84.82^{bc}	69.50^{b}	53.83^{a}	74.55^{b}
Sept	81.90^{bc}	104.92^{d}	54.92^{a}	94.90^{cd}	70.50^{bc}	54.33^{a}	75.25^{b}
Oct	85.98^{bc}	110.80^{d}	55.83^{a}	99.42^{cd}	71.58^{ab}	54.83^{a}	76.26^{ab}
Nov	90.98^{bc}	112.90^{c}	57.33^{a}	104.08^{c}	72.98^{ab}	55.50^{a}	72.98^{ab}
Dec	95.48^{bc}	116.27^{c}	65.42^{a}	109.53^{c}	74.00^{ab}	56.17^{a}	79.25^{ab}
Jan	99.62^{bc}	126.91^{d}	67.48^{a}	114.39^{cd}	75.58^{ab}	57.50^{a}	80.25^{ab}
Feb	103.92^{bc}	142.44^{d}	71.07^{a}	128.55^{cd}	76.50^{ab}	58.50^{a}	84.00^{ab}
March	107.12^{c}	155.62^{d}	75.59^{ab}	140.51^{d}	78.58^{ab}	59.75^{a}	89.15^{bc}

** Significant at 0.01 levels
Means with same letter as superscript are homogeneous

The collar diameter was reported in the range of 5.5 mm to 30.1 mm. A greater collar diameter (14.2) was recorded for T2 [Soil: partially decayed Municipal waste (1:1)] and lowest values of collar diameter (5.5) was reported for T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] at the beginning of the field performance (Table 4). The treatment with maximum collar diameter (30.1) T4 [Soil: partially decayed Tea waste (1:1)] and least (13.3) value recorded for T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] at the end of study period. There was no significant increase in collar diameter at different intervals from the beginning to the end of the study.

Table 4. Mean diameter (mm) under different treatments of *Swietenia macrophylla* at monthly intervals in plantation

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	12.4^{c}	14.2^{c}	9.0^{b}	12.4^{c}	7.8^{ab}	5.5^{a}	7.5^{ab}
May	13.3^{c}	15.0^{c}	9.5^{b}	14.0^{c}	8.4^{ab}	5.9^{a}	8.6^{ab}
June	13.9^{c}	16.0^{c}	10.2^{b}	15.8^{c}	9.4^{b}	6.1^{a}	9.5^{b}
Jul	14.7^{c}	17.1^{c}	10.9^{b}	17.8^{c}	10.4^{b}	6.8^{a}	10.6^{b}
Aug	15.2^{c}	18.4^{cd}	11.3^{b}	18.9^{d}	11.2^{b}	7.3^{a}	11.3^{b}
Sept	15.8^{c}	19.2^{cd}	11.7^{b}	19.7^{d}	11.9^{b}	8.2^{a}	12.2^{b}
Oct	16.7^{cd}	20.2^{de}	12.4^{ab}	21.5^{e}	13.9^{bc}	9.1^{a}	12.9^{abc}
Nov	17.2^{c}	21.9^{d}	13.0^{ab}	23.1^{d}	14.5^{bc}	10.0^{a}	13.8^{abc}
Dec	17.5^{b}	23.2^{c}	13.3^{ab}	25.3^{c}	15.0^{ab}	10.7^{a}	14.2^{ab}
Jan	18.2^{b}	24.1^{c}	13.7^{a}	27.1^{c}	15.3^{ab}	11.6^{a}	14.7^{ab}
Feb	19.1^{b}	25.4^{c}	14.0^{a}	29.2^{c}	15.7^{ab}	12.4^{a}	15.4^{ab}
March	20.1^{b}	26.4^{c}	14.4^{a}	30.1^{c}	16.3^{ab}	13.3^{a}	16.0^{ab}

** Significant at 0.01 levels
Means with same letter as superscript are homogeneous

The increment percent calculated for the growth in height and diameter in nursery level at the end of the study. The availability of nutrients in growing substrate greatly affects the growth of seedlings. With regards to height and diameter increment at nursery level after eighth month showed the maximum increase was in T7 (28.32 per cent) and -3.53 per cent as compared to the control (T1) (Fig 2). The least (-28.98 and -36.15 %) height and collar diameter respectively was registered in T3.

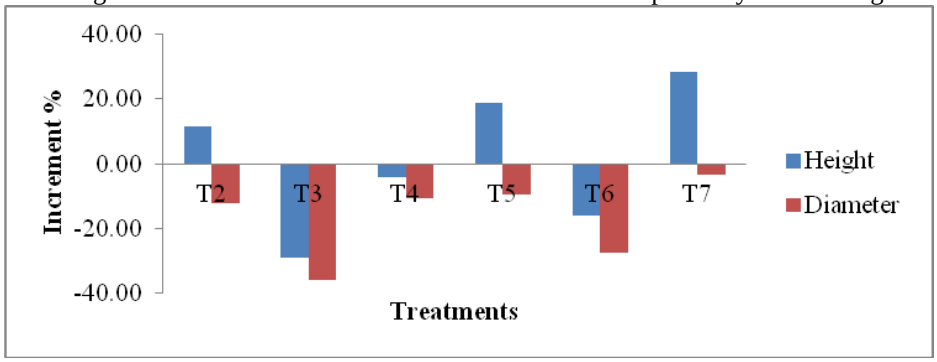

Fig 2. Increment percentage in height and collar diameter under different treatments of *Swietenia macrophylla* in the nursery

The increment percent was also calculated for the growth in height and diameter in plantation level at the end of the study. It indicated that maximum increment per cent in the plantation was recorded in T2 (45.28) and T4 (49.55) for height and diameter respectively. The least increment was observed in T6 (-44.22 and -33.83) respectively for height and diameter as compared with control (T1) (Fig 3).

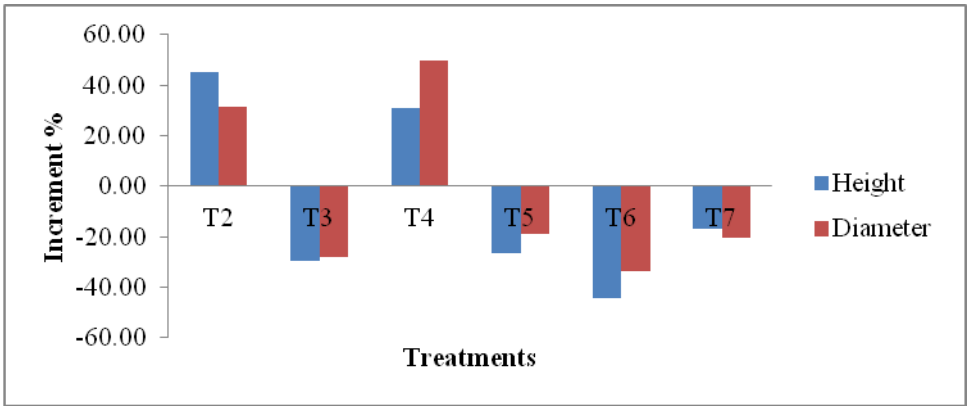

Fig 3. Increment percentage in height and collar diameter under different treatments of *Swietenia macrophylla* in plantations

DISCUSSION

Disposal of solid waste has a major problem in the country, especially in Kerala as the availability of land fill sites have diminished and requirements for making landfills environmentally acceptable have driven up the costs substantially. Reuse of organic wastes in agriculture holds promise in general, since they offer a locally available fertility resource, and their removal provides an effective and environmentally acceptable option of waste disposal. The present study investigates the effect of municipal garbage and industrial waste as a component of potting media on the growth and vigour of mahogany in nursery as well as in the field.

Partially decomposed municipal garbage and Industrial waste when used as a component potting media were not significantly influenced the survival rate of seedlings. Survival of seedlings was ranged from 95 to 100 per cent. Survival was found maximum in both treatments T2 [Soil: partially decayed Municipal waste (1:1)] and T3 [Soil: partially decayed Coir waste (1:1)]. It could be stated that survival rate was directly proportional to the period of decomposition of garbage. Gopikumar *et al.* (2002) have conducted a study to find out the effect of garbage and coir dust on establishment and growth of seedlings of *Tectona grandis*, *Ailanthus triphysa* and *Albizia falcataria*. The study revealed seedlings when planted in potting media of soil: sand: cowdung and soil: coir: dust recorded 100 per cent success with regard to both initial establishment and final survival rate. Gopikukar, (2009) reported the potting media containing municipal garbage, initial establishment were found to be good in *Dalbergia latifolia*.

A balanced rooting medium that contains an adequate supply of nutrients is essential for plants to attain maximum growth and development. Balanced rooting media greatly affects the plant height and availability of growing substrate with the supplement of essential nutrients is essential for attaining maximum plant height (Ikram *et al.* 2012). It was observed from this experiment that, compared to other media, municipal garbage should be considered high ranking as a potting medium for plant height. Results showed that coconut coir waste, tea waste alone and in combination with soil contributed to produce maximum plant height. Plant height is also greatly affected by the environment, especially root medium. Results indicated that using different substrates in differing proportion as potting mix had different effects on plant height. With regards to height, maximum value was recorded by treatment T7 [Soil: partially decayed Tea waste: sand (1:1:1)] in mahogany. This is in agreement with the findings of other research trials as represented by Adersh (2001) in teak. Similar results were also observed from the studies of Herrera *et al.* (2008), Mehmood *et al.* (2013), Ribeiro *et al.* (2000), Sharifian *et al.* (2014), Tariq *et al.* (2012) and Wilson *et al.* (2002). Reported that addition of cowdung can improve soil physical propertied and also nutrient availability and this may be the probable reason for the better growth of seedlings in potting media containing cowdung (Adersh, 2001). Treatment with sand and coir pith (T3) represented lowest height. Vidyasagran *et al.*, 2014 reported the use of mixture of soil, sand and municipal garbage can optimizes the quality of mahogany seedlings in nursery.

Plants exhibiting maximum stem diameter with strong vigor can be used successfully. Collar diameter of the seedlings at end of the study revealed a different response to various potting media applied. Here maximum values were registered in both treatment T1 [Soil: Sand: cow dung (1:1:1 ratio-control treatment)] and T2 [Soil: partially decayed Municipal waste (1:1)]. However minimum collar

diameter was recorded in treatment T3 for mahogany. Addition of coir waste to soil proved less influence on collar diameter and height. Sharifian *et al.* (2014) have noticed greater shoot weight of sugar maple seedlings when grown in green house medium. The nutrient content in the potting media have a high effect in the growth increment in seedlings. The partly decomposed garbage has high nutrient content and air space for the conduction of air and water. It may the reason for the increment in the growth. Similar observations were reported by many research trials. Mohan *et al*. (1991) have reported that a combination of soil, sand and FYM in the ratio 1:1:1 increased the height and dry matter production of seedlings of *Swetenia macrophylla* and *Dalbergia latifolia*. Gopikumar, (2009) reported *Dalbergia latifolia* showed a positive response on growth and vigour in terms of shoot growth parameters were found to be most promising when the seedlings were grown in potting media containing 4 weeks decomposed municipal garbage and soil: sand: cowdung.

The use of garbage waste for the preparation of potting media provides plants with significant quantities of essential nutrients, which should be taken into account in fertirrigation. This is an important result, in economic term, the production of quality seedlings were ensured, the cost of production may be decreased and the reduction in environmental pollution. The study revealed that the use of garbage with soil can provide high seedling survival rate for *Swietenia macrophylla*, good drainage, water holding capacity, aeration and optimum nutrient, ultimately lead to the production of good stoke and mitigate environmental pollution. The experimental trial in plantation showed, there was no significant effect for the potting media.

CONCLUSION

Urban waste materials are not always adequately used in current commercial, afforestation practices, such as nurseries, despite the possible immediate benefits from using them, especially if they are readily available and less expensive than traditional substrates like peat, vermiculite etc. This work shows that the utilization of municipal garbage as potting media at nurseries has proven to be a useful procedure to obtain suitable growing media for the propagation of commercially important tree species *Swietenia macrophylla* (Mahogany) seedlings, which are frequently used for afforestation in tropics. In general, plant growth and nutrition were enhanced by using the municipal solid waste-based compost for this purpose. The use at nursery of this kind of domestic refuse could contribute to solve two important problems: waste disposal (which is becoming a serious problem in many countries) and limit in ecological problems (mining for sand and peat).

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MICROPROPAGATION OF AN ENDANGERED MEDICINAL HERB *OCIMUM CITRIODORUM* VIS.

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Abstract: An efficient protocol has been developed for rapid micropropagation of *Ocimum citriodorum* Vis., an endangered medicinal herb. The cotyledons were excised from the *in vitro* germinating seedlings and used as explants for the present study. The explants yielded the highest frequency of 87.49% shoot regeneration with an average shoot length of 4.98 cm on Murashige and Skoog (MS) medium supplemented with 1 mg l^{-1} 6- benzylamino purine (BAP) + 0.1 mg l^{-1} napthalene acetic acid (NAA) + 500 mg l^{-1} casein hydrolysate (CH) + 25 mg l^{-1} adenine sulphate (AS). Alteration from the optimal concentration of BAP resulted in the formation of callus. Regenerated microshoots were separated and rooted on MS medium containing NAA (0.5 mg l^{-1}). Well-developed complete plantlets were transferred onto plastic cups containing sterile soil and humus (1:1). Subsequently the acclimatized plantlets were successfully grown in garden. The regenerated plants were morphologically identical and exhibited similar growth characteristics as compared to the donor plants. Cytological studies of the regenerants revealed no change in chromosome numbers. Thus, regeneration protocol demonstrated in the present study provides a basis for the germplasm conservation and investigation of its medicinally active constituents.

Keywords: Cotyledonary explant, cytology, histological observations, *ocimum citriodorum*

INTRODUCTION

Ocimum citriodorum Vis. (Lemon basil) belongs to the family Lamiaceae, is rich in aromatic essential oils and valuable for its medicinal, volatile and culinary properties (Venugopal and Rao, 2011). It is a hybrid between basil (*Ocimum basilicum*) and African Basil (*Ocimum americanum*) (Janarthanam and Sumathi, 2012). Lemon basil grows upto 20-40 cm in height. It flowers in late summer to early fall and bears white flowers. Its leaves are similar to basil leaves, but narrower. Seeds form on the plant after flowering and dry on the plant itself. Lemon basil is a popular herb in Arabian, Laotian, Persian and Thai cuisine. It is primarily grown in Northeastern Africa and Southern Asia, for its strong lemon fragrance in cooking and in the preparations of antioxidant tea bags (Janarthanam and Sumathi, 2012). It is helpful to ease the people suffering from early ejaculation, late menstruation, breast milk, works as a gas cleanser in the human body, helpful in removing fever (Epriliati and Ginjom, 2012) and inhibits hepatocarcinogenesis (Tripathi, 2011).

Ocimum plants possess essential oil, which contains biologically active constituents that are insecticidal, nematicidal, fungistatic, antimicrobial or antioxidant (Janarthanam and Sumathi, 2012). These properties can be attributed to the predominant essential oil constituents, such as estragol, eugenol, linalool, citral and 1-8, cineole (Stanko *et al.*, 2010a). It was observed that essential oil obtained from the lemon basil inhibits the growth of *Staphylococcuss aureus*. Its essential oil is effective against many other food borne pathogenic bacteria also such as, *Enterococcus faecalis, Enterococcus faecium, Proteus vulgaris* and *Staphylococcus epidermis* (Stanko *et al.*, 2010a).

The conventional method for the propagation of *Ocimum species* is through seed germination and stem cuttings. However, poor germination of the seeds (< 10%) due to season dependency (Saha *et al.*, 2014) and susceptibility to seedling blight and root rot diseases (Siddiqui and Anis, 2009) as well as unusually longer time (28 days or more, Sulistiarini, 1999) required for the rooting from stem cuttings, restricts its multiplication. Therefore, it is necessary to develop an *in vitro* rapid and reproducible protocol for the large scale production of such medicinally important plant (Venugopal and Rao, 2011). Ideally, the medicinal plants should have the same genetic make-up as of the selected high-yielding clones. As seedling progeny of *Ocimum* shows variability due to cross pollinating nature of the plant (Gopi *et al.*, 2006), the *in vitro* micropropagation could prove an effective tool for obtaining the species with high progeny uniformity (Asghari *et. al*., 2012). *In vitro* plant regeneration of *Ocimum citriodorum* from leaf (Venugopal and Rao, 2011) and nodal segment (Venugopal and Rao, 2011; Janarthanam and Sumathi, 2012) have been reported earlier. Janarthanam and Sumathi (2012) reported that the highest percentage of shoot formation with maximum number of shoots per culture was obtained from the nodal explants of *O. citriodorum* on Murashige and Skoog (1962) medium augmented with 1 mg l^{-1} BAP and 0.025 mg l^{-1} indole acetic acid (IAA) and rooting of the shoot was accomplished when 0.5 mg l^{-1} indole butyric acid (IBA) was alone present with the basal medium (Janarthanam and Sumathi, 2012). Venugopal and Rao (2011) reported that the higher frequency of shoot formation was obtained from leaf and nodal explants in MS medium containing BAP and IBA. However, to date, there is no report on *in vitro* studies of *O. citriodorum* through cotyledonary

explant. The present study is the first report to describe a simple, rapid, reproducible, economical and high frequency regeneration protocol for the *in vitro* micropropagation of *O. citriodorum* using cotyledonary explants and the subsequent establishment of these plants in soil.

MATERIAL AND METHOD

Plant material and culture conditions

Seeds of *O. citriodorum* were collected from the two year old plants growing in the beds of Botanical garden of University of Delhi, Delhi, India. These seeds were cleaned thoroughly under running tap water, followed by washing with teepol detergent solution and then with sterile distilled water. The cleaned seeds were surface sterilized with 0.2% (w/v) mercuric chloride ($HgCl_2$) for 5 min and finally the traces of sterilant were removed by repeatedly washing in sterile distilled water. All subsequent operations were carried out in a laminar air flow chamber. Thereafter, seeds were germinated on MS (1962) medium supplemented with 3% sucrose and solidified with 0.8% agar. No plant growth regulators (PGRs) were added. The seeds were incubated for 1 month and cotyledons excised from these aseptically germinating seedlings were used as explants.

The explants were cultured on MS medium supplemented with one of the four cytokinins namely, BAP, kinetin (Kn), thidiazuron (TDZ) and N^6- (- 2 isopentenyl) adenine (2iP) at different concentrations (0.5, 1.0, 1.5, 2.0 mg l^{-1}) with their adaxial face in contact with the culture medium. The best PGR for the shoot regeneration was determined based on the regeneration rate. After selecting BAP as the best PGR for direct shoot regeneration, further experiments were carried out to assess the influence of NAA, CH and AS on the shoot regeneration. All plant growth regulators were obtained from Sigma Aldrich (USA). Salts and other chemicals were obtained from Qualigens, Glaxo and SRL, Mumbai (India). Sucrose (3%, w/v) as carbon source was added to the media. The pH of the medium was adjusted to 5.8 using 0.1 N NaOH or 0.1 N HCl. Approximately, 20 ml media was dispensed in each 150 × 25 cm test tubes (Borosil, India), plugged with non absorbent cotton wrapped in two-layered muslin cloth and sterilized by autoclaving at 1.06 kg cm^{-2} at 121℃ for 15 min. The cultures were maintained on continuous light emitted from fluorescent incandescent tubes (40 W, Phillips, Kolkata, India) for 16 h light followed by 8 h dark period in a culture room at 25 ± 2℃ temperature with a relative humidity of 55 ± 5 %.

Rhizogenesis and acclimatization of regenerated plantlets

Occasional rooting was observed in shoot proliferation cultures that were left for over 5 weeks. However, for proper rooting the microshoots with 4-6 leaves (2-3 cm) were harvested and transferred to hormone free MS medium for 2 weeks to eliminate any carry over effect of cytokinins (Shibli *et al.*, 1997). Elongated shoots (about 4-5 cm in length) were then carefully transferred to the MS medium supplemented with NAA (0.1-1.0 mg l^{-1}), IBA (0.1-1.0 mg l^{-1}) and IAA (0.1-1.0 mg l^{-1}). MS basal medium was used as control. Cultures were incubated under the same conditions as mentioned above.

Well developed plantlets were carefully removed and washed thoroughly in running tap water to remove agar. Further, they were treated with 1% bavistin (BASF, Mumbai, India) solution to prevent any fungal infection. Thereafter, they were transferred to plastic pots (5 cm diameter) containing autoclaved soil: humus (1:1). Subsequently, acclimatization was achieved by covering the plastic pots with polythene bags to maintain the humidity. The plants were irrigated with one-tenth of MS basal salt solution devoid of sucrose and inositol. After 1 week, 3-5 holes were made in polythene bags and plants were irrigated after every 4 days. The potted plants were maintained in the culture room. After 45 days, the plantlets were transplanted to earthen pots (25 cm diameter) containing garden soil. They were kept under shade in a net house for another 2-3 weeks before being transferred to field for developing into mature plants. Pre-acclimatization or gradual plant exposition to external environment could contribute to the future survival of the plant under greenhouse conditions (Dibax *et al.*, 2010).

Recording of data and statistical analysis

The morphogenetic response of explants were evaluated after 6 weeks of culture in terms of (i) shoot inducing frequency of explants, (ii) average number of shoots per explants and (iii) average shoot length per explant. The following parameters were considered for the rhizogenesis: (i) root inducing frequency of shoots, (ii) average number of roots per shoot and (iii) average root length. For *in vitro* regeneration, the shoot inducing frequency of explants, the average shoot length, root inducing frequency of shoots and average root length has been represented as mean values along with standard error (mean ± SE). The mean values were calculated on the basis of a minimum of 12 replicates and each experiment was repeated twice. The data expressed as mean ± SE was statistically analyzed using ANOVA (Analysis of Variance) through SPSS (Statistical Package for Social Sciences) version 16.0. The differences between means were tested for significance by Duncan's multiple range test (DMRT) at p=0.05.

Histological studies

For histological observations regenerating explants were excised and fixed in a mixture of formalin: acetic acid: ethanol (1:1: 16) for 24 h following dehydration in an ethanol/ xylene series.

The material was infiltrated and embedded in paraffin wax. Sections were cut on a rotary microtome at 7-8µm thickness, dried onto slides, dewaxed in xylene and rehydrated in a descending ethanol series. Sections were stained with fast green and counter stained with safranin. Slides were observed under a Zeiss, Primo Star Microscope (Carl Zeiss Micro Imaging GmbH, Gottingen, Germany) and suitable sections were photographed using a Canon – G10 digital camera.

Scanning Electron Microscopy

To support the findings of *in vitro* studies scanning electron microscopy was also performed for the *in vitro* regenerated plantlets. Samples were fixed for 24 h with Karnowfsky's fixative and stored in 0.1M phosphate buffer (pH- 7.2). The tissues were critical point dried and sputter coated with gold. Observations and photographs were made on Leo-435 VP variable pressure scanning electron microscope (Co-operation Zeiss- Leica).

Cytological examination of mother plant and regenerants

To determine the chromosome number of the regenerants the root tips were collected. The root tips were pre-treated with ice for 24 h at 4℃. They were fixed in freshly prepared Carnoy's solution (alcohol: acetic acid= 3:1) for 24 - 48 h and stored in 70% (v/v) ethanol at 4℃ (Wang *et al.,* 2012). Fixed root tips were subsequently washed 3-4 times with distilled water and hydrolyzed in 1M HCl for 10 min at 60℃ and then rinsed in distilled water (Mohammad *et al.,* 2013). Subsequently root tips were stained with Feulgen stain for 1 hr. After washing, tips were immersed in aceto-carmine and squash preparations were made for the cytological studies. Cytogenetic examination and chromosome counting were carried out with a Zeiss, Primo Star Microscope equipped with a Canon – G10 digital camera (Carl Zeiss Micro Imaging GmbH, Gottingen, Germany). The chromosome numbers of the regenerants were compared with that of mother plant to prove that they are genetically similar to their parent.

RESULT

Shoot induction and elongation

In order to establish an efficient *in vitro* regeneration protocol for the commercial exploitation of this important endangered herb, the explants were excised from the aseptically germinating seedlings (Fig.1e). The explants were inoculated on MS basal medium as well as medium supplemented with various concentrations (0.5, 1.0, 1.5, 2.0 mg l^{-1}) of cytokinins (BAP, Kn, TDZ, 2iP). The explants cultured on the MS basal medium, enlarged in size and became necrotic after 2 weeks of inoculation. Addition of cytokinin was essential for differentiation of multiple shoots. Of the four cytokinins tested BAP was found to be the best for the induction of shoots followed by 2iP, TDZ and Kn (Table 1). On MS media containing BAP (1 mg l^{-1}), the explants initially enlarged from its original size after 6 days of inoculation (Fig. 2a) followed by the appearance of protuberances like structure. Such structures differentiated into shoot buds and subsequently gave rise to shoots on the same media composition without an intervening callus phase after 3-4 weeks of inoculation (Fig. 2b). On altering the concentration of BAP from the optimal level, calli were produced. In order to enhance the morphogenic response, NAA was incorporated in the MS medium with optimum concentration of BAP. Significant increase in shoot production was observed (62.49%), when NAA was added to the medium at low concentration (0.1 mg l^{-1}), suggesting a synergistic effect of NAA on shoot proliferation (Table 2). Higher concentration of NAA (above 0.1 mg l^{-1}) in the medium resulted in the production of callus. A remarkable threefold increase in morphogenic response could be achieved (Table 2) when adenine sulphate and casein hydrolysate were incorporated in MS medium with BAP and NAA. Thus the maximum shoot regeneration frequency (87.49 %) was observed on MS medium containing BAP (1 mg l^{-1}) + NAA (0.1 mg l^{-1}) + CH (500 mg l^{-1}) + AS (25 mg l^{-1}) with an average of 6.04 shoots per explant having an average shoot length of 4.98 cm after 4-5 weeks of culture (Table 2 and Fig. 2b- g).

Fig. 1 (a-e): A schematic presentation of the cotyledonary explants from seedling of *O. citriodorum*: (a) An inflorescence of the mother plant from which seeds were collected; (b) Seeds on the MS basal medium; (c) Germinating seedlings after 2 weeks of inoculation; (d) Explant as it looks before excision from the seedling; (e) Excised cotyledonary explant (CE)

Table 1: Effect of different concentrations of cytokinins on multiple shoot induction from the cotyledonary expalnts of *Ocimum citriodorum*

Plant growth regulators (mg l^{-1})		**No. of cultures forming shoots (%)**	**No. of shoots/ explant**	**Shoot length (cm)**
BAP	0.5	0a	0a	0a
	1.0	29.16c	4.0 ± 0.0de	3.78 ± 0.31cde
	1.5	0a	0a	0a
	2.0	0a	0a	0a
Kn	0.5	0a	0a	0a
	1.0	0a	0a	0a
	1.5	20.83bc	4.41 ± 0.12e	4.20 ± 0.50e
	2.0	16.66bc	3.83 ± 1.17abc	3.65 ± 0.21bcd
TDZ	0.5	24.99bc	2.75 ± 0.35b	3.82 ± 0.03de
	1.0	12.49ab	2.75 ±0.35b	3.45 ± 0.21bcd
	1.5	20.83bc	3.41 ± 0.12cde	3.62 ± 0.45bcd
	2.0	0a	0a	0a
2iP	0.5	0a	0a	0a
	1.0	16.66bc	3.0 ± 0.70bc	3.30 ± 0.07bc
	1.5	20.83bc	3.0 ± 0.00bc	3.40 ± 0.28bcd
	2.0	25.00bc	2.83 ±0.24b	3.24 ± 0.16b

Mean values in a column followed by different letters are significantly different as determined by SPSS at p = 0.05 according to DMRT

Table 2: Effect of CH and AS on multiple shoot induction from the cotyledonary explants of *Ocimum citriodorum* in the MS medium containing optimum concentration of BAP and NAA.

Plant growth regulators (mg l^{-1})				No. of cultures forming shoots (%)	No. of shoots /explants	Shoot length (cm)
BAP	NAA	CH	AS			
1.0	0.1	-	-	62.49a	4.16±0.57a	4.03±0.19a
1.0	0.1	500	25	87.49b	6.04±0.06b	4.98±0.00b
1.0	0.1	700	50	79.16ab	5.95±0.007b	4.66±0.07b

Mean values in a column followed by different letters are significantly different as determined by SPSS at p = 0.05 according to DMRT

Root induction and acclimatization of plantlets

The *in vitro* induced shoots were placed on MS basal medium as well as on the medium supplemented with auxins (IBA, IAA and NAA) at various permutation and combinations. Shoot failed to produce roots in the MS basal medium. No significant results were obtained in the MS medium supplemented with different concentrations (0.1 – 1.5 mg l^{-1}) of IBA and IAA (data not shown).However, root primordial emerged from the base of shoots after 2 weeks of transfer on MS medium supplemented with NAA (0.5 mg l^{-1}) (Fig. 2h). A maximum of 87.49% shoots induced an average of 6.04 roots with an average root length of 4.77 cm after 3-4 weeks of transfer on MS medium augmented with NAA (0.5 mg l^{-1}) (Table 3 and Fig. 2i, j). Higher concentration of NAA drastically reduced the root inducing frequency (Table 3). Plantlets with well developed shoots and roots were removed from the culture tubes, thoroughly washed and transferred to the thermo cups containing sterile soil and humus (1:1) (Fig. 2k). The plants were hardened by following the procedure stated in material and methods and subsequently transferred to the garden soil under natural environment (Fig. 2l). About 95% survival frequency was observed for the *in vitro* regenerated plantlets. The plants were green, healthy and phenotypically similar to the mother plant.

Table 3: Effect of different concentrations of NAA on root induction from the microshoots obtained from the cotyledonary explants of *Ocimum citriodorum*

Concentration of NAA (mg l^{-1})	No. of cultures forming roots (%)	No. of roots/ microshoot	Root length (cm)
0.1	16.66a	1.25±0.25a	1.20±0.10a
0.5	87.49c	6.04±0.20c	4.77±0.04d
1.0	41.66b	3.20±0.20b	4.21±0.07c
1.5	20.83a	1.80±0.37a	3.18±0.09b

Mean values in a column followed by different letters are significantly different as determined by SPSS at p = 0.05 according to DMRT

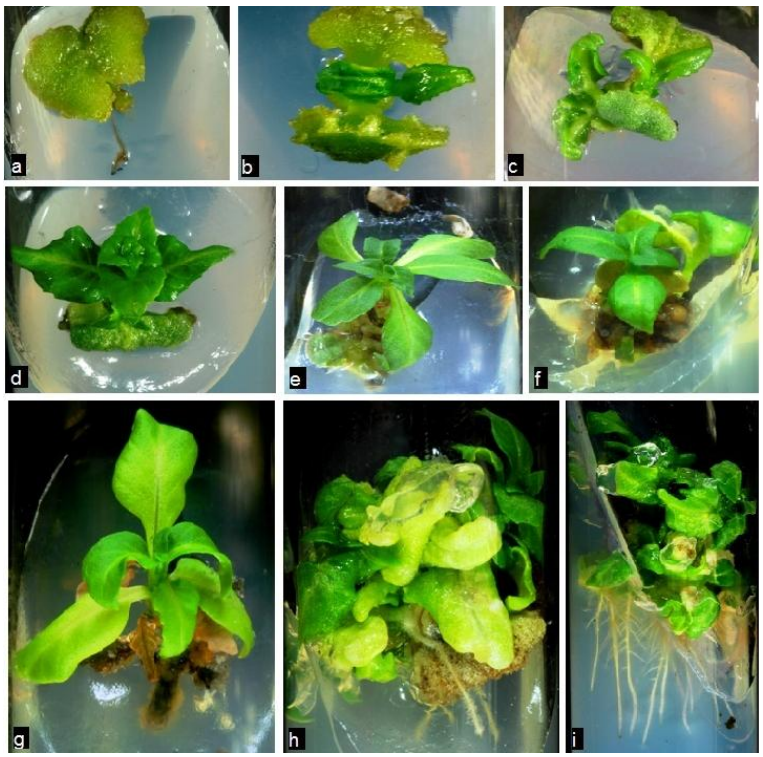

Fig. 2 (a-l): Direct organogenesis through cotyledonary explants of *O. citriodorum:* (a) Enlargement of the explant after 5 days of inoculation on the MS medium containing BAP (1 mg l^{-1}); (b) Initiation of shoot formation after 2 weeks of inoculation on the MS medium containing BAP (1 mg l^{-1}) + NAA (0.1 mg l^{-1}) + CH (500 mg l^{-1}) + AS (25 mg l^{-1}); (c) Differentiation of multiple shoots after 2-3 weeks of inoculation; (d) Enhanced shooting after 3-4 weeks of culture on the same medium; (e) Excised single shoot growing well on the same medium composition after 1 week of subculture; (f) Rapid proliferation and multiplication within 2 weeks; (g) Elongation of shoot after 3 weeks; (h) Root induction from the excised shoots after 2-3 weeks of transfer on the MS medium containing NAA (0.5 mg l^{-1}); (i) Profuse rooting after 3-4 weeks of transfer on the root induction medium; (j) Plantlet showing healthy shoots and roots just before hardening; (k) 1 month old *in vitro* regenerated plant proliferating in the pot containing sterile soil: humus (1:1); (l) Tissue culture raised plants well established in the field after 3 months of transfer

Histological observations

Histological studies were carried out during a period of two week culture to analyse the regeneration process. During the first two days no clear histological changes were detectable (Fig. 3a). The first visible changes thereafter consisted of the setting of a cell differentiation process in the epidermal and sub-epidermal layers of the explants. Epidermal cells divided periclinally and anticlinally producing both further epidermal cells and a new subepidermal layer (Fig. 3b). This process led to the formation of clusters of smaller daughter cells that differed from the mother ones by their thinner wall and densely stained nuclei and cytoplasm. These particular cell clusters formed meristemoids (M) (Fig. 3b). The arrangement of cells in these bulges, their shape, size and development of tracheary elements (Te) (Fig. 3b) suggested that these were the site of origin of shoot primordia. After 1 week of culture, formation of shoot bud (Sb) with leaf primordial (lp) was observed (Fig. 3c). A transverse section of 2 weeks old culture showed shoot bud (Sb), first leaf primordial (lp1) and second leaf primordial (lp2) with bulges of midrib (mr) (Fig. 3d).

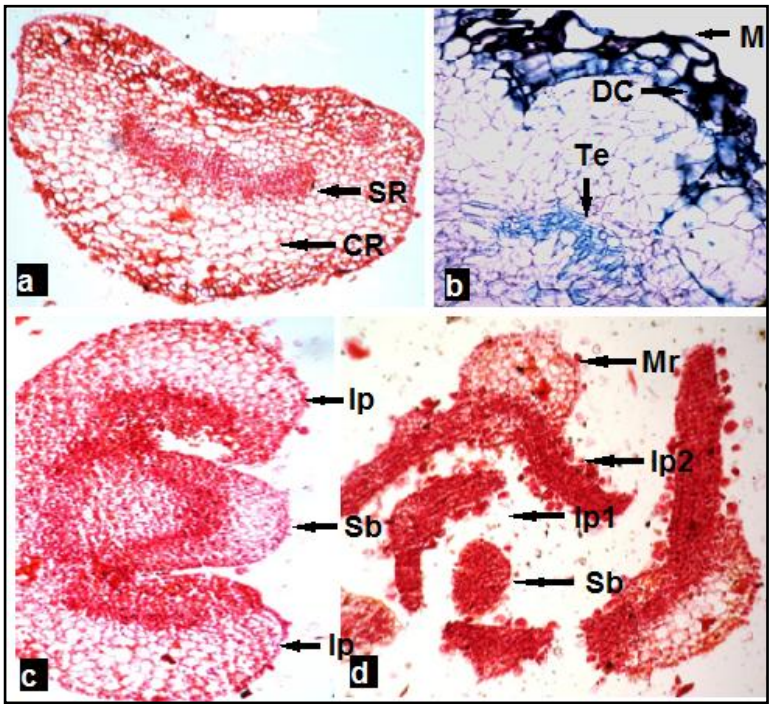

Fig. 3 (a-d): Histological evidences of regeneration of complete plantlet from cotyledonary explants of *O. citriodorum*: (a) Cotyledonary leaf explants freshly prepared from 5 day old seedling showing stellar region (SR) and cortical region (CR); (b) High magnification of 3 days old culture showing the presence of dedifferentiated cells (DC) in the epidermal and sub-epidermal tissues, initiation of formation of first meristemoids (M) and tracheary element (Te); (c) Longitudinal section of 1 week old culture showing shoot bud (Sb) and leaf primordial (lp); (d) Transverse section of 2 week old culture showing shoot bud (Sb), first leaf primordium (lp1), second leaf primordium (lp2) with bulges of midrib (mr)

Scanning Electron Microscopy (SEM)

SEM observations of the regenerating explant revealed typical shoot formation with an apex and shoot primordia. The shoot primordium was covered by epidermis, built of more or less equal sized cells. Shoot bud formation was initiated from the explants as small nodular outgrowth without any apparent callus stage. This developing outgrowth eventually led to the formation of shoot buds (Fig. 4b).The formation of buds of different size could be observed in the developmentally active region of the cotyledonary explants, thus documenting that they have the much sought after potential for *in vitro* plant regeneration ability in this plant species. On the surface of the regenerated leaf, glandular trichomes were observed (4c). The trichomes consisted of a stalk cell, a neck cell and a pear shaped secretory cell (capitate type II). Thus, these observations confirmed the results of *in vitro* studies.

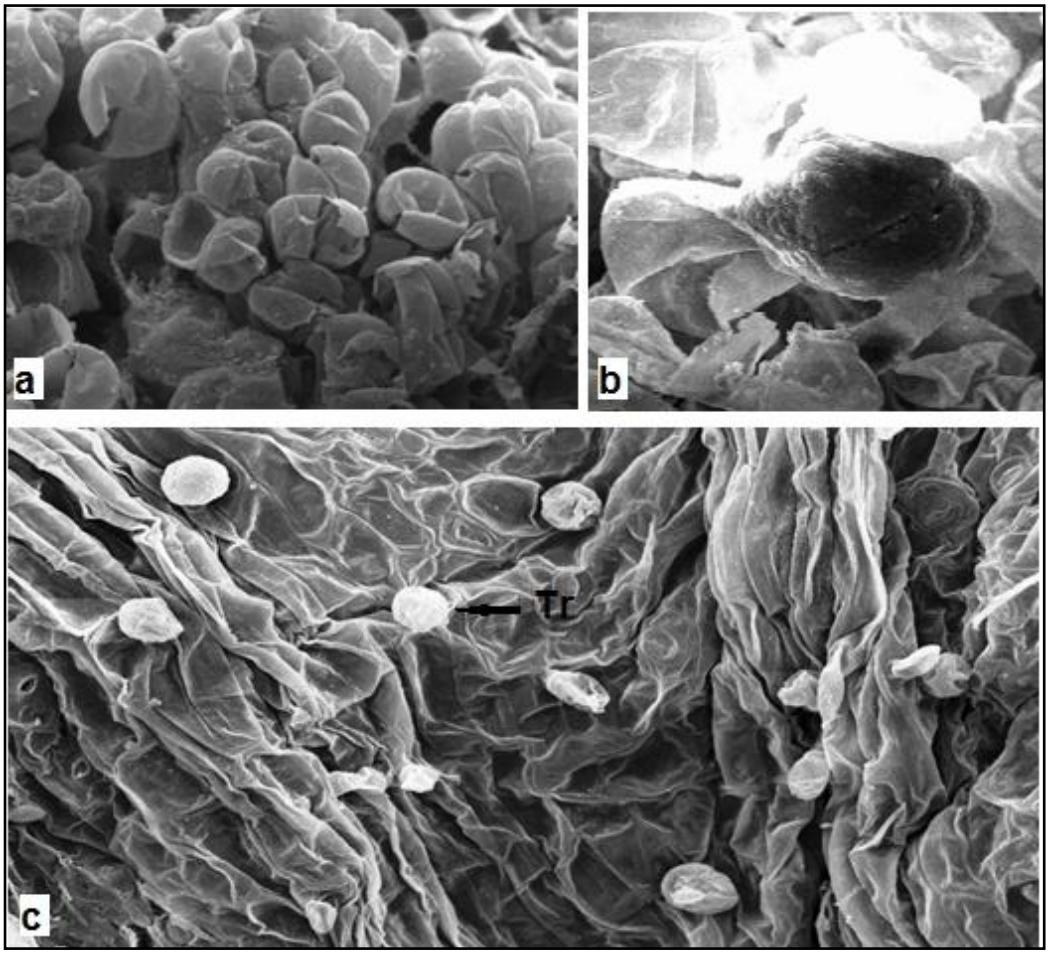

Fig. 4 (a-c): Scanning electron micrograph showing the development of shoot bud and leaf from the cotyledons of *O. citriodorum*: (a) SEM of upper surface of the explants after 5-6 days of culture showing callus like structure; (b) Shoot bud; (c) Surface of *in vitro* regenerated leaf showing trichomes (Tr)

Cytological analyses

The chromosome number has been found to be 2n = 72 from both regenerants (Fig. 5a) and mother plant (Fig. 5b). In the present study, cytogenetic analysis did not reveal any signs of abnormal mitosis in dividing cells from the root tips of *in vitro* regenerated plantlets. Although plants regenerating in culture medium may show variability (Chakravarty and Sen, 1992).The plantlets regenerating from the cotyledons in the present study appear to be uniform and genetically stable.

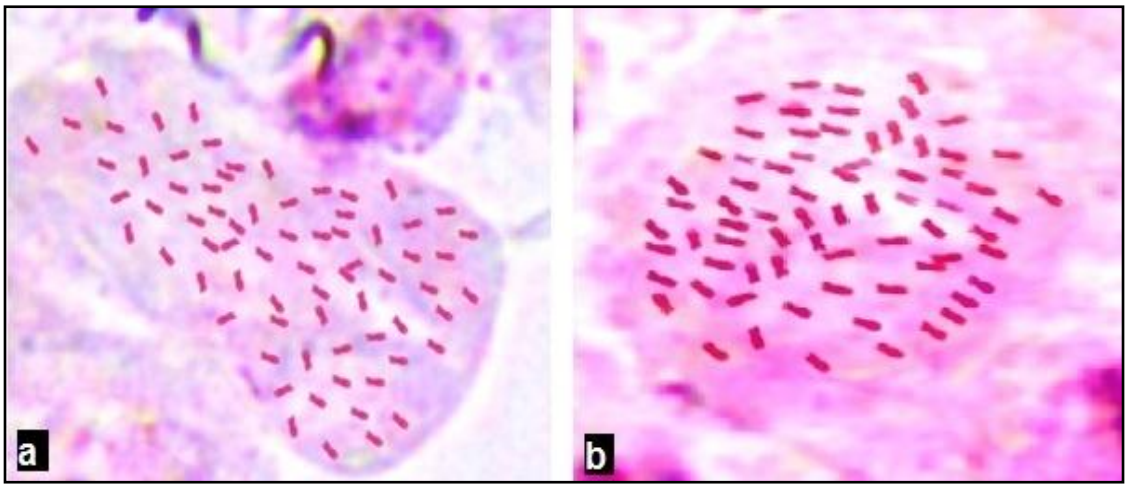

Fig. 5 (a-b): Cytological analysis of *O. citriodorum*: (a) 72 chromosomes of a metaphase cell from a root tip squash of a regenerant; (b) Root tip squash showing chromosomes of the donor plant.

DISCUSSION

Development of direct shoot regeneration protocol from cotyledons of *O. citriodorum* is one of the important requisitions toward clonal mass multiplication for commercial and pharmaceutical application. Obtaining regenerants of same genetic composition is yet another significant parameter toward this direction. In the present study, the plantlets were regenerated directly from the cotyledons of *in vitro* raised seedlings of *O. citriodorum.* MS medium was used for the *in vitro* studies as it is the most appropriate and widely used medium in dicotyledonous morphogenic processes due to high NO^{3-} and NH^{4+} concentration and proportion between these nitrogen forms (Dibax *et al.*, 2010). Of the four cytokinins, *viz*. BAP, Kn, TDZ and 2iP tested, BAP proved to be the best both in terms of percentage morphogenic cultures as well as average shoot number per explant. Significance of BAP in inducing multiple shoots has already been reported in different species of *Ocimum* like, *O. basilicum* (Sahoo *et al.*, 1997), *O. sanctum* (Singh and Sehgal, 1999), *O. gratissimum* (Gopi *et al.*, 2006), *O. citriodorum* (Janarthanam and Sumathi, 2012) and *O. basilicum* (Shahzad *et al.*, 2012). Thus, our results are in consistence with the earlier reports. The promotory effect of BAP in the present study over other cytokinins could be due to its easy permeability, increased affinity for active cell uptake, less resistance to the enzyme cytokinin oxidase, or receptor abundance in its perception apparatus which interacts with the coupling elements in the signal transduction chain (Burch and Stuchbury, 1987). Moreover, BAP if added exogenously shortens the duration of S phase of cell division through recruitment of latent origin of DNA replication both *in vitro* and *in vivo* (Francis and Sorell, 2001). Addition of growth regulators such as auxins to the culture is extremely important, since they are able to start cell division and control the growth processes and cell elongation (Asghari *et al.*, 2012). In the present study also the morphogenic response enhanced by the incorporation of NAA in the medium containing optimum concentration of BAP. This suggested synergistic effect of NAA on the shoot proliferation from the explant. This could be due to the fact that auxin in combination with cytokinin, leads to rapid cell division, forming a large number of relatively small and undifferentiated cells (Mendoza and Kaeppler, 2002). Besides it, auxin to cytokinin ratio modulates the cell division, cell elongation and plant regeneration (Sahu *et al.*, 2013). The number of shoot per culture was decreased when BAP concentration was increased from its optimal level (1 mg/l). This may be due to the toxicity of BAP at higher concentration which might lead to genetic, physiological and morphological changes, resulting in a reduction of the proliferation rate *in vitro (*Narayanswamy, 1977).

The multiplication and establishment of cotyledonary explant was further improved by the addition of AS and CH. This could be due to the fact that adenine in the form of adenine sulphate can stimulate cell growth and greatly enhance shoot formation (Murashige, 1974) by providing an available source of Nitrogen to the cell. This nitrogen can be taken up more rapidly than inorganic Nitrogen (Thom *et al.*, 1981). Our results confirmed the efficiency of CH in *in vitro* growth which could be due to its high concentration of glutamine that balances the shortage of amino acid synthesis when the medium has a phosphorous deficiency (Miel, 1985).

In the present study, rooting of the shoots was induced in the MS medium supplemented with NAA. Similar results were recorded in *O. sanctum* (Begum *et al.*, 2000) and *O. basilicum* also (Pattnaik and Chand, 1996). This could be probably due to fact that NAA reduces the induction period (Washida *et al.*, 2004) as well as increases the biomass (Kusmapudi *et al.*, 2010) by inducing proliferation and lateral root

formation (Nandgopal and Kumaria, 2007; Sudha and Seeni, 2001).

From the histological studies it is evident that *O. citriodorum* displayed the direct pattern of regeneration. The present study revealed the time course of the organogenesis and the triggering of cell division that leads to the formation of a complete plantlet. Shoot primordia were observed after 3-5 days of culture on the inductive media, it may imply that BAP activates cell division of the competent cells (Mendoza *et al.*, 1993).

The regenerants have been further revalidated as genetically uniform and similar to the mother plant by chromosome counting. Cytogenetic analysis can provide information about abnormal mitosis or changes in ploidy levels (Radic *et al.*, 2005). In the present study cytogenetic analysis did not reveal any signs of abnormal mitosis in dividing cells from the root tips of *in vitro* regenerated plantlets. The base number of *Ocimum* has been suggested as x =12 (Stanko *et al.*, 2010b). *O. citriodorum* is probably an allohexaploid (2n = 6x = 72) as referred by Paton and Putievsky (1996). Our results are confirmatory with the reports of Mukharjee *et al.* (2005) and Stanko *et al.* (2010b) who observed 2n = 72. However, some researchers observed altered chromosome numbers also, like Paton and Putievsky (1996) who reported 2n = 64 for the same species.

CONCLUSION

The present study has demonstrated the feasibility of a direct regeneration and clonal propagation protocol to produce true-to-type plants of *O. citriodorum.* To the best of our knowledge, this is the first report of successfully inducing plantlets from the cotyledons of *O. citriodorum.* The ability of reliably producing true-to-type plants, offers a promising tool for its structural and functional genomics, as well as biotechnological studies.

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EVALUATION OF TGMS LINE OF SAFFLOWER (*CARTHAMUS TINCTORIUS* L.) AT RAIPUR

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Abstaract : Safflower is an often cross pollinated oilseed crop. The oil of safflower contains lenoleic and oleic acid supposed to be the best for human health. Number of spiny or non spiny varieties of safflower has been developed throught the India. Now there is constant platue in the yield, varieties A-1, Bhima and JSF-1 are some of the high yielding varieties their yield level is not crossed by most of the newly developed varieties. This constant yield platue in safflower can be break down by exploitaion of heterosis, through development of hybrid varieties. To develop male sterile lines number of genetic tools such as CMS, GMS and now TGMS lines are in use and under testing. The major constraint in hybrid development through GMS is maintanence of male sterile lines and required skill hence not popular. At Nimbkar Agricultural Research Institute (NARI), Phaltan (Maharastra), thermo genic male sterile (TGMS) lines TMS-3-6-7-9 in safflower has been identified. Its seed has been send to Raipur for its evaluation for pollen sterility and its performance under rice based cropping system at Raipur.

Keywords : *Carthamus tinctorius*, crop, safflower

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is grown mainly as edible oilseed crop during winter and spring seasons, under rainfed irrigation conditions. India shares first rank in area and production with 50.6% share in the world area under safflower and 36.6% share in the world production (Anjani, K. 2012). There has been a decreasing trend in safflower area and production in the world since 1987, despite impressive improvement in productivity from 559kg/ha during 1987-88 to 890 kg/ha during 2008-09 (Damodaran and Hegde, 2010).

The productivity level has reached near plateau in the last one decade (1999-2008) due to various reasons like moisture stress, poor soil nutrient status, salinity and damage due to insect pests and diseases. These constraints togather with limited genetic diversity with low genetic advance and variation in expression of yield and its components in different environments are some of the major limitations to progress for achieveing quantum jump in seed yielding cultivars.Getting high jump in productivity at a rapid pace under adverse growing conditions is the real challenge to safflower researchers (Anjani, K. 2012). Exploitation of heterosis is one of the major way to break the yield platue. High degree of heterosis was reported in safflower for number of characters like yield (177%) and oil yield (80%). The major ways to develop hybrids in safflower are through genetic male sterility system (GMS) in troduced by Heaton and Knowles, (1980) and Joshi et al., (1983) , CGMS system introduced by Hill (1989) and use of TGMS lines. The TGMS system is more feasible for this crop.

MATERIAL AND METHOD

TGMS line (TMS-3-6-7-9) received from Nimbkar Agricultural Research Institute (NARI, Phalton) was evaluated at Raipur. The TGMS line was sown on 23rd November, 2012 at Research cum Instructional Farm of IGKV, Raipur. The normal agronomical package of practices were applied. The plot size was 3X3 sq m, with a spacing 45 X 20 cm apart. After flowering the flowers were morphologically as well as cytologically examined for pollen sterility. As the temperature was raised the pollen behaviour of TGMS line was recorded. The pollen sterility was tested by bagging the flower as well as by I, KI solution under microscope.

RESULT AND DISCUSSION

The flowering in safflower crop varieties generally varies from 80-110 days, depends upon the rosette period of the variety and responsible for early and delayed floering of the varieties. In TGMS line TMS-3-6-7-9 the rosette period was for 20 days hence the crop flowered in arround 80 days after sowing.

Initial morphological study of the flower

The flowers were small and their opeing was also very small and few florets were emerged from the flower. The cpitulum was small to medium in size. The anthers coming out from them was thin and rudementry, donot showed presence of any pollens either visually at field or under microscope in the laboratory, under Iodean- Potassium Iodied solution. No sign of the pollens were observed in cytological study at initial flowering stage. After four days there was 99.9% sterility were observed, which remains 99.8% till 25th Februarywhen the temperature was 29.8^{O}C. After it the atmospheric temperature becomes gradually incresing and the pollen behavor was observed as in table-1.

Pollen study at frequent intervals

After 10 days of first blooming the number of flowers were increased. The temperature during this

period was between 29-30^{O}C. From 2nd week of March the cytological studies indicated the presence of 18% pollen fertility, which reached up to 32 % on 20th March 2013 (Table-1,2). The meterological data during the period indicated that from last week of February the Maximum temperature started increasing and reached up to 32.3 ^{O}C and in the third week of March the temperature shoot up upto 36.4^{O}C, which reaches up to 38 in the end of March (table-3).

Similarly the five flowers were bagged by butter paper bags at frequent interval inorder to study the pollen sterility through selfing. No seed setting was recorded till 1st March (Table -2). But with increase in atmospheric temperature the average seed setting was recorded from 5 to 9 seeds per capitulum up to 20th March when the temperature was 36.4^{O}C.

The study indicated negative corelation between pollen sterility and the raised in environmental temperature, in low temperature the TGMS line TMS 3-6-7-9 had no pollen formation, but as soon as the temperature increases the sterility reduces and formation of fertile pollen grains starts. In low temperature or during winter flowering, the TGMS line TMS-3-6-7-9 showed 100% rudimentary anthers without pollen grains and worked as the male sterile line, and can be used as female parent in hybrid seed production programme at Raipur. Whereas, with the gradual increase in the temperature appearance of fertile pollen begins and as the temperature goes above 32 OC, the fertile reached up to 32%. This indicated that in higher temperature seed multiplication of this line can be done, as in higher temperature this line performs normal fertile line.

Table 1: Results of I-KI test for pollen sterility at Raipur.

S.No	Date of evaluation of Pollen grains for fertility	% Fertility	% Sterility
1	12.2.2013 (Flower initiatiion stage)	0.2	99.8%
2	16.2.2013	0.1	99.9%
3	25.2.2013	0.2	99.8%
4	1.3.2013	0.3	99.7%
5	10.3.2013	18	82
6	15.3.2013	30	70
7	20.3.2013	32	68

Table 2: Resuts of selfing of flowers by bagging at Raipur.

S.No	Date of evaluation of Pollen grains for fertility	No. of flowers bagged	% of seed setting
1	12.2.2013 (Flower initiatiion stage)	5	Nil
2	16.2.2013	5	Nil
3	25.2.2013	5	Nil
4	1.3.2013	5	Nil
5	10.3.2013	5	5 seeds (average)
6	15.3.2013	5	5 seeds (average)
7	20.3.2013	5	9 seeds (average)

Table 3: Meterological data of the station during the study.

Meteorological week	Temp. in C		Rainfall (mm)	No. of Rainy days	Sunshine hr.	RH	
	Min.	Max.				Min. (%)	Max. (%)
32. Feb 05-11	16.8	30.0	0.2	0	6.7	44	86
33. 12-18	16.4	29.7	11.6	2	6.7	47	87
34. 19-25	14.6	29.8	0.8	0	9.9	36	84
35. 26-04	13.8	32.3	0.0	0	10.0	22	79
36.Mar. 05-11	14.8	34.3	0.0	0	9.6	19	71

37. 12-18	20.4	33.8	0.0	0	6.1	31	70
38. 19-25	20.2	36.4	0.0	0	8.3	22	66
39. 26-01	22.7	38.1	0.0	0	7.8	21	62

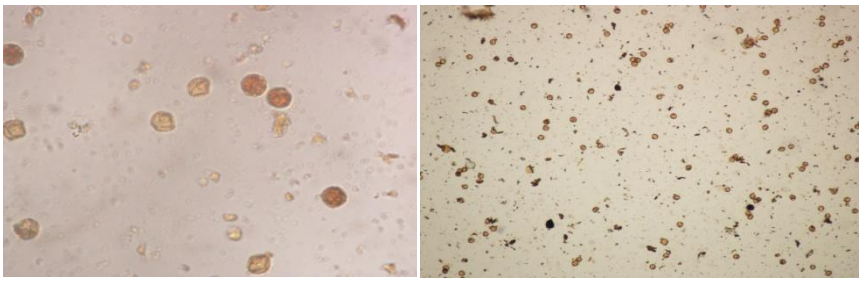

Fig-1: Study of pollen sterility in I-KI solution under microscope.

Fig-2: Flower of the TGMS line TMS-3-6-7-9.

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COMPARATIVE CYPSELAR FEATURES OF TWO SPECIES OF *TAGETES* (TAGETEAE-ASTERACEAE) AND THEIR TAXONOMIC SIGNIFICANCE

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Abstract : Morphological and anatomical studies of cypselas in *Tagetes lucida* L. and *Tagetes tenuifolia* L. have been-carried out in details with the help of light microscope. Some morphological features like cypselar surface hairs, carpopodium, detachment area, pappus bristles have potential value for characterization. Anatomically, phytomelanin layer is present in the mesocarpic region and which is continuous in case of *Tagetes tenuifolia* and discontinuous in case of *Tagetes lucida*. In the cypsela of *Tagetes lucida*, testa and endosperm layers are uniseriately arranged, whereas in *Tagetes tenuifolia*, testal layer is uniseriately arranged but endosperm layer is biseriately arranged. Based on the above mention morpho - anatomical features, an artificial key to the studied taxa has been constructed.

Keywords: Diacritical features; tageteae; asteraceae

INTRODUCTION

The tribe Tageteae contains 32 genera and approximately 270 species, which are found mostly in the South-Western USA and Mexico (Jeffrey, 2007). According to the observation of Loockerman et al.(2003), this tribe has approximately 216 New World species with a center of diversity in the Mexican highlands. According to Strother (1977), the genus *Tagetes* belongs to the Tribe Tageteae (Asteraceae) comprising of 50 species which are distributed in warmer parts of America. The name of this tribe was proposed by Cassini (1819), but the tribe was previously included in the tribe Heliantheae. Tageteae are generally annual or perennial herbs, although some members are shrubby or suffrutescent (Loockerman *et al.*, 2003). The most stricking character of this tribe is the presence of pellucid glands containing aromatic oils on the leaves and phyllaries. According to the opinion of Soule (1993), a number of species of *Tagetes* are used as medicinal beverages, or sold as green herbs or vegetables in Latin America. Majority of the earlier taxonomist including Cassini, (1829); Lessing (1832); De Candolle (1836); had been placed this tribe within the subfamily Asteroideae. Bremer (1987, 1994); has mentioned this group as a distinct tribe, which is closely related with the tribe Heliantheae sensu lato. Strother (1977) has placed this tribe into two sub tribes. *Pectis* is a genus, which is placed within the first subtribe and remaining genera have been included under 2nd sub tribe. In spite of being a fairly a large genus in *Tageteae*, the cypselar morphological and anatomical features have not been studied in details. The aims of this study is to elaborate the detailed morpho-anatomical features of cypselas of this genus, with the help of light microscope.

MATERIAL AND METHOD

Mature, identified, cypselas of *Tagetes lucida* and *Tagetes tenuifolia* were collected from Botanischer Garten der Universitat Zurich with the collection number-XX0Z-20031315 and XX0Z-20110213 respectively. Cypselas were process, following the work of Mukherjee and Sarkar (1994). For anatomical studies techniques of Johansens (1940) were followed with Safranin and lightgreen and ultimately mounted in Canada balsum.

RESULTS AND DISCUSSION

Tagetes lucida

Cypselar Morphology (Fig.1 A-G, 3 A-D)

Cypsela homomorphic, 7 mm x 0.05 mm including awn, 5 mm x 0.05 mm excluding awn, black, obovate, margin entire, straight, upper part truncate whereas lower part tapered. Ellipsoidal in cross sectional configuration. Surface pubescent. Surface hair appressed to ascending in orientation with the surface, made up of body and basal cells. Body cells of surface hair with biseriately forked type. The tip portion of body cells arranged at different plain. Within the surface 16 ribs present, alternating with furrow. Furrows wider than ribs.At the upper portion of cypsela, stylopodium present, inconspicuous, fully immersed into the nectar. Pappus awn like, represented by ear like structure. With in the surface, phytomelanin layer observed. At the basal region of cypsela, carpopodium present, narrow than the base, symmetric, quadrangular. Carpopodial cells with thick-walled, pentangular, not pitted, arranged in single row.

Cypselar Anatomy (Fig.1 H-I)

Cypsela elliptic in cross sectional configuration. Ribs present; 16 in number, in conspicuous. Cypselar wall 0.03 mm and 0.02 mm wide at ribs and furrow

region respectively. Pericarp thick, differentiated into epicarp and mesocarp. Epicarp uniseriate, made up of thin walled, rectangular, compactely arranged, parenchyma cells, provided with cuticle. Internal to the epicarp mesocarp present, homogenous, made up of compactely arranged, more or less pentangular, sclerenchyma cells. In between the epicarp and mesocarp, phytomelanin layer present, discontinuously arranged. Testa attached with cypselar wall, made up of thick walled, horizontally placed, parenchyma cells, uniseriately arranged. Endosperm persists in mature cypsela, uniseriate, made up of, barrel shaped, parenchyma cells, uniseriately arranged. Mature embryo occupies a major part of cypsela, cotyledons 2 in number, arranged at right angle to the axis of cypsela, containing 12 resin ducts (6 ducts in each cotyledon).

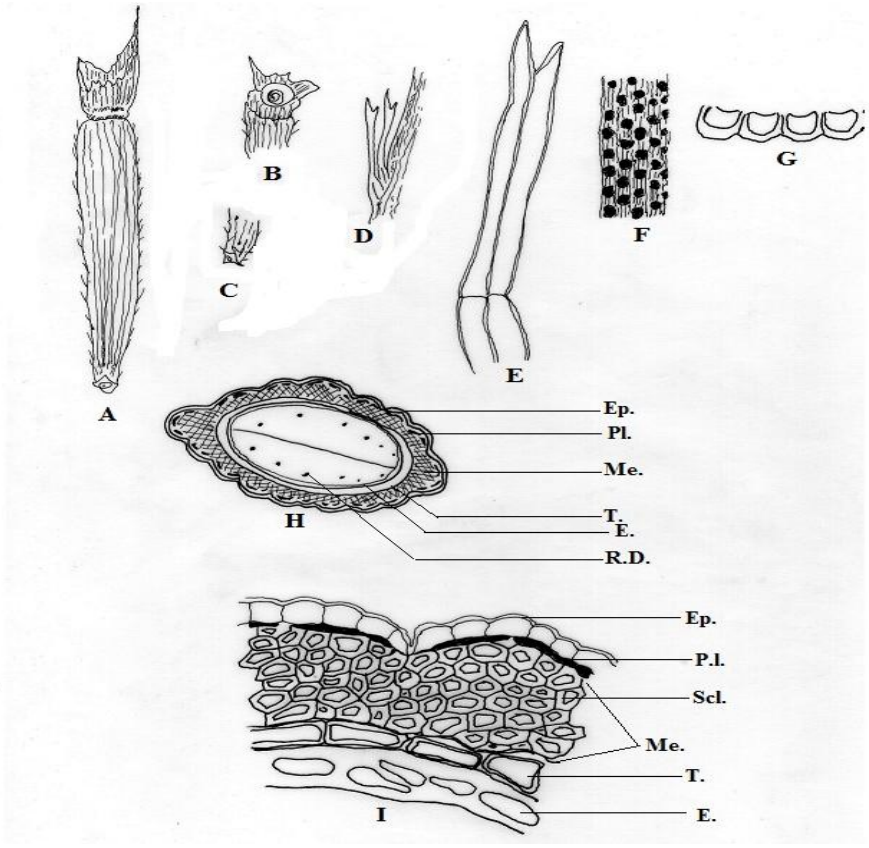
Tagetes tenuifolia

Cypselar morphology (Fig. 2 A-E, 3 E-G)

Cypsela homomorphic, 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn, dark brown, linear, straight. Surface pubescent, surface hair adpressed to ascending in orientation, made up of body and basal cells. The tip portion of body cell with biseriately forked type, situated in a different plane. Within the surface, phytomelanin layer exist. Stylopodium inconspicuously developed. At the upper portion of cypsela, pappus present; awn like, homomorphic, yellow brown, arranged in a single circle. At the basal region of cypsela, carpopodium present; symmetric, more or less rounded. Carpopodial cells with thick walled, arranged in 3 rows.

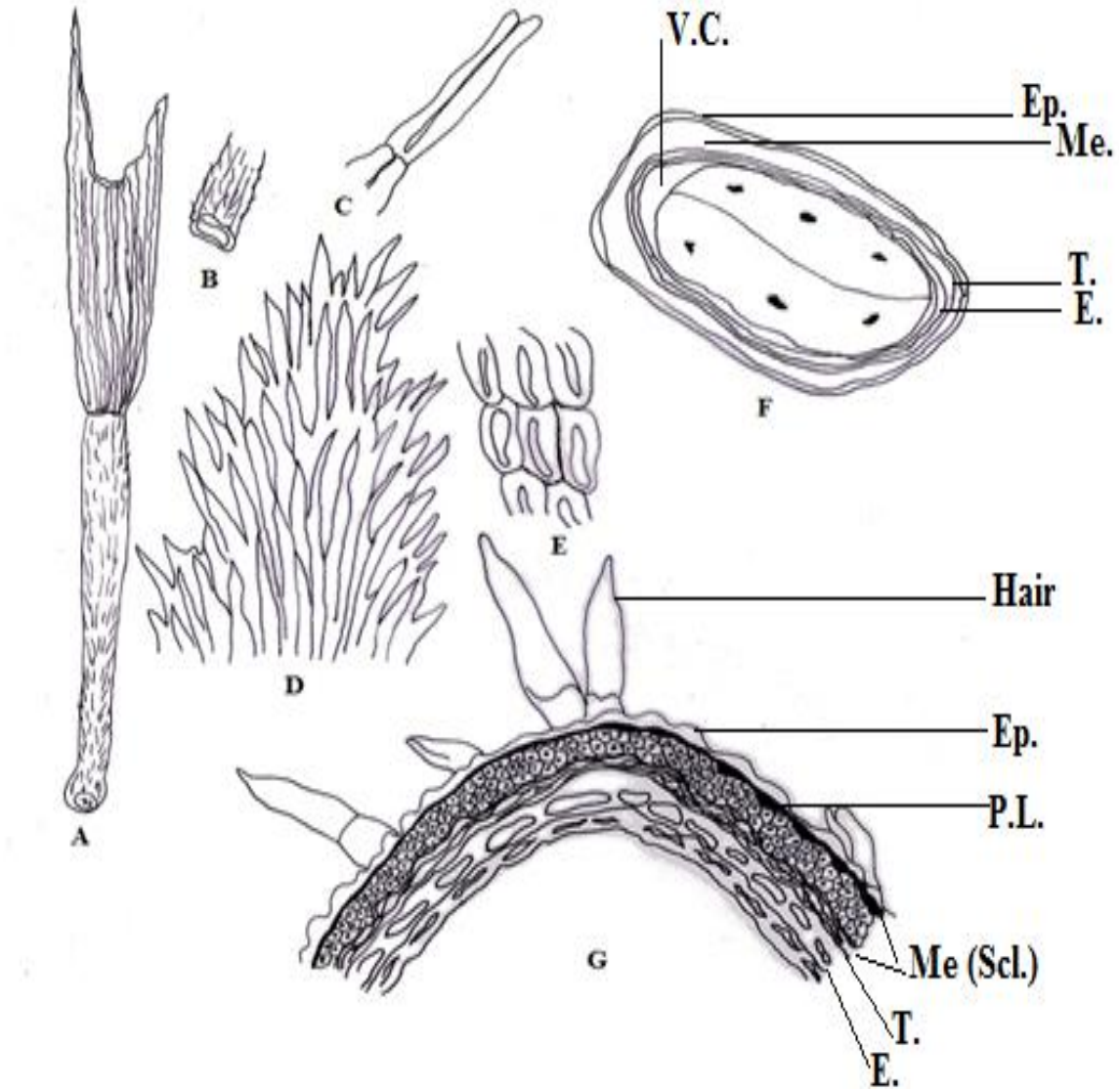
Cypselar anatomy (Fig. 2 F-G)

Cypsela more or less elliptic in cross sectional configuration. Pericarp thick, on an average 0.02 mm, differentiated into epicarp and mesocarp. Epicarp uni-seriately arranged, parenchymatous. Internal to the epicarp, mesocarp present; made up of continuously arranged, sclerenchyma cells. Just below the epicarpic region, phytomelanin layer present, continuously arranged. Testa attached with cypselar wall, approximately 0.005 mm, made up of crusted layer of parenchyma cells, uni-seriately arranged. Endosperm persists in mature cypsela, thick walled, parenchymatous, biseriately arranged. Mature embryo occupies a major part of cypsela, cotyledons 2 in number, arranged oblique to the axis of cypsela, containing 6 resin ducts (3 ducts in each cotyledon).



1 mm. A,B,C. 0.1 mm. D,H. 0.05 mm E,F,g,I

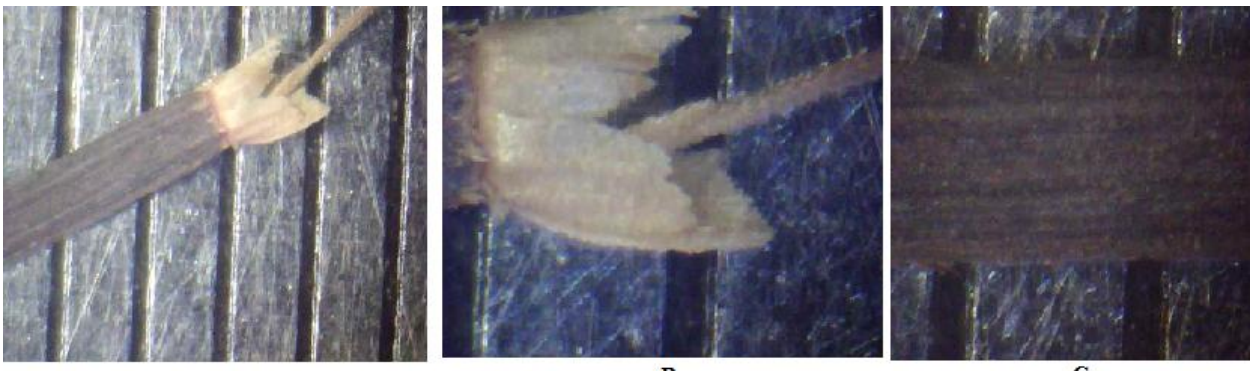
Fig.1: Cypselar morpho-anatomy of the species *Tagetes lucida*
1.A-G: Cypselar morphology: A-Cypsela, B-Upper part, C-Lower part, D- Surface showing hairs, E-An intact surface hair, F-Surface showing phytomelanin deposition, G-Carpopodial cells; 1.H-I: Cypselar anatomy: H-Diagramatic view, I-Cellular view.



1 mm A,B 0.1 mm C,D, F 0.05 mm E,G

Fig.2: Cypselar morpho-anatomy of the species *Tagetes tenuifolia*
1.A-E: Cypselar morphology: A-Cypsela, B-Basal part, C-Surface hair, D- Part of pappus, E-Carpopodial cells; F-G- Cypselar anatomy: F-Diagramatic view, G-Cellular view.

Abbriviations: Ep-Epicarp, Me-Mesocarp, Pl-Phytomelanin layer, T-Testa, Scl-Sclerenchyma, E-Endosperm, RD-Resin duct, V.C.-Vellicular cavity



A B C

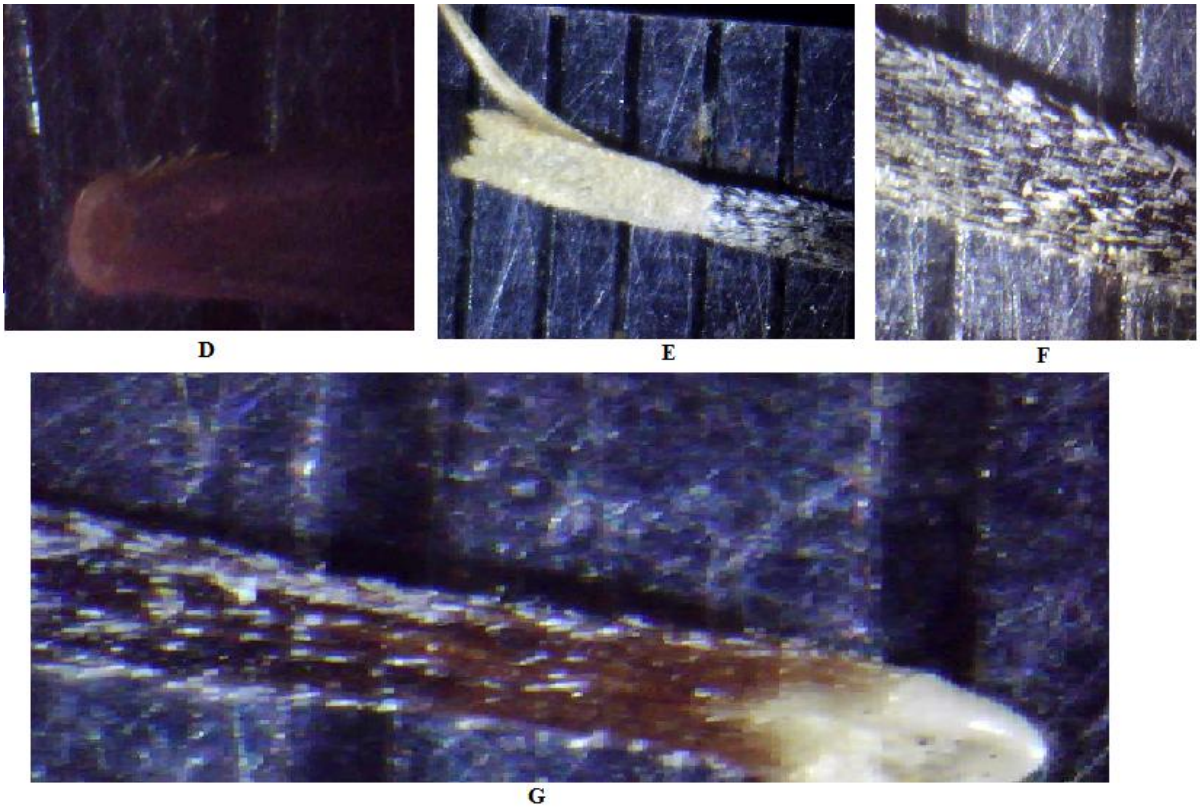


Fig. 3. Micro photographs of studied cypselas.
3. A-D- *Tagetes lucida*: A-Cypsela, B-Pappus, C-Surface, D-Carpopodium; E-G- *Tagetes tenuifolia*: E-Cypsela, F-Surface showing hairs, G- Basal portion of cypsela, showing carpopodium

Table 1: Comparative morpho-anatomical features of studied cypselas

Tagetes lucida	Tagetes tenuifolia
1. Cypsela homomorphic, 7 mm x 0.05 mm including awn, 5 mm x 0.05 mm excluding awn.	1. Cypsela homomorphic, 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn
2. Cypsela black in colour	2. Cypsela dark brown in colour
3. Cypsela obovate in shape	3. Cypsela linear in shape
4. Surface containing 16 ribs	4. Surface containing 4 ribs
5. Carpopodium quadrangular in shape	5. Carpopodium more or less rounded in shape
6. Carpopodial cells are arranged in single row	6.Carpopodial cells are arranged in three rows
7. Testa uni-seriately arranged, parenchymatous, horizontally placed.	7.Testa uni-seriately arranged, made up of crusted layer of parenchyma cells.
8. Endosperm uni-seriately arranged, parenchymatous.	8.Endosperm bi-seriately arranged, parenchymatous.
9. Cotyledons placed at right angle to the axis of cypsela	9.Cotyledons placed obliquely to the axis of cypsela
10. Each cotyledon containing 6 resin ducts	10.Each cotyledon containing 3 resin ducts

The studied cypselas are homomorphic. Surface is pubescent. Surface hair is twin type, ascending in orientation with the surface, made up of body and basal cells. This type of surface marking is also present in case of *Tagetes minuta*, of this tribe (Mukherjee and Sarkar, 1999). Pappus is an important taxonomic character of cypsela. Pappus is also present in *Tagetes minuta*, of this tribe. General morphology of the cypsela of this species is more or less equal with some primitive members of the tribe Senecioneae. In this connection, Mukherjee (1992), has mentioned a connecting link between the tribe Tageteae and Senecioneae. Not only the tribe Senecioneae, it is also related with the tribes of other Heliantheae Allianee Group (Panero and Funk, 2002; 2008; Funk et al,2009; Cawford and Tadesse, 2014; Pandey et al, 2014). According to the information of Bremer (1996) this group has been treated as a subtribe in Helenieae. The similarity between the tribe Tageteae and Heliantheae are as follows

1. Presence of awn like pappus

2. Presence of phytomelanin layer
3. Mode of arrangement of mechanical tissue (Sclerenchyma tissue) in the pericarpic zone.
4. Nature of testa and endosperm.

From this above mention observation, it may be concluded that, the tribe Tageteae is closely related with the tribes of other Heliantheae Allianea Group such as Heliantheae, Helenieae, Eupatorieae, Bahieae, Coreopsideae, Madieae, Millerieae, Perityleae, Polymnieae due to the presence of awns and phytomelanin pigment etc.

Key to the studied cypselas

1a. Cypsela 7 mm x 0.05 mm including awns and 5 mm x 0.05 mm excluding awns; obovate; carpopodial cells uniseriately arrange; phytomelanin layer discontinuously arranged; testal layer made up of horizontally placed, parenchyma cells; endosperm layer uni-seriately arranged..... ***Tagetes lucida***

1b. Cypsela 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn; linear; carpopodial cells triseriately arrangeme; phytomelanin layer continuously arranged; testal layer made up of crusted layer of parenchyma cells; endosperm layer biseriately arranged.....***Tagetes tenuifolia***

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BUD GROWTH AND POSTHARVEST PHYSIOLOGY OF GLADIOLUS AND CHRYSANTHEMUM-A REVIEW

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Abstract: This paper deals with mechanism of flower bud growth and postharvest physiology of gladiolus and chrysanthemum. Both gladiolus and chrysanthemum are leading cut flowers trade in India as well as World. A spike of gladiolus occurs of an acropetal sequence of stage of bud development on a single axis. A critical stage in flower bud growth in the spike of gladiolus is initiated by gibberellic acid and sustained by sucrose. The important role of continued and sequential basipetalis starch hydrolysis in the gladiolus petals could be to maintain by constant osmotic as well as a sink potential in the growing area of the petal. In case of, Chrysanthemum flower fresh and dry weights of the ray florets increase until the capitula is fully open. The soluble protein content declines after opening of capitula. The maximal activity of this enzyme and acid invertase coincide with the period of highest increment in fresh and dry weight. Postharvest senescence of gladiolus and chrysanthemum depends mainly of theirmethods of harvesting, transporting and increase the longevityof flowers. Two factor play a major role in regulating the vase life of cut flower are carbohydrate supply and water balance. This can be achieves through using of sucrose along with any of the following chemicals CoCl2, NiCl2, FeCl2 and AgNO3.

Keywords: Gladiolus, chrysanthemum, bud growth, postharvest, physiology, vase life

INTRODUCTION

Man has selected flowers for their beauty, hues, shapes, scents and keeping quality. In India, flowers are generally cut without stalk and used as fresh. Wreaths of jasmine, marigold, crossandra, tuberose, chrysanthemum, rose and champak are offered in temples and also used for personal adornments. The physiology of senescence of flowers grown in India is meagre. It is only recently that floral decorations as practiced in the developed countries have gained popularity in our country. With its varied agro climatic conditions and relatively low cost of production, India has immense opportunities not only to meet the local demands of both traditional and vase flowers but also a high potential for export trade. Lack of enterprise, lack of technical ideas,improper standardized method of growing and harvesting flowers of internationally acceptable quality, problems of packing and transport and also a practically nonexistent production base have been major impediments in realizing this goal.

Improvement in the quality of blooms has necessitated research into the basic and applied aspects of flower physiology in some of the major international centres of flower production such as Netherlands, UK, USA and Israel. There is a resurgence of interests in India to broaden the technical base and enthuseentrepreneurs to take up export of flowers. In India, 27122 Million metric tonnes of flowers are exported and its worth of Rs. 423.4 crores (APEDA, 2014). Research in several aspect of flower initiation, flower bud development and opening, sex expression, pollination biology and physiology of senescence in a large number of plants, especially ornamentals has been carried out for the past three decades in ICAR, New Delhi and several other science universities. In this paper, the main findings on mechanism involved in flower bud growth and on postharvest physiology of gladiolus and chrysanthemum are reviewed.

Mechanism of flower bud growth in gladiolus and chrysanthemum

A spike of gladiolus presentsa nature's own flower arrangement. It is ideal material for bud opening studies. The occurrence of an acropetal sequence of stage of bud development on a single axis makes it possible to carry out several studies. The spike bears buds in two rows (distichous arrangement) with the telescoping of the outer bracts over one another (Fig 1.). The elongation of the flowering axis between the budsloosens and separates the outer bract from the axis. The fresh weight of corolla increases 16 times and the dry weight by seven times and the outer bract separates out until the corolla attains its full expansion (Rao, 1979; Bala*et al*., 1986). The spike harvest one week before the first floral bud opens and which need exogenous supply of sugars subsequent flower growth and opening (Rao and Mohanram, 1981). The growing corolla continues to import sugars throughout its development. The function of sugar is not directly involved in the metabolism. A part of the accumulated sugar in the petals is secreted as nectar. In gladiolus, this occurs at anthesis. The petal belonging to the buds with unseparated outer bracts were observed to contain

abundant starch in the ground parenchyma only(Rao and Mohanram, 1980).Bala (1982) reported that α-amylase and acid invertase activities increase with the progression of corolla development and have a positive correlation with the amount of carbohydrates. The decline in starch in late developmental stages can be correlated with the sharp rise in α-amylase activity and reducing content. The system of overlapping outer bracts which completely enclose the flower buds and their gradual separation represents a system programmed for sequential exposure of successive buds to light and stimulation of α-amylase, to permit an orderly development of buds (Mohanram*et al*., 2004). Rao (1982) illustrated that the outer bract acts as a natural qualitative light filter and regulate the production of α-amylase and petal growth by a red/far-red control. α-amylase is formed exclusively in the petal epidermis on perception of light.A crucial structural and biochemical role of the epidermis in the percept on of light leading to petal growth has been recognized. Rao (1979, 1982) has observed that the epidermal cells of petals of gladiolus possess microlenses. These are formed by the outwardgrowth of the outer radial wall of the epidermal cells causing the formation of curved structure, which thicker in the middle than edges. These microlense act to focus light specifically on to the nucleus which situated in the central zone of inner radial wall of the epidermal cells.A critical stage in flower bud growth in the spike of gladiolus, which is initiated by gibberellic acid and sustained by sucrose, has also been identified by Rao and Mohanram, (1986). One important role of continued and sequential basipetal starch hydrolysis in the gladiolus petals could be to maintain a constant osmotic as well as a sink potential in the growing area of the petal, in spite of water uptake(Rao and Mohanram, 1980).

Chrysanthemum is only flower next to rose in importance as cut flower in world trade. It comes in various sizes and shapes and has an unmatched wholesomeness and elegance. Pardhasaradhi (1985) had made a detailed study of the growth of chrysanthemum capitulam using different stages. His finding revealed that the fresh and dry weights of the ray florets increase until the capitulum is fully open. The soluble protein content declines after opening of capitulam. The maximal activity of this enzyme and acid invertase coincide with the period of highest increment in fresh and dry weight. Amylase activity has increase in the florets till the half open flower stage. Ethylene production is low during initial stages of development of the capitulum and increase with age (Fig 2.). Anelegant method has been developed in this laboratory to study the expansion of ray florets. This consist of floating ray florets (9 to 9.5mm) of *Chrysanthemum morifolium*var*jyotsna* removed from the outer most whorl of young capitulam and it can be taken into petri-plates containing 30 ml of the test solution (Pardhasaradhi and Mohanram, 1987). Using this technique it has been shown that KCL causes upto 33% increase in elongation. The value for GA_3 and sucrose when used individually are 39.8 and 28.9% increase in elongation respectively. Maximum growth response (82.8%) is recorded in combination of KCL+GA_3+sucrose. It is inferred that the increased turgor resulting from sucrose promoted potassium uptake along with GA_3caused tissue extensibility accounts for the enhanced floret growth. Ray floret expansion is also retarded by Trimethyl Ammonium Chloride (CCC), an inhibitor of gibberellin biosynthesis. Pardhasarathi (1985) implied that endogenous gibberellins are involved in ray floret growth. The CCC effect can be overcome by simultaneous application of GA_3.

Postharvest physiology of flower

Flowers naturally lose moisture and colour fade with limited time. While flowers like jasmine and tuberose turn brown and dry, in some plants mass shedding of petal occurs. Although majority of flower are short lived, there are orchids such as *Phalaenopsisshilleriana* in which a flower may stay fresh on the plant for as long as four months as it waits for the specific insect pollinator (Molisch, 1938). In most of plants petal wither, the sepals drop and the stamens dry up following pollination. A clear understanding of the causes of senescence should help in developing methods of harvesting, transporting and increase the longevity of gladiolus and chrysanthemum. Two factor play a major role in regulating the vase life of cut flower are carbohydrate supply and water balance. Injury at the cut end or growth of microorganism in the lumen of xylem vessels (physical blockage) or accumulation of microbial secretions and metabolic by products (physiological blockage) could prevent absorption which resulted in severe water deficit. Cut flower longevity is also curtailed by ethylene (Chandra and Mohanram, 1980). Investigation ofpostharvest physiology of chrysanthemum and gladiolus has shown that addition of a respirable substrate like sucrose and antimicrobial agent (streptomycin and 8-hydroxyl quinoline citrate)willprolongthe vase life (Mohanram and Rao, 1977).

Flower senescence

Senescence of flowers is strongly promoted by ethylene. Ethylene induced senescence of carnation flowers was reported by Crocker and Knight (1908). It prevents opening of young blossoms, causes closure of opened flowers and fading of petals. Pollination also causes fading of flowers and it has been inferred that the senescence of the flower is triggered by pollen-auxin stimulated ethylene production (Burg and Dijkman, 1967). Similar, finding was also identified by Lang (1961) in rose and gladiolus.Antiethylene compounds such as CoCl2, NiCl2, FeCl2 and AgNO3 promote the vase-life and increase the size of the cut capitula in chrysanthemum and marigold (Chandra *et al*, 1981).

Use of sucrose along with CoCl2, NiCl2, FeCl2 and AgNO3causes a further increment in vase life of gladiolus by 20-24 days as compare to 7-8 days in water (Fig 3.).

Fig 1. Flower bud growth in Gladiolus development

Fig 2. Initial stages of development of capitulam in chrysanthemum

Fig 3. Gladiolus kept under sucrose solution

CONCLUSION

This is brief account of the work carried out by ICAR and other science research departments, has shown the various ongoing and completed experiments. We also recognized the need to understand the science behind empirical indigenous practices of growing, harvesting and storage of gladiolus and chrysanthemumto put it on a sound basis for exporting oriental flowers to the rest of the world. And also reviewed brief subject related to the basis of flower growth and wish to develop techniques to prolong the shelf life of harvested flower and we find a little information available in India mostly based on ongoing experimentation and systematic analysis.

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MOLECULAR CHRACTERIZATION OF CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM* RAMAT) GERMPLASM USING RAPD MARKERS

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Abstract: Genetic variation among 24 chrysanthemum cultivars was examined by RAPD markers. A total of 79 fragments was produced with 10 RAPD primers and out of which 64 (81.01%) were found polymorphic and 15 bands (18.99%) monomorphic. The number of polymorphic fragments varied from 4.0 (OPF13) to 15 (OPF06) with an average of 7.9 bands per primer. The PIC was varied from 0.10 to 0.66 with an average .50, MI varied from o.36 to 6.99 with an average 2.92 and RP value was noted in the ranged from 5.17 to 14.50 with an average 9.40. UPGMA clustering revealed two major group (Group1 and Group 2) and these further devided into seven clusters. Among the 24 genotypes, Poncho, Terri, Rangoli, Sweta, Ravikiran and Nanco are divergent and may be useful for breeding programme. Results suggested that RAPDs are highly useful for assessing the genetic diversity analysis among the chrysanthemum germplasm and parental selection studies in chrysanthemum.

Keywords: Chrysanthemum, molecular chracterization, RAPD markers, genetic diversity

INTRODUCTION

Chrysanthemum is the second largest cut flower after rose among the ornamental plants (Kumar *et al.*, 2006). Several species of chrysanthemum are ornamental and grown in gardens for their large, showy, multi colored flowers (Anon 1950). Now a day, ornamental plants market demands new cultivars for different characteristics (Minano *et al*., 2009). However, the information for higher flower yield and yield contributing parameters is limited. Genetic improvement and development of new varieties in chrysanthemum is very difficult due to genome complexity, high level of heterozygocity, occurrence of inbreeding depression, self incompatibility and high rate of failure of many crosses. (Wolff and Peter-van Rijn, 1993) . In newly developed varieties, systematic identification and characterization of cultivars is extremely important in horticultural crops in order to protect the plant breeders right (Kumar, *et al*., 2006). It is also interesting in particularly in chrysanthemum where many varieties are unknown. (Martin et al, 2002) Therefore, it is necessary to estimate the genetic variation and mode of inheritance of different plant parameters in order to select diverse parents for productive breeding programs in chrysanthemum. Morphological characterization is labor intensive and the phenotypic plasticity of plants makes environment variation a major problem. It is a simple technique to assess genetic variation in genotypes under normal growing environment. (Fu *et al.*, 2008 and Condit, 1955). Therefore, molecular markers are considered as useful tools for identification of plant cultivars. The number of molecular markers has been used to detect the variation in ornamental plants (Rout and Mohapatra, 2006). Out of which RAPD is widely used due to easily available markers.

In the present study, our objectives were to assess the genetic diversity in twenty four released varieties of chrysanthemum by using RAPD markers to identified diverse genotype for breeding programme.

MATERIAL AND METHOD

Plant material

A total of 24 genetically diverse genotypes of chrysanthemum were obtained from NBRI, Lucknow, IARI, New Delhi) (Table 1). Young leaves were collected from the field, put into labeled envelopes, and stored in an ice box for transport to the laboratory. In the laboratory the leaves were stored at –20°C in a freezer until their DNA was extracted.

Table. 1: Qualitative traits of 24 genotypes of chrysanthemum

S. No.	Genotypes	Growth habit	Flower colour	Disc colour	Type of Flower	Maturity group
1	Gaity	Upright and Medium	Pink	Yellow	Double	Mid
2	Kundan	Upright and Tall	Yellow	*	Double	Late
3	Santa Dina	Upright and Tall	Dark pink	Orange	Semi Double	Mid
4	Selection-69	Spreading and tall	Pink	Yellow	Double	Late
5	Selection-44	Spreading and Dwarf	Bronze with yellow margin	Yellow	Semi Double	Mid

6	White Prolific	Upright and Tall	White	Light yellow	Double	Mid
7	Terry	Upright and Medium	Bronze	Yellow	Semi Double	Early
8	Nanaco	Upright and Tall	Yellow	*	Double	Early
9	Rangoli	Upright and Dwarf	Dark pink	Yellow	Semi Double	Mid
10	Kirti	Spreading and Medium	White	Yellow	Semi Double	Early
11	Ravi Kiran	Upright and Tall	Red with pink margin	Dark red	Semi Double	Mid
12	Sonoton	Upright and Tall	Dark pink	Yellow	Single	Early
13	Sweeta	Upright and Tall	Light pink	*	Double	Mid
14	Poncho	Spreading and Medium	Orange	Orange	Single	Mid
15	Basmati Yellow	Upright and Tall	Dark Yellow	*	Double	Mid
16	Kamaudi	Upright and Tall	Mauve	*	Double	Late
17	Delilah	Upright and Medium	Pink	Yellow	Semi Double	Mid
18	Ratlam Selection	Upright and Tall	White with cremish center	*	Double	Mid
19	SKC-83	Upright and Dwarf	Pink	Yellow	Single	Early
20	White Bouquet	Upright and Medium	White with cremish center	*	Double	Early
21	Reagan Yellow	Upright and Tall	Pink	Yellow	Double	Mid
22	Mother Teresa	Upright and Dwarf	White with cremish center	Yellow	Double	Early
23	Birbal Sahni	Upright and Tall	White	*	Double	Mid
24	Fish Tail	Upright and Medium	White	*	Double	Mid

DNA extraction and RAPD analysis

Total genomic DNA was extracted from fresh and young leaf tissues following CTAB method (Doyle and Doyle, 1990). The quality of DNA was checked on 0.8% agarose gel and DNA concentration was determined using a Bio-Rad's Smart Spec^{TM} Plus spectrophotometer.

Molecular data analysis

Data generated by using 10 RAPD primers on 24 chrysanthemum genotypes were scored in binary format and further analyzed as described previously (Kumar *et al*., 2009). Besides this, PIC (polymorphism information content) Botstein et al. (1980), marker index (MI) (Milbourne *et al*., 1997) and Resolving Power (Rp) (Prevost and Wilkinson's, 1999) were also calculated.

RESULT

RAPD Analysis

Diversity analysis based on RAPD fingerprinting showed that the total number of polymorphic bands, number of monomorphic bands, PIC, marker index (MI) and resolving power (Rp) obtained for each primer are shown in the Table 3 and comparative list is presented in the Table 1&3. A total of 79 bands were detected using 10 RAPD primers on the basis of the presence (1) or absence (0) of the bands, out of these 15 were monomorphic and 64 were polymorphic thus generating 80.01% polymorphism (Table 2) among the 24 genotypes included in the investigation. Amplification patterns of various RAPD primers are shown in Figure 2a&b. RAPD DNA bands varied between 4 (OPF-13) and 15 (OPF-06) with an average of 7.9 bands per primer. The maximum number of polymorphic bands (13 bands) was obtained using OPF-06 primer. The average number of polymorphic bands was 6.4 per primer. The molecular size of the bands amplified using ten primers were in the range of 100-2100 bp (Table 2).

Polymorphic Information Content (PIC) *i.e.* the value of a marker for detecting polymorphism within a population, depending on the number of detectable alleles and the distribution of their frequency were calculated for individual primers. PIC values for RAPD primers ranged from 0.10 for OPD-08 to 0.66 for OPF-17, with an average of 0.50. Thus the study indicated that the RAPD primer OPF-17 used in the study was most polymorphic. Primers OPF-06, OPJ-08, OPC-15 and OPF-14 had PIC values more than average and therefore, may well be considered to be well spread over the entire genome randomly. The marker index (MI) varied between 0.36 (OPD-08) and 6.99 (OPF-06) with average marker index of 2.92.The resolving power (RP) varies between 5.17 (for OPF-17) and 14.50 (OPF-06) with an average value of 9.40.

All the 79 bands, generated from 10 RAPD primers, were subjected to calculate the genetic similarity index (RAPD-GS) among the 24 genotypes. Genetic similarities were calculated using the Nei-Li similarity co-efficient. Significant genetic variation was found among all chrysanthemum genotypes with the GS value ranging from 0.59 to 0.94 (Table 5). Of the 24 pair wise combinations generated by chrysanthemum genotypes, the highest genetic similarity was found between genotype Terry and genotype Nanaco, and genotype Reagan Yellow and genotype Birbal Sahni; while the lowest genetic similarity 0.59 was observed between genotype Selection-69 and genotype Mother Teresa. UPGMA clustering method for dendrogram construction and cultivar differentiation indicated that all 24 genotypes of chrysanthemum were discriminated successfully by RAPD markers. All the 24 genotypes of chrysanthemum were classified into two main groups (Group 1 and Group 2) at the coefficient of GS=0.70 (Figure 1). Group 1 and Group 2 divided further to give a total of Seven clusters, as described under. Group 1 divided into two clusters (Cluster I and Cluster II) at the coefficient of GS=0.73. Cluster I further subdivided into two sub clusters (Cluster Ia and Cluster Ib) at the coefficient of GS=0.83. Cluster Ia included 4 genotypes namely, Ratlam Selection, Reagan Yellow, Delilah and Kamaudi. Cluster Ib comprised of 3 genotypes viz., SKC-83, Birbal Sahni and Basanti Yellow. Cluster II subdivided into two sub clusters (Cluster IIa and Cluster IIb) at the coefficient of GS=0.75. Cluster IIa included only a single genotype Poncho; while Cluster IIb included 5 genotypes, viz., Sweeta, Sonoton, Fish Tail, Ravi Kiran and Nanaco. Group 2 further divided into two clusters (Cluster III and Cluster IV) at the coefficient of GS=0.81. Cluster III contained only two genotypes, Kirti and Mother Teresa. Cluster IV divided into two sub clusters (Cluster IVa and Cluster IVb) at the coefficient of GS=0.82. Cluster IVa included just one genotype, Terry. Cluster IVb included most of the genotypes (eight) namely, Rangoli, Selection-44, Kundan, Selection-69, Santa Dina, White Prolific, White Bouquet and Gaity.

Table 2: Analysis of RAPD markers.

Components	**RAPD**
Total number of Primers used	10
Polymorphic markers	all
Total number of bands amplified	79
Average number of bands per primer	7.9
Maximum number of bands amplified by a single primer	15
Number of polymorphic bands	64
Percentage of polymorphic bands (%)	81.01
Average number of polymorphic bands per primer	6.4
Maximum number of polymorphic bands amplified by a primer	13
PIC	
maximum	0.66
minimum	0.10
average	0.50
Marker Index (MI)	
maximum	6.99
minimum	0.36
average	2.92
Resolving power (Rp)	
maximum	14.50
minimum	5.17
average	9.40
Size of PCR product	0.1-2.1kbp

Taable 3: RAPD Primer code, no. of polymorphic alleles, no. of monomorphic alleles & PIC, MI and Rp value of 24 chrysanthemum genotypes

S.No.	Primer code	Polymorphic bands	Monomorphic bands	Diversity index (PIC)	Marker Index (MI)	Resolving Power (Rp)
1	OPF-06	13	2	0.62	6.99	14.5
2	OPC-07	7	0	0.50	3.49	8.42
3	OPJ-08	11	2	0.62	5.81	13.17
4	OPD-08	5	2	0.10	0.36	13.25
5	OPK-11	4	2	0.33	0.88	8.75
6	OPF-13	2	2	0.37	0.37	5.92
7	OPJ-13	5	2	0.52	1.84	8.25
8	OPF-14	7	1	0.65	4.01	9
9	OPC-15	5	2	0.62	2.21	7.58
10	OPF-17	5	0	0.66	3.29	5.17

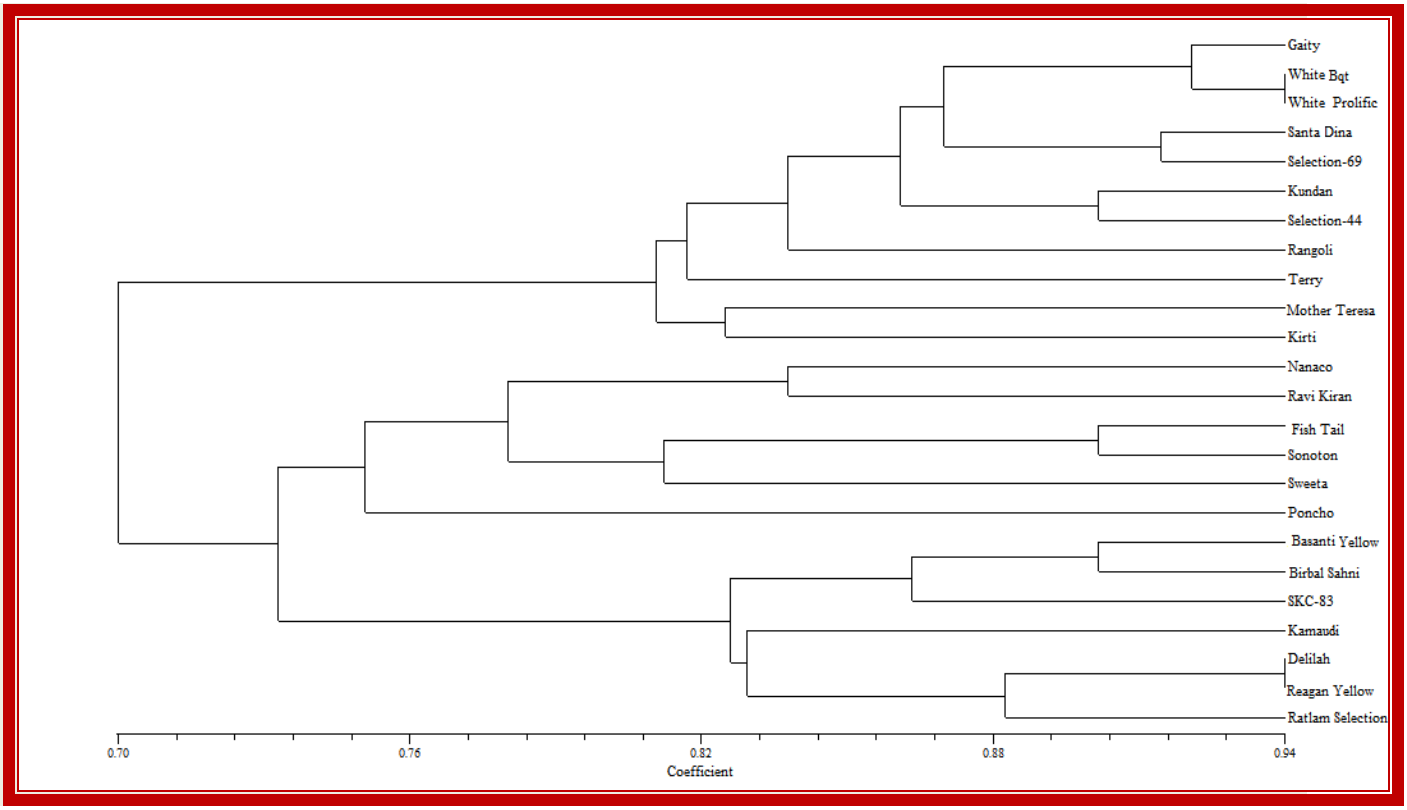

Fig. 1: Dendrogram showing clustering of 24 chrysanthemum genotypes constructed using UPGMA based on Jacquard's similarity coefficient obtained from RAPD analysis.

Table 4: List of RAPD primers

S.No.	Primer Code	Sequence	Make
1.	OPF-06	5'GGGAATTCGG3'	IDT
2.	OPC -07	5'GTCCCGACGA3'	IDT
3.	OPJ-08	5'CATACCGTGG3'	IDT
4.	OPD-08	5'GTGTGCCCCA3;	IDT
5.	OPK-11	5'AATGCCCCAG3'	IDT
6.	OPF-13	5'GGCTGCAGAA3'	IDT
7.	OPJ13	5'CCACACTACC3'	IDT
8.	OPF14	5'TGCTGCAGGT3'	IDT
9.	OPC-15	5'GACGGATCAG3'	IDT
10.	OPF17	5'AACCCGGGAA3'	IDT

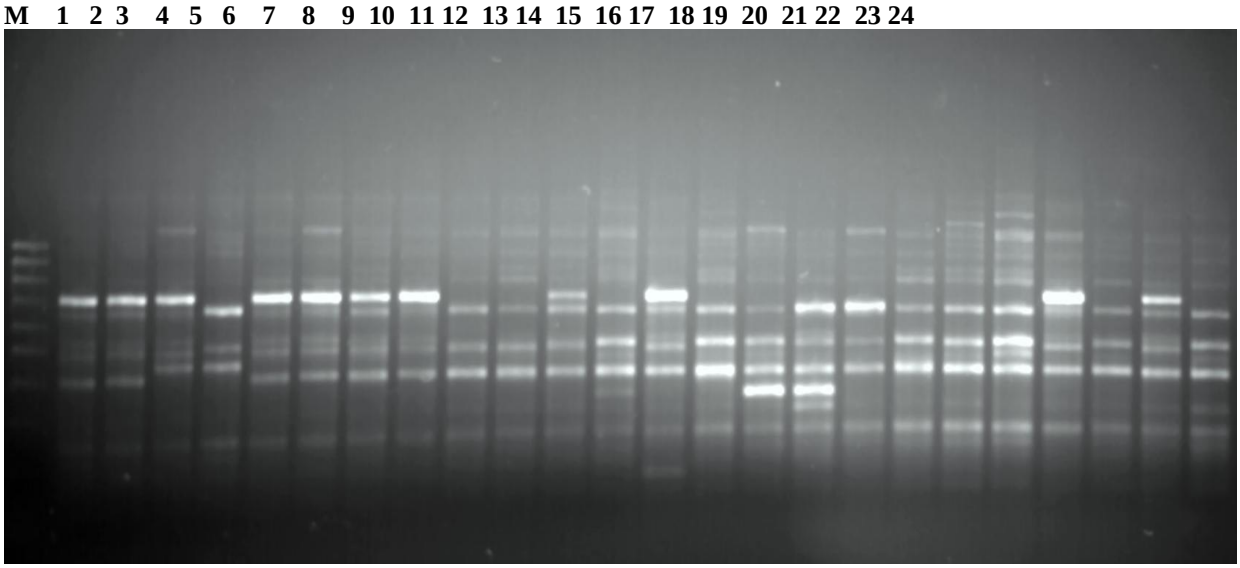

Fig. 2a: RAPD profiling pattern of 24 chrysanthemum genotypes with OPF-06 primer

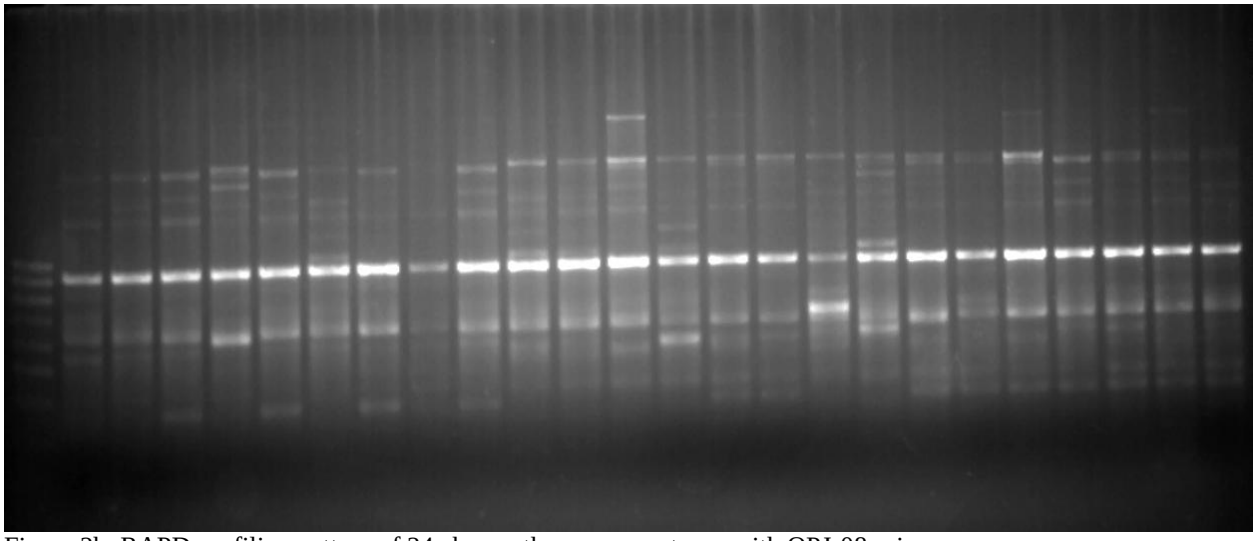

Figure 2b. RAPD profiling pattern of 24 chrysanthemum genotypes with OPJ-08 primer

Table 5: Similarity matrix generated by Jaccard's similarity coefficient for 24 genotypes of chrysanthemum obtained from RAPD analysis.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24
C1	1																							
C2	0.91	1																						
C3	0.85	0.86	1																					
C4	0.85	0.81	0.82	1																				
C5	0.89	0.87	0.91	0.81	1																			
C6	0.89	0.9	0.86	0.78	0.87	1																		
C7	0.91	0.85	0.86	0.81	0.9	0.8	1																	
C8	0.92	0.86	0.85	0.82	0.86	0.81	**0.94**	1																
C9	0.82	0.81	0.82	0.8	0.86	0.84	0.81	0.77	1															
C10	0.8	0.81	0.75	0.75	0.76	0.86	0.76	0.75	0.82	1														
C11	0.86	0.8	0.81	0.78	0.82	0.85	0.85	0.86	0.78	0.78	1													
C12	0.82	0.81	0.8	0.82	0.81	0.78	0.81	0.82	0.77	0.72	0.83	1												
C13	0.76	0.8	0.73	0.68	0.77	0.85	0.72	0.71	0.73	0.84	0.77	0.71	1											
C14	0.76	0.75	0.68	0.68	0.72	0.72	0.77	0.73	0.76	0.78	0.77	0.76	0.8	1										
C15	0.68	0.72	0.66	0.61	0.67	0.7	0.7	0.66	0.71	0.76	0.67	0.71	0.8	0.9	1									
C16	0.7	0.73	0.65	0.62	0.66	0.76	0.63	0.62	0.67	0.75	0.66	0.64	0.78	0.76	0.86	1								

C17	0.7	0.73	0.7	0.7	0.68	0.76	0.63	0.62	0.75	0.7	0.68	0.7	0.73	0.73	0.78	0.8	1							
C18	0.73	0.72	0.71	0.66	0.72	0.7	0.75	0.71	0.71	0.73	0.72	0.71	0.77	0.85	0.87	0.78	0.78	1						
C19	0.73	0.7	0.68	0.63	0.7	0.67	0.72	0.71	0.66	0.68	0.72	0.71	0.75	0.82	0.85	0.76	0.68	0.9	1					
C20	0.67	0.66	0.67	0.62	0.68	0.63	0.66	0.62	0.65	0.64	0.66	0.64	0.66	0.76	0.76	0.67	0.7	0.81	0.83	1				
C21	0.71	0.72	0.76	0.63	0.77	0.7	0.7	0.68	0.71	0.63	0.72	0.68	0.67	0.7	0.75	0.68	0.78	0.8	0.77	0.81	1			
C22	0.67	0.68	0.67	**0.59**	0.68	0.66	0.63	0.62	0.67	0.7	0.63	0.62	0.68	0.76	0.81	0.72	0.75	0.83	0.81	0.85	0.89	1		
C23	0.75	0.73	0.75	0.65	0.76	0.71	0.71	0.7	0.7	0.64	0.76	0.7	0.68	0.73	0.76	0.7	0.77	0.83	0.81	0.82	**0.94**	0.87	1	
C24	0.68	0.65	0.66	0.66	0.65	0.62	0.65	0.63	0.63	0.66	0.67	0.63	0.67	0.75	0.77	0.71	0.71	0.85	0.87	0.83	0.82	0.86	0.86	1

DISCUSSION

Molecular traits based diversity

Polymorphic genetic markers have wide potential applications in plant improvement programmes as a means for varietal and parentage identification, evaluation of polymorphic genetic loci affecting quantitative economic traits, and genetic mapping. A total of 79 bands were detected using 10 RAPD primers in the present study, out of these 15 were monomorphic and 64 were polymorphic (Table 2), thus generating 81.01% polymorphism. The results of polymorphism generated by RAPD in chrysanthemum genotypes were in close conformity with those of earlier investigators (Wolff. and Peters, 1993; Wolff, 1996; Martin, *et al.,* 2002, Kumar, *et al.,* 2006. The maximum number of polymorphic bands (13 bands) was obtained using OPF-06 primer. The average PIC, MI and Rp values for RAPD primers were 0.50, 2.92 and 9.40 respectively. RAPD primers except OPF-13 are significantly efficient in analysis considering the values of PIC and Rp.

In the present study, a dendrogram was constructed based on the basis of RAPD markers which showed 81.01 per cent of the bands observed were polymorphic between the 24 chrysanthemum genotypes. This seems to be relatively high when compared to the reports of other RAPD studies, e.g. in Brassica spp (Demeke *et.al.,* 1992), Alternaria spp (Wilkie *et.al*., 1993) Sorghum (Tao *et al*.1993), Alfalfa (Yu and Nguyen, 1994), celery (Yang and Quiros, 1993) and Sweet Potato (Connolly *et.al.,* 1994). One of the reasons for this high level of polymorphism could be that the intra-specific variation in chrysanthemum is extensive. The other reason could be that we have used primers with 60 to 70% GC content, whereas some other workers, including Yamamoto *et al*. (1994) have included primers with less GC content also in their studies. Fukuoka *et al.* (1992) observed an increase in the number of bands with increasing GC content of the primers. They got an average of 0.8 bands per primer with 40 per cent, 6.1 bands with 50 per cent and 8.6 bands with 60 per cent GC content. The explanation for this correlation between the GC content of the primer and the number of bands is that the stability of base complementation is high when G is pairing with C by three hydrogen bonds than the complementation of A with T by two hydrogen bonds.

CONCLUSION

In the present study, RAPD analysis provided good insight of genetic diversity. UPGMA analysis clearly separated the genotypes into distinct groups. Therefore, the present study suggested that molecular markers could be used to achieve a reliable evaluation and robust characterization of the species diversity. Present study showed that some genotypes like Poncho, Terri, Rangoli, Sweta, Ravikiran and Nanco were more diverse than others and these genotypes could be a good alternative source for fruitful chrysanthemum breeding program.

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ASSESSMENT OF GENETIC DIVERSITY IN CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM* RAMAT) USING MICROSATELLITE MARKERS

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Abstract: The genetic diversity among 24 chrysanthemum cultivars was investigated by 07 Simple Sequence Repeats (SSRs). A total of 16 bands were produced out of which 15 bands were found polymorphic and 01 band monomorphic. The number of polymorphic fragment varied from 02 (RM1) to 03 (RM433) with an average 2.14 fragment per primer and percent polymorphism varied from 66.75 to 100% with an average of 93.75%. The PIC varied from 0.42 to 0.95 with an average of 0.74. The RP and MI ranged from (0.83 to 0,57) to (4.0 and 2.76) with an average (2.03 and 0.57) respectively. The UPGMA clustering revealed two major groups and found considerable amount of genetic diversity. Among the 24 cultivars, Ravikiran, Selection 44, Kundan, Terri, Sonton and Poncho are divergent and may be used for breeding programme Results suggested that SSRs are highly useful for assessing the genetic diversity analysis among the chrysanthemum germplasm and parental selection studies in chrysanthemum.

Keywords: Chrysanthemum, molecular charecterization, SSR marker, genetic diversity

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflorum* syn. *Chrysanthemum morifolium*) is one of the most important ornamental crops in the world and it has been cultivated more than 2000 years (Martin and Benito, 2005). It is a genus of about 30 species of herbs and shrubs, which are all perennial flowering plants in the family Asteraceae or Compositae. The cultivated chrysanthemum is originally native of Asia (China and Japan) and northeastern Europe. It is the second largest cut flower after rose among the ornamental plants (Kumar *et al*., 2006). Several species of chrysanthemum are ornamental and grown in gardens for their large, showy, multi colored flowers (Anon 1950). Now a day, ornamental plants market demands new cultivars for different characteristics (Minano et al, 2009). However, the information for higher flower yield and yield contributing parameters is limited. Genetic improvement and development of new varieties in chrysanthemum is very difficult due to genome complexity, high level of heterozygocity, occurrence of inbreeding depression, self incompatibility and high rate of failure of many crosses. (Wolff and Peter-van Rijn, 1993). In newly developed varieties, identification and characterization of cultivars is extremely important in order to protect the plant breeders right (Kumar, *et al*., 2006). It is also interesting particularly in chrysanthemum where many varieties are unknown. Therefore, it is necessary to estimate the genetic variation and mode of inheritance of different plant parameters in order to select diverse parents for productive breeding programs and to compliment traditional breeding efforts in chrysanthemum. Morphological characterization is labor intensive and the phenotypic plasticity of plants makes environment variation a major problem. It is a simple technique to assess genetic variation in genotypes under normal growing environment. (Fu et al, 2008 and Condit, 1955). Therefore, molecular markers are considered as useful tools for identification of cultivars.

Among the available molecular markers, microsatellites commonly known as simple sequence repeats (SSRs) have been widely used due to highly polymorphic, heterozygous conserved sequences which can be used as co-dominant markers. (Rallo *et al*., 2000, Cipriani *et al*., 2002 and Rajora and Rahman, 2002). The aim of the study was to assess the genetic diversity among 24 chrysanthemum cultivars grown in Northern India

MATERIAL AND METHOD

Plant material and field experiment

A total, 24 genetically diverse genotypes of chrysanthemum were obtained from NBRI, Lucknow, IARI, New Delhi. (Table 1). Young leaves were collected from the field of Horticultural Research Centre (HRC), put into cultivar named envelopes, and stored in an ice box for transport to the laboratory. In the laboratory the leaves were stored at –20°C in a freezer until their DNA was extracted.

Table 1: Qualitative traits of 24 genotypes of chrysanthemum

S. No.	Genotypes	Growth habit	Flower colour	Disc colour	Type of Flower	Maturity group
1	Gaity	Upright and Medium	Pink	Yellow	Double	Mid

2	Kundan	Upright and Tall	Yellow	*	Double	Late
3	Santa Dina	Upright and Tall	Dark pink	Orange	Semi Double	Mid
4	Selection-69	Spreading and tall	Pink	Yellow	Double	Late
5	Selection-44	Spreading and Dwarf	Bronze with yellow margin	Yellow	Semi Double	Mid
6	White Prolific	Upright and Tall	White	Light yellow	Double	Mid
7	Terry	Upright and Medium	Bronze	Yellow	Semi Double	Early
8	Nanaco	Upright and Tall	Yellow	*	Double	Early
9	Rangoli	Upright and Dwarf	Dark pink	Yellow	Semi Double	Mid
10	Kirti	Spreading and Medium	White	Yellow	Semi Double	Early
11	Ravi Kiran	Upright and Tall	Red with pink margin	Dark red	Semi Double	Mid
12	Sonoton	Upright and Tall	Dark pink	Yellow	Single	Early
13	Sweeta	Upright and Tall	Light pink	*	Double	Mid
14	Poncho	Spreading and Medium	Orange	Orange	Single	Mid
15	Basmati Yellow	Upright and Tall	Dark Yellow	*	Double	Mid
16	Kamaudi	Upright and Tall	Mauve	*	Double	Late
17	Delilah	Upright and Medium	Pink	Yellow	Semi Double	Mid
18	Ratlam Selection	Upright and Tall	White with cremish center	*	Double	Mid
19	SKC-83	Upright and Dwarf	Pink	Yellow	Single	Early
20	White Bouquet	Upright and Medium	White with cremish center	*	Double	Early
21	Reagan Yellow	Upright and Tall	Pink	Yellow	Double	Mid
22	Mother Teresa	Upright and Dwarf	White with cremish center	Yellow	Double	Early
23	Birbal Sahni	Upright and Tall	White	*	Double	Mid
24	Fish Tail	Upright and Medium	White	*	Double	Mid

DNA extraction and SSR analysis

Genomic DNA extraction and further microsatellite analysis was performed as described earlier (Kumar *et al*., 2009). Details of SSR primers used are provided in Table 3.

Molecular data analysis

Data generated by using 10 microsatellites primers on 24 chrysanthemum genotypes were scored in binary format and further analysed as described previously (Kumar *et al*., 2009). Besides this, PIC (polymorphism information content) Botstein et al. (1980), marker index (MI) (Milbourne et al. 1997) and Resolving Power (Rp) (Prevost and Wilkinson's, 1999) were also calculated.

RESULT

The genetic data generated through SSR profiling among 24 cultivars, a total of 16 bands were detected using 7 SSR primers, out of which only one was monomorphic and 15 were polymorphic (Table 2). Amplification patterns of various SSR primers are shown in Figure 1. SSR DNA bands varied between 2 (RM447, RM284, RM1, RM152 and RM259) and 3 (RM408 and RM433), with an average of 2.29 bands per primer. The maximum numbers of polymorphic bands (3 bands) were obtained using RM408 and RM433 primers (Fig 2a&b). The average number of polymorphic bands was 2.14 per primer. In the present study, 93.75% polymorphism was obtained by SSR assay. PIC value for SSR ranged from 0.42 (RM408) to 0.95 (RM1, thus highly polymorphic), with an average of 0.74. The marker index (MI) ranged from 0.57 (RM 408) to 2.76 (RM433), with average of 1.57. The resolving power (RP) varied between 0.83 (RM1) and 4 (RM408) with an average value of 2.03.

All the 16 bands, generated from 7 SSR primers, were subjected to calculate the genetic similarity index (SSR-GS) among the 24 genotypes. Genetic similarities were calculated using the Nei-Li similarity co-efficient. Significant genetic variation was found among all chrysanthemum genotypes with the GS value ranging from 0.13 to 0.96 (Table 5). Of the 24 pair wise combinations generated by chrysanthemum genotypes, the highest genetic similarity was found between genotypes Gaity and Selection-69; and genotypes Sonoton and Sweeta; while the lowest genetic similarity was observed between genotype Gaity and genotype Ratlam Selection. The UPGMA clustering method for dendrogram construction and cultivar differentiation indicated that application of SSR assay classified all the 24 genotypes of chrysanthemum into two main groups (Group 1 and Group 2) at the coefficient of GS=0.50 (Figure 1). Group 1 and Group 2 further divided in to seven clusters, as described under.

Group 1 divided into 2 main clusters (Cluster I and Cluster II) at the coefficient of GS=0.68. Cluster I further divided into two sub clusters (Cluster Ia and Cluster Ib) at the coefficient of GS=0.85. Cluster Ia included just two genotypes namely, Ratlam Selection and SKC-83. Cluster Ib included six genotypes namely, Kamaudi, Delilah, Reagan Yellow, Mother Teresa, Basanti Yellow and Poncho. Cluster II divided into two sub clusters (Cluster IIa and Cluster IIb) at the similarity coefficient of GS=0.73. Cluster IIa contained only one genotype, Ravi Kiran. Cluster IIb comprised of six genotypes, viz., Sonoton, Sweeta, Fish Tail, Kirti, Rangoli and Nanaco. Group 2 divided into 2 main clusters (Cluster III and Cluster IV) at the coefficient of GS=0.62. Cluster III included two genotypes, Selection-44 and Kundan. Cluster IV divided into 2 sub clusters (Cluster IVa and Cluster IVb) at the coefficient of GS=0.76. Cluster IVa comprised only a single genotype, Terry. Cluster IVb included six genotypes, viz., White Bouquet, Santa Dina, White Prolific, Birbal Sahni, Selection-69 and Gaity.

Table 2: Analysis of SSR markers.

Components		**SSR**
Total number of Primers used		7
Polymorphic markers		all
Total number of bands amplified		16
Average number of bands per primer		2.29
Maximum number of bands amplified by a single primer		3
Number of polymorphic bands		15
Percentage of polymorphic bands (%)		93.75
Average number of polymorphic bands per primer		2.14
Maximum number of polymorphic bands amplified by a primer		3
PIC		
maximum		0.95
minimum		0.42
average		0.74
Marker Index (MI)		
maximum		2.76
minimum		0.57
average		1.57
Resolving power (Rp)		
maximum		4
minimum		0.83
average		2.03
Size of PCR product		0.4-1.0kbp

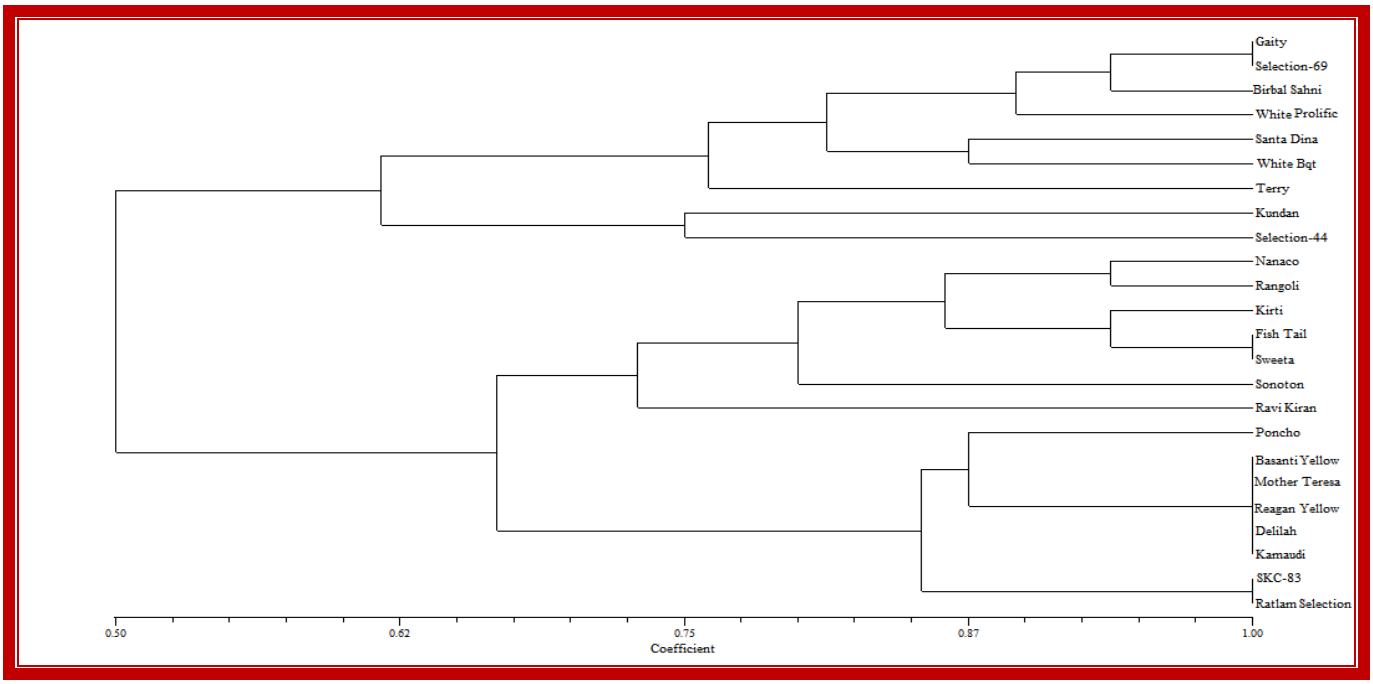

Fig. 1: Dendrogram showing clustering of 24 chrysanthemum genotypes constructed using UPGMA based on Jacquard's similarity coefficient obtained from SSR analysis.

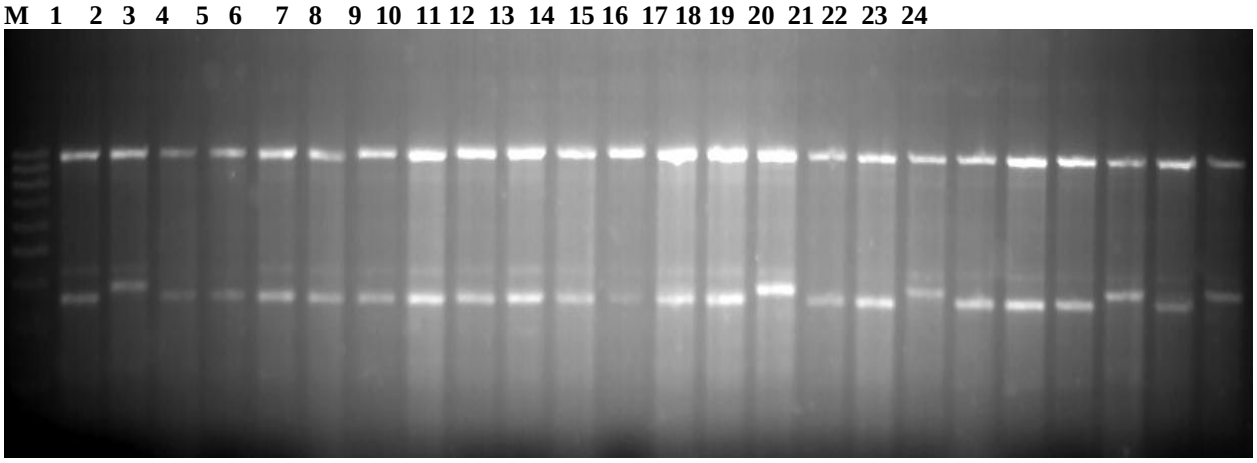

Fig. 2a: SSR profiling pattern of 24 chrysanthemum genotypes with RM408 primer

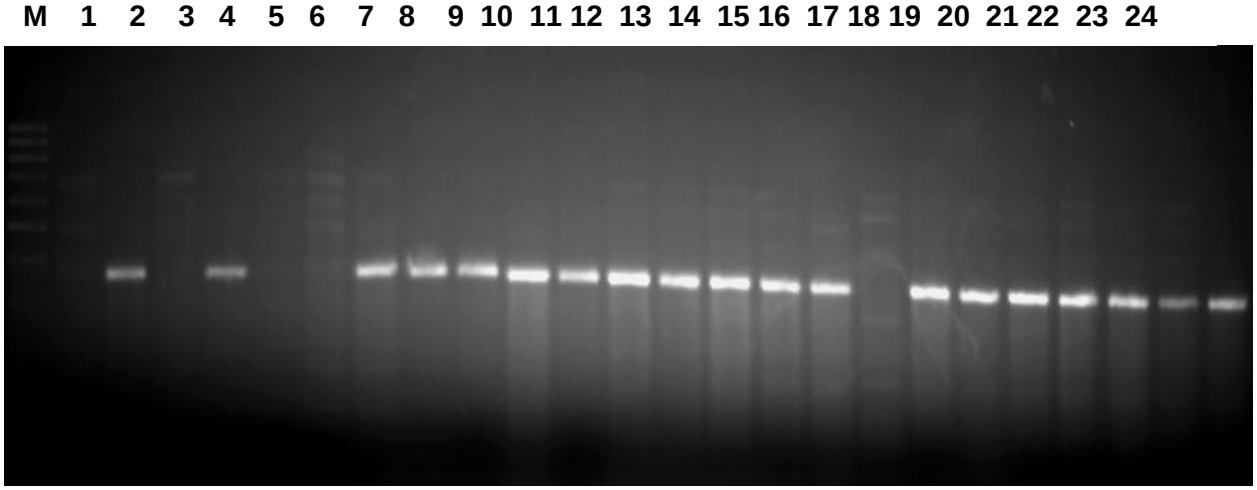

Fig. 2b: SSR profiling pattern of 24 chrysanthemum genotypes with RM433 primer

DISCUSSION

The term SSR (simple sequence repeat markers) microsatellite was coined by Litt and Luty (1989). These markers essentially belong to the repetitive DNA family. Fingerprints generated by the corresponding primers are also known as oligonucleotide fingerprints. Microsatellites or short tandem repeats/simple sequence repeats (STRs/SSRs) consist of 1 to 6 bp long monomer sequences which are repeated several times. In the present study, a total of 16 bands were detected using 07 SSR primers, out of which only one was monomorphic and 15 were polymorphic (Table 2). SSR bands varied between 2 (RM447, RM284, RM1, RM152 and RM259) and 3 (RM408 and RM433), with an average of 2.29 bands per primer. The maximum numbers of polymorphic bands (3 bands) were obtained using RM408 and RM433 primers. The average number of polymorphic bands was 2.14 per primer thus generated 93.75% polymorphism . This seems to be relatively high when compared to the reports of other SSR studies, e.g. in Gerbera hybrida (Gong and Deng, 2012), Pelargonium (Becher *et.al*., 2000). In our study, SSR markers gave more polymorphism then RAPD markers which has been earlier used by some workers in chrysanthemum (Kumar *et al*., 2006, Baliyan et al, 2014). It might be due to that microsatellite markers are more informative than RAPD markers. Therefore, it is highly polymorphic, consistant and co-dominant markers which provide excellent markers for clone and cultivar identification in poplars. (Rehman and Rajora, 2002), (Dayanadan *et al.* 1998; Rehman *et al.* 2000; Rajora and Rehman 2002), as well as in a number of agricultural and horticultural plants (Becher *et al.* 2000; Li *et al.*, 2000). . The primer RM1, was observed to be highly polymorphic (PIC value of 0.95). The average PIC, MI and Rp values for SSR primers were 0.74, 1.57 and 2.03 respectively. Depending upon the value of PIC, MI and Rp, it may be concluded that most of the SSR primers except RM1 were highly significant in analysis. Through SSR assay (Fig 1), the 24 chrysanthemum genotypes were divided into seven clusters. The information on SSR analysis in chrysanthemum in literature is not available.

Table 3. SSR Primer code, no. of polymorphic alleles, no. of monomorphic alleles & PIC, MI and Rp value of 24 chrysanthemum genotypes

S.No.	Primer code	Polymorphic bands	Monomorphic bands	Diversity index PIC	Marker Index (MI)	Resolving Power (Rp)
1	RM447	2	0	0.73	1.47	2
2	RM284	2	0	0.82	1.64	1.67
3	RM408	2	1	0.42	0.57	4
4	RM433	3	0	0.92	2.76	1.67
5	RM1	2	0	0.95	1.90	0.83
6	RM152	2	0	0.57	1.14	2.08
7	RM259	2	0	0.75	1.50	2

Table 4: List of SSR primers

S.No.	Primer Code	Forward Sequence	Reverse Sequence	Make
1.	RM 447	CCC TTG TGC TGT CTC CTC TC	AGC GGC TTC TTC TCC TCC TC	IDT
2.	RM 284	ATC TCT GAT ACT CCA TCC AT	CCT GTA CGT TGA TCC GAA GC	IDT
3.	RM 408	CAA CGA GCT AAC TTC CGT CC	ACT GCT ACT TGG GTA GCT GA	IDT
4.	RM 433	TGC GCT GAA CTA AAC ACA GC	AGA CAA ACC TGG CCA TTC AC	IDT

5.	RM 1	'GCA AAA ACA CAA TGA AAA AA'	GCG TTG GTT GAC CTG AC'	IDT
6.	RM 152	GAA ACC ACC ACA CCT CAC CG	CCG TAT ACC TTC TTG AAG TA	IDT
7.	RM 259	TGG AGT TTG AGA GGA GGG	CTT GTT GCA TGG TGC CAT GT	IDT

Table 5: Similarity matrix generated by Jaccard's similarity coefficient for 24 genotypes of chrysanthemum obtained from SSR analysis.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24
C1	1																							
C2	0.56	1																						
C3	0.88	0.69	1																					
C4	**0.96**	0.63	0.81	1																				
C5	1	0.56	0.88	0.84	1																			
C6	0.69	0.75	0.81	0.63	0.69	1																		
C7	0.88	0.56	0.75	0.84	0.88	0.56	1																	
C8	0.75	0.69	0.88	0.81	0.75	0.69	0.88	1																
C9	0.75	0.44	0.63	0.81	0.75	0.44	0.88	0.75	1															
C10	0.63	0.19	0.5	0.56	0.63	0.44	0.5	0.38	0.62	1														
C11	0.56	0.43	0.44	0.5	0.56	0.38	0.56	0.44	0.69	0.91	1													
C12	0.63	0.19	0.5	0.56	0.63	0.31	0.63	0.5	0.75	0.88	0.84	1												
C13	0.5	0.44	0.63	0.44	0.5	0.56	0.5	0.63	0.5	0.62	0.69	**0.96**	1											
C14	0.69	0.25	0.56	0.63	0.69	0.38	0.69	0.56	0.69	0.81	0.88	0.84	0.81	1										
C15	0.56	0.38	0.44	0.5	0.56	0.25	0.56	0.44	0.56	0.69	0.75	0.81	0.69	0.88	1									
C16	0.69	0.25	0.56	0.63	0.69	0.38	0.69	0.56	0.69	0.81	0.88	0.93	0.81	1	0.88	1								
C17	0.63	0.19	0.5	0.56	0.63	0.31	0.62	0.5	0.75	0.75	0.81	0.88	0.62	0.81	0.69	0.81	1							
C18	**0.13**	0.44	0.5	0.31	0.38	0.31	0.38	0.5	0.5	0.5	0.56	0.62	0.62	0.56	0.69	0.56	0.75	1						
C19	0.16	0.31	0.63	0.44	0.5	0.44	0.5	0.62	0.62	0.62	0.69	0.75	0.75	0.69	0.56	0.69	0.88	0.88	1					
C20	0.5	0.31	0.63	0.44	0.5	0.44	0.5	0.62	0.62	0.62	0.69	0.75	0.75	0.69	0.56	0.69	0.88	0.88	1	1				
C21	0.5	0.31	0.63	0.44	0.5	0.44	0.5	0.62	0.62	0.62	0.69	0.75	0.75	0.69	0.56	0.69	0.88	0.88	1	1	1			
C22	0.38	0.44	0.5	0.31	0.38	0.31	0.38	0.5	0.5	0.5	0.56	0.62	0.62	0.56	0.69	0.56	0.75	1	0.88	0.88	0.88	1		
C23	0.5	0.31	0.63	0.44	0.5	0.44	0.5	0.62	0.62	0.62	0.69	0.75	0.75	0.69	0.56	0.69	0.88	0.88	1	1	1	0.88	1	
C24	0.5	0.31	0.63	0.44	0.5	0.44	0.5	0.62	0.62	0.62	0.69	0.75	0.75	0.69	0.56	0.69	0.88	0.88	1	1	1	0.88	1	1

CONCLUSION

In the present study, SSR-based analysis provided good insight of genetic diversity. On the other hand, SSR data, UPGMA analysis clearly separated the genotypes into distinct groups. Therefore, the present study suggested that microsatellite markers should be used in order to achieve a reliable evaluation and robust characterization of chrysanthemum germplasm. Present study showed that some genotypes like SKC-83, Ratlam Selection, Gaity, and Selection-69 were more diverse than others and these genotypes could be a good alternative source for fruitful chrysanthemum breeding program.

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PHENOLOGICAL BEHAVIOUR OF SELECTED TREE SPECIES IN TROPICAL DECIDUOUS FOREST OF HASTINAPUR REGION IN WESTERN U.P.

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Abstract : Vegetative and reproductive phenology of 20 selected tree species in tropical deciduous forest of Hastinapur region in western U.P. was monitored through fortnightly visit during November 2009 to December 2011 revealed that there exists a strong seasonality for leaf flush, leaf fall, flowering and fruiting phenophases. A considerable variation was found in leaf flushing, leaf fall, flowering and fruiting behaviour that could be partly attributed to biotic and abiotic factors. Peak activity of leaf fall and leaf emergence that occurred in the early dry period, could be to take full advantage of the first rainy season for vegetative growth and reproduction. Interphenophases duration between phenological events varied for different selected dominant tree species. The fruiting phenology follows closely the flowering phenology. The duration of maturation of leaves was the shortest, while that of fruit ripening was the longest.

Keywords: Hastinapur, phenology, tree species, tropical deciduous forest, etc.

INTRODUCTION

Phenology is the study of the timing of recurring biological events, among phases of the plant species, which provide a background for collecting and synthesizing detailed quantitative information on rhythms of plant communities. Tropical plants with their high level of species diversity display phenological events such as leaf drop, leaf flush, flowering and fruiting, etc. in relation to time and space. (Singh and Singh, 1992). Phenology patterns are most diverse and least understood. Studies from different parts of world have shown that climatic factors are mainly responsible for vegetative and reproductive phenology at both community and species level. Phenology of the tropical forest tree species is not well understood, although water stress is most frequently cited as a primary factor responsible for the timing of phenological events (Singh and Singh, 1992). However, various phenological events are triggered by rainfall, water availability, temperature, photoperiod, duration of dry spell and change in day length. The composition of tree species, their periodic straightification, and life span are some important analytic aspects of a plant community. Plant phenology has great significance because it not only provides knowledge of plant growth pattern and development as well as the effects of environment and selective pressure on flowering and fruiting behaviour (Zhang *et al*., 2006). Plant phenology are the result of interaction of biotic and abiotic factors over evolutionary time and through natural selection, the biotic and abiotic factors have entrained rhythemicity in plant life that results in appropriate of flowering, fruiting and leaf flushing and efficient growth and reproduction (Van Schaik *et al*.,1993).

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

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

MATERIAL AND METHOD

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

suffering from various disturbances such as grazing, burning and cutting etc.

Methodology: Three sites were selected for phenological study. All the individual of selected tree species with a girth of 31cm and above were marked with a metal tag. Each site was visited once a fortnight from November, 2009 to December, 2011 to record the change for the 9 phenological events namely production of young leaves (YL), maturation of leaves (ML), abscission of leaves (AL), production of young flowers (YF1), maturation (anthesis) of flowers (MF1), abscission of flowers (AF1), production of young fruits (YFr), maturation of fruits (MFr) and ripening of fruits (RFr).

During the fortnightly visits, marked individual were qualitatively characterized for these 9 phenological events (Prasad and Hegde, 1986) and phenostage of each species was determined by considering the status of majority of individuals. In the case of species represented by only a few individuals, those present in nearby areas were observed to confirm the phenological status of that species. For each selected dominant tree species, majority of individuals observed phenophages event on a sampling date was recorded. The duration of phenological events in a species was computed by obtaining the number of days required for the completion of an event from the date of the fortnightly visit when the event was first observed. For each species, interphenophase duration, i.e. period between successive phenological events, were then obtained.

Table-2.5: Tree species, vegetation type (VT) and interphenophase duration (days).

S.N.	Tree Species	VT	Interphenophase duration (days)					
			YL-ML	ML-AL	YF1-MF1	MF1-AF1	YFr-MFr	MFr-RFr
1	*Acacia nilotica*	D	29	278	29	28	58	153
2	*Acacia farnesiana*	D	30	283	31	27	49	151
3	*Acacia catechu*	D	34	267	34	30	47	161
4	*Ailanthus excelsa*	D	33	279	35	30	30	43
5	*Albizia lebbeck*	D	29	278	27	22	179	61
6	*Bauhinia purpurea*	SE	31	301	20	22	59	89
7	*Butea monosperma*	D	30	285	23	25	30	80
8	*Bauhinia racemosa*	D	32	287	27	29	37	67
9	*Bauhinia variegata*	D	29	285	28	27	41	69
10	*Cassia fistula*	D	25	268	29	26	136	125
11	*Dalbergia sissoo*	D	30	289	19	21	38	48
12	*Diospyros cordifolia*	D	20	296	23	24	61	38
13	*Eucalyptus globulus*	E	-	-	29	28	36	41
14	*Prosopis juliflora*	D	24	298	29	26	36	79
15	*Pongamia pinnata*	E	-	-	20	26	72	68
16	*Phoenix sylvestris*	E	-	-	18	46	129	117
17	*Pithecelobium dulce*	D	25	283	22	29	75	51
18	*Tectona grandis*	D	29	281	29	34	62	65
19	*Heterophragma adenophyllum*	D	34	302	35	75	31	73
20	*Zizyphus xylopyra*	D	38	282	25	23	125	116

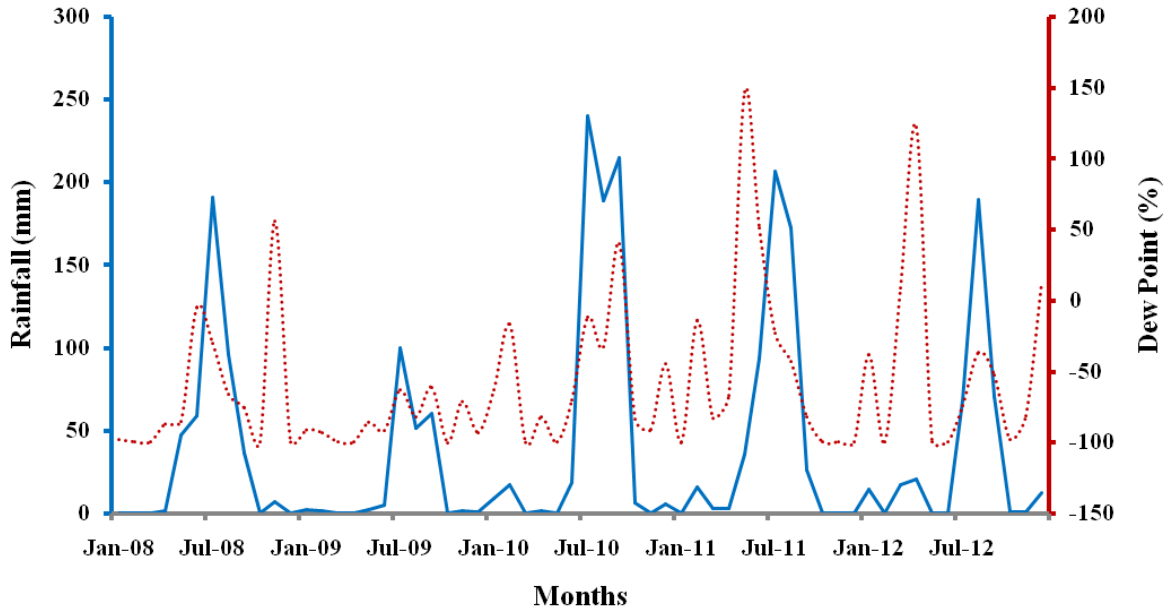


Figure-2.1: Monthly Average Rainfall and Dew Point Time Series of Meerut.

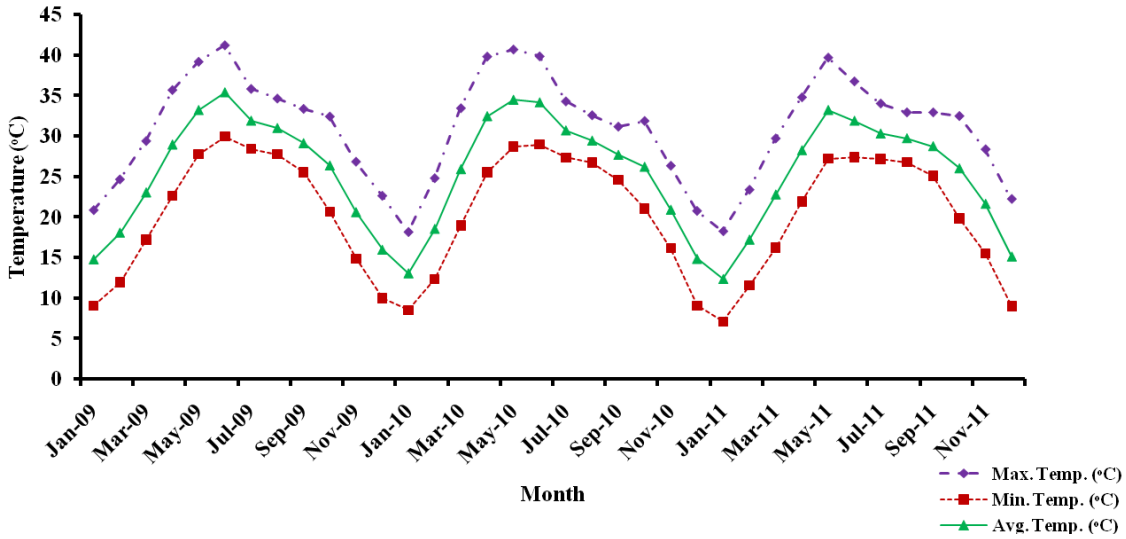
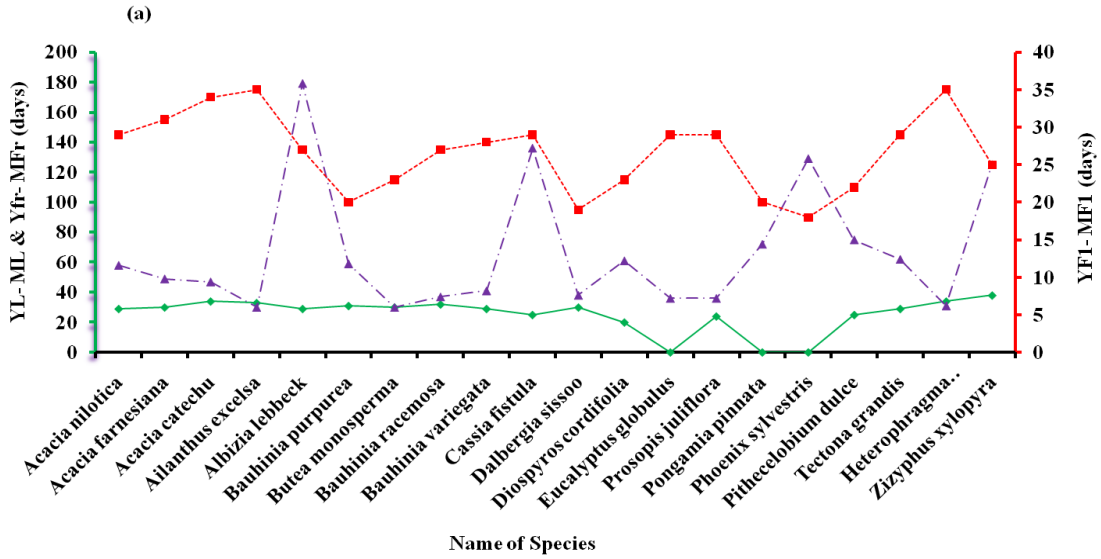


Figure-2.2: Monthly Average Time Series of Temperature.



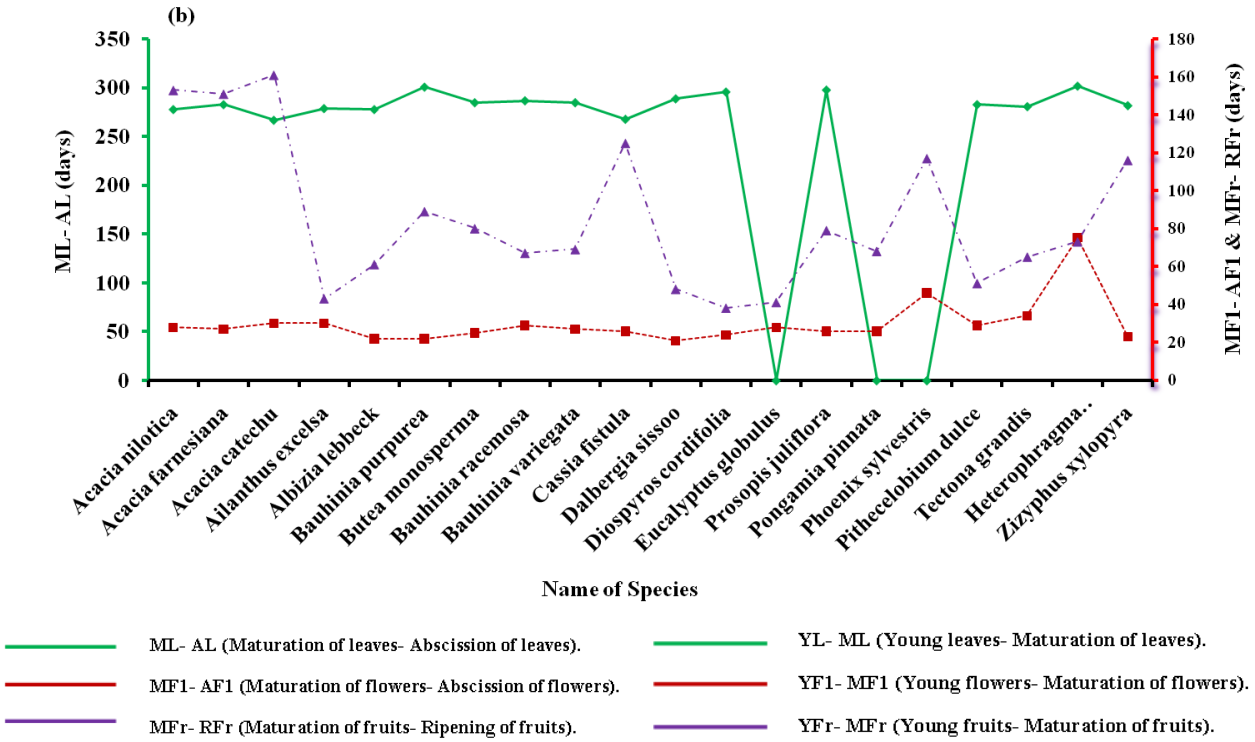


Figure-2.3 (a & b): Variation in different interphenophases of dominant tree species.

RESULT AND DISCUSSION

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

In present study, on the basis of leaf shading nature we categorized 16 tree species namely *Acacia nilotica, Acacia farnesiana, Acacia catechu, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia variegata, Cassia fistula, Dalbergia sissoo, Diospyros cordifolia, Prosopis juliflora, Pithecelobium dulce, Tectona grandis, Heterophragma adenophyllum and Zizyphus xylopyra* as deciduous species, three tree species namely *Eucalyptus globulus, Pongamia pinnata, Phoenix sylvestris* as evergreen and one namely *Bauhinia purpurea* as semi- evergreen species (Table-2.1).

Foliage phenology: In the present study, we observed that leaves emerge and mature during the period with minimal rainfall, high temperature and increasing day length in all three sites and leaves abscission occurs when the temperature begins to decrease and day length is short. The duration of leaf maturation varied from 20 days (*Diospyros cordifolia)* to 38 days (*Zizyphus xylopyra)*. The period between maturation and abscission of leaves ranged from 267 days (*Acacia catechu)* to 302 days (*Heterophragma adenophyllum)* (Table-2.1).

Leaf Initiation: Leaf flushing was also a periodic phenomenon in all the selected 20 dominant tree species with considerable variation. Among 20 species observed, 11 species namely *Acacia nilotica, Acacia farnesiana, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia variegata, Dalbergia sissoo, Prosopis juliflora, Pithecelobium dulce* and *Heterophragma adenophyllum* leaf initiation started in March, two species namely *Cassia fistula* and *Zizyphus xylopyra* leaf initiation started in June, two species namely *Diospyros cordifolia* and *Tectona grandis* leaf initiation started in February whereas in *Acacia catechu* in April and *Bauhinia purpurea* in January. There was a complete absence of leaf flushing in most of the selected tree species from September to January except *Bauhinia purpurea* (semi- evergreen) which showed leaf initiation in January.

Leaf Flush Duration: Single episodic of leaf flush and leaf fall occurred in all selected deciduous tree species during the annual cycle. Wide diversity existed among the species in terms of duration of leaf flush. 11 species (*Acacia nilotica, Acacia farnesiana, Ailanthus excelsa, Albizia lebbeck, Butea monosperma, Bauhinia racemosa, Bauhinia variegata, Dalbergia sissoo, Prosopis juliflora, Pithecelobium dulce* and *Heterophragma adenophyllum)* produced new leaves through March-April, two species (*Cassia fistula* and *Zizyphus*

xylopyra) produced new leaves through June- August and two species (*Diospyros cordifolia* and *Tectona grandis*) produced new leaves through February- April. *Bauhinia purpurea* (semi- evergreen) produced new leaves through January- February. It was also observed that a few individual of each species continued to leaf flush in later month also. The three evergreen tree species (*Eucalyptus globulus, Pongamia pinnata and Phoenix sylvestris*) showed leaves exchanging. These tree species exchanged leaves because leaf- flushing usually occurs shortly before or immediately after the completion of leaf shading during the early or mid dry season.

Leaf fall: Leaf fall initiation was a periodic activity in all selected dominant tree species; the onset of leaf fall initiation was different in all selected tree species. In mostly selected tree species leaf shading began in late October with peak in November and December. Many deciduous tree species were leafless in February, whereas a few of them were almost leafless in March for a short duration. However three evergreen tree species (*Eucalyptus globulus, Pongamia pinnata* and *Phoenix sylvestris*) showed no concentrated leaf fall during the study period.

The reason behind the emergence and maturation of leaves in dry season could be due to increased daylength, rise of temperature and change in photoperiod which favours to maximise the photosynthesis and vegetative growth (Kushwaha and Singh, 2005; Bajpai *et al*., 2012; Thakur *et al*., 2013). Seasonal changes in photoperiod and thermoperiod are generally coupled and their joint action may control growth rhythm of trees. The summer flushing enables tree species to activate canopy development before the monsoon rainfall begins and to make maximum use of short rainy season for productivity. Increasing photoperiod along with rising temperature may cause starch to sugar conversion in roots and stems and osmotic adjustment in bud tissues of the summer flushing tree; this may induce bud break through increased water absorption and availability of sugar (Borchert, 1994). Osmotic adjustment in fine roots may also have a role in increased water absorption from the soil during the dry season, helping rehydration of stem. The role of photoperiod has also been confirmed by Rivera *et al*., (2002) who reported that spring flushing in tropical semi deciduous trees is induced by an increase in photoperiod of 30 minutes or less. They further suggested that production of new foliage shortly before the rainy season is likely to optimise the synthetic gain in tropical forests with relatively short growing season. This was also supported by Elliot *et al*., (2006) and Kushwaha and Singh, (2005).

The leaf fall was concentrated in cool and dry winter months i.e. from October to February. Prasad and Hegde, (1986) observed a similar pattern of leaf fall in tropical deciduous forest in Bandipur Tiger Reserve, Southern Indian region. Raich and Borchert, (1982) suggested that leaf fall during the dry season was directly influenced by the decline in soil moisture and increase in water stress condition. The result was also in conformity with Singh and Singh, (1992) who reported that initiation of leaf fall coincides with the onset of the post monsoon low temperature dry period and can be a mechanism maintaining turgidity of shoots. In the present study, marked asynchrony occurred in selected tree species with respect to leaf flush completion, initiation and completion of leaf fall and the extent of leafless period. The wide difference in duration of leaf flush and timing of leaf fall observed amongst tree functional groups, exposed to same regime of climatic conditions, may be caused by the variation among the components of the soil- plant- atmosphere continuum that determine tree water status. The variation in the onset of monsoon, amount and distribution of rainfall during the annual cycle may affects the factors regulating the soil- plant- atmospheric water continuum, resulting in change in asynchrony/synchrony (Kushwaha and Singh, 2005). Borchert, (1994) hypothesized that in the dry forest, within species asynchrony in trees is guided by differences in water availability and hence tree water is likely to cause the observed variation in phenology. Global climate change may force variation in timing, duration and synchronisation of phenological events (e.g. date of initiation and completion of leaf flush, leaf fall and leafless period) in the tropical forests (Raich, 1995). Although progress has been made in understanding the drivers of leaf phenology at the molecular level (Yoshida, 2003), a picture of leaf onset and senescence mechanisms is only beginning to emerge.

Reproductive Phenology: We have selected and observed 20 selected tree species in 3 different sites of Hastinapur, Meerut during the study. All the tree individual of each selected species showed high variability in production of flowers and fruits in terms of quantity and frequency.

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

showed first in April but *Acacia farnesiana* and *Albizia lebbeck* showed second peak in November while *Acacia nilotica* in September. The duration of flower maturation and abscission varied in different selected species. The duration of flower maturation varied from 18 days (*Phoenix sylvestris*) to 35 days (*Ailanthus excelsa* and *Heterophragma adenophyllum*). The period between maturation and abscission of flower ranged from 21 days (*Dalbergia sissoo*) to 75 days (*Heterophragma adenophyllum*) (Table-2.1)

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

Fruit maturation and abscission period varied in different selected tree species. In the case of fruit, the duration of maturation varied from 30 days (*Ailanthus excelsa and Butea monosperma)* to 179 days *(Albizia lebbeck).* The period between maturation and abscission of fruits ranged from 41 days (*Eucalyptus globulus*) to 161 days (*Acacia catechu*). During the study it is observed that the fruiting phenology follows closely the flowering phenology most of the tree species. Interphenophase duration between different phenological events varied for different species. It was shortest for maturation of leaves and longest for ripening of fruits (Table-2.1).

Trees are highly variable among the individual in the quantity of flowers and fruits produced, and even the frequency of reproduction (Bullock, 1982; Sarukhan *et al*., 1984). Vegetative and reproductive developments are strongly interrelated in all plants, but in trees these relationships are considerably more complex than in herbaceous plants because of the structural complexity of the shoot system. In contrast to herbaceous plants, flower development in many trees is not continuous from flower induction to anthesis, but may become temporarily arrested at some intermediate stage. Final development of flower buds and anthesis will occur many months after flower initiation. This functionally important distinction has not been adequately considered in many discussions of flowering in tree (Borchert, 1983). At present, available evidence suggests that carbohydrate levels as well as the balance between plant growth regulators in vegetative buds are involved in the control of flower induction (Zeevaart, 1976). The combination of all biotic and abiotic factors establishing conditions favorable for flower initiation and development varies with the species-specific position of the inflorescence within a tree's branch system and with the seasonal pattern of vegetative and reproductive growth. Like all other aspects of tree development, the phenology of flowering is determined partly by genetic, partly by environmental factor (Borchert, 1983). Various physiologically active sites or sinks (e.g. leaf buds and leaves, flower buds and flowers, and fruit) may compete for water, nutrients and metabolites (Lieberman, 1982), and such internal competition may lead to the partitioning in time of plant functions like leafing and flowering. Tropical dry region trees exhibit considerable diversity in seasonal water relation (Borchert *et al*., 2005). Interaction between water availability, tree structure and ecophysiological characteristics leads to varying phenological patterns. Selected deciduous tree species (including *Bauhinia purpurea*, a semi- evergreen species) present in the study sites exhibited four basic patterns of flowering in relation to leaf flushing as described by Kikim and Yadav, (2001); (a) Flowering before leaf flushing in *Butea monosperma, Cassia fistula* and *Zizyphus xylopyra.* (b) Simultaneous flowering and leaf flushing in *Prosopis juliflora*, (c) Flowering soon after leaf flushing in *Bauhinia racemosa, Bauhinia veriegata, Dalbergia sissoo*, (d) Flowering long after leaf flushing in *Acacia nilotica*, *Acacia farnesiana*, *Acacia catechu*, *Ailanthus excelsa*, *Albizia lebbeck, Bauhinia purpurea, Diospyros cordifolia Tectona grandis and Heterophragma adenophyllum*. However, Singh and Kushwaha (2006) recognized five flowering types in 119 tropical tree species.

In several species initiation of fruit ripening begins in post-monsoon period and continues up to the end of cool and dry winter period that may be due to the difference in fruit maturation activity of different species as reported for sub-tropical forests in north-eastern India (Kikim and Yadava 2001). In our study, some tree species (*Cassia fistula, Tectona grandis, Heterophragma adenophyllum and Zizyphus xylopyra*) fruit ripening begins in post monsoon period and continues up to the end of cool and dry winter period. Thus fruit dehiscence of tree species coincides with the onset of monsoon to allow optimal germination (Singh and Singh, 1992; Singh and Kushwaha, 2006). The pattern of fruiting activity maintains the availability of fruits to herbivores throughout the year. In the present study the edible fruits of *Acacia nilotica, Acacia farnesiana, Acacia catechu, Ailanthus excelsa, Cassia fistula* and *Zizyphus xylopyra* are available in winter season whereas those of *Bauhinia purpurea, Butea monosperma, Dalbergia sissoo* and *Diospyros cordifolia* are available in summer season to the wild animals.

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EFFECT OF ZINC AND IRON APPLICATION ON YIELD AND ACQUISITION OF NUTRIENT ON MUSTARD CROP (*BRASSICA JUNCIA* L.)

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Abstract: The field experiment was conducted on Pusa Bold variety of Mustard with 10 treatments in RBD in rabi season-2009-10 at Crop Research Centre of, Sardar Vallabhbhai Patel University of Agriculture and Technology; Meerut (U.P). Maximum primary branches (11.05), secondary branches (31.33), Siliqua per plant (545.35), number of seed per Siliqua (13.55), seed weight per plant 30.38 g and test weight (1000 seed weight, 6.50 g) were recorded, the biological yield was observed highest (114.80 q ha^{-1}) and the grain yield was also (23.40 q ha^{-1}) in T9{100 per cent NPK (RDF) + Zn @ 25 Kg ha^{-1} (B) + Fe @ 25 Kg ha^{-1} (B)}. The maximum Stover yield noticed 91.40 q ha^{-1} as compared to T1 (control) (40.82 q ha^{-1}.), highest total nitrogen uptake by mustard crop, recorded 97.87 kg/ha, in case of phosphorus and potassium uptake by mustard crop was also observed 21.82 kg/ha and 152.82 kg/ha , respectively. The all over present investigation shows that the maximum yield attributes was found when zinc and iron was applied basal with recommended dose of fertilizers.

Keywords: Mustard, micronutrient, uptake Kg ha^{-1}

INTRODUCTION

India is one of the leading oil seed producing country in the world. Rapeseed and mustard are the main oil seed crops grown in rabi season in India. Oil seeds the second largest agricultural commodity after cereals in India. Its production was 7.20 tonnes from 6.3 m ha mainly confined with the states *viz.*, Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat, West Bengal, Assam, Bihar, and Punjab. Among the states, Uttar Pradesh alone produces about 13.78 per cent of total mustard production from 14.03 per cent area, whereas, Rajasthan on top with 48.64 per cent production from 45.06 per cent area in India during 2008-09.

Iron is critical for chlorophyll formation and photosynthesis. Chlorophyll is the small "sun-panels" which the plants use to harvest energy from the sun and gives plants green pigment. Photosynthesis is the process during which the actual sun- rays are harvested. Iron is also used by enzymes to regulate transpiration in plants. This transpiration process allows nutrients to reach all parts of the plants. Without iron the above functions would not work.

Since these functions are essential for plant growth, iron is an essential element. So there is a need to focus on these nutrients, especially zinc as it is one of the most important micronutrient. While, applying with iron and NPK. Zinc deficient soil can be found throughout the world and are normally associated with low soil organic matter and alkaline of soil. Zinc deficiencies are corrected in most cases by applying a granular Zinc ($ZnSO_4.7H_2O$) fertilizer. Growth of winter crops in the soils is adversely affected due to reduction in zinc availability at low temperatures.

Although zinc can be applied as foliar application in emergency measure, greatest yields are obtained when it is applied to the soil. Soil application of zinc is normally made at the seeding of crop. Sometimes, Zn deficiency appears due to the low amount of Zn as recommended and low temperature as required during the crop growth. Deficiency of zinc can also appear after seeding of the crop in soils with high phosphorus contents. Zinc sulphate improves phosphorus utilization and regulates plant growth and increase leaf size, promotes silking, hastens maturity and increase to test weight.

MATERIAL AND METHOD

A field experiment was conducted during the rabi season of 2008-09 at the crop research center of SVBPUAT, Meerut. The soil was sandy loam with pH 8.36 and low in organic carbon 0.36per cent, available N (79.80) , available K (165.30) and medium in available P (14.80) kg ha^{-1} and sufficient amount of Zn and Fe (0.49 and 12.25 ppm). The treatments T_1-Control (without fertilizers), T_2-100 per cent NPK @ 80,60,40 Kg ha-1 (RDF), T3- 100 per cent NPK (RDF) + Zn @ 25 $^{Kg\ ha\text{-}1}$ (B), T4- 100 per cent NPK (RDF) + Zn (F), T5- 100 per cent NPK (RDF) + Fe @ 25 Kg ha^{-1} (B), T6- 100 per cent NPK (RDF) + Fe (F), T7- 100 per cent NPK (RDF) + Zn @ 25 Kg/ha (B) + Fe (F), T8- 100 per cent NPK (RDF) + Zn (F) + Fe @ 25 Kg ha-1 (B), T9- 100 per cent NPK (RDF) + Zn @ 25 Kg ha-1 (B) + Fe @ 25 Kg ha-1 (B) and T10 - 100 per cent NPK (RDF) + Zn (F) + Fe (F)were laid out in RBD in the three replications. The calculated quantity of Zn and Fe was applied as based as well as foliar at first and second irrigation as per treatment 30 and 60 DAS, respectively. Indian mustard variety Pusa Bold was sown at 30 cm row spacing using 4 kg seed ha^{-1}.

RESULT AND DISCUSSION

Effect on growth and yield and yield attribute of mustard

The data on growth parameters and yield and yield attribute of mustard are presented in Table 1 and 2. Various plant growth parameter of mustard crop are affected by varying the method of application of micronutrients during the crop season. The plant height was significantly influence by the different method of zinc and iron application at all the growth stages. Plant height is an index of good vegetative growth. The maximum plant height 98.25 cm at 60 DAS and 196.25 cm at harvest was observed in T9 [100 per cent NPK (RDF) + Zn @ 25 Kg ha-1 (B) + Fe @ 25 Kg/ha (B)] treatment, i.e. 36.45 and 26.20per cent increase in plant height were observed at 60 and 147 DAS, respectively (Table 2). Primary branches increase with advancement of crop age the maximum branches was observed in T9 (11.05) at 60 DAS significantly, when zinc and iron applied basal and foliar (Table 1). The similar results were also reported by Meena *et al.* (2006), Chaudhary *et al.* (2007), Yadav *et al.* (2007) and Ravi *et al.* (2008).

Maximum number of secondary branches at 60 DAS (31.33) and at harvest 147 DAS (34.67) were recorded in T9 [100 per cent NPK (RDF) + Zn @ 25 Kg/ha (B) + Fe @ 25 Kg/ha (B)]. (Table 1) significantly increase in number of branches per plant as compared to T_1 attributed to increase in absorption and translocation of assimilation and stimulation graphical and lateral meristems to grow result supported by Husain and Kumar (2006).

The numbers of Siliqua per plant at harvesting highest (545.35), number of seed per Siliqua was recorded maximum in T_9 (13.55). The highest length of Siliqua found 5.20 cm (Table- 2), treatment in which recommended dose of fertilizer were applied along with zinc and iron application as basal. The significant increase in number of Siliqua per plant and number of seed per Siliqua as compared to T_1(Control). It is evident that zinc and iron element play an important role in plant, similar results were reported by Sudhakar *et al.* (2002) and Husain and Kumar (2006). Significantly result was observed, when zinc and iron was applied basal along with RDF (T9) in seed weight per plant and 1000 seed weight (6.50g) the result was supported by Sudhakar *et al.* (2002), and Zizala *et al.* (2008).

Yield attributes

The grain yields of mustard in different treatments are significant; when zinc and iron are applied alone and with combination significantly increased the grain yield. The highest grain yield was recorded in T9 (23.40 q/ha) followed by T7 and T8 gave grain yield 22.14 and 20.45 qha^{-1}. i.e. 145, 132 and 115 per cent increased in grain yield by T9, T7 and T8, respectively over control. (Table 2). Similar observation were also recorded by Saxena *et al.* (2005), Kumar *et al.* (2006), Meena *et al.* (2006), Chaudhary *et al.* (2007), Jatl and Mehra (2007), Yadav *et al.* (2007) and Ravi *et al.* (2008). Similarly the Stover yield was recorded significantly maximum in T9 (91.40 q ha^{-1}) followed by T7, T8 and T10 gave values 87.74, 79.25 and 75.82 q ha^{-1}, respectively. The stover yield was observed 123, 114, 94 and 86 per cent higher as compared to T_1 (control). These results are supported by the findings of Saxena *et al*. (2005), Chaudhary *et al.* (2007), Jat and Mehra (2007) and Chandra and Khandelwal (2009).

Nutrient uptake

The data on N, P and K uptake by grain of mustard are presented in Table 3. Total uptake of NPK by mustard crop was maximum recorded with RDF along with zinc and iron applied as basal. The total nitrogen uptake was recorded significantly highest in T9. Total phosphorus uptake was found maximum in T9 followed by T7 over control , and the total potassium uptake by mustard crop was also in highest in T9 over the maximum per cent in increase of nutrient was recorded 191, 236 and 222 per cent NPK, respectively over control. The result are supported by Malewar *et al.* (2001), Giri *et al.* (2003), Kumar *et al.* (2006), Meena *et al.* (2006), Chaudhary *et al.* (2007), Jat and Mehra (2007), Ravi *et al.* (2008), Zizala *et al.* (2008) and Chandra and Khandelwal (2009).

CONCLUSION

It is concluded from that investigation the application of recommended dose of fertilizer (100per cent NPK) @ 80: 40: 40 recorded better grain yield (11.90 q ha^{-1}) of mustard crop. The highest grain yield (23.40 q ha^{-1}) was obtained in the treatment consisting the basal application of zinc and iron along with 100per cent nitrogen, phosphorus and potash (Recommended dose of fertilizer) (T_9). The addition of Zn and Fe as basal @ 25 Kg/ha along with 100per cent NPK (RDF) prone super ion to foliar application of Zn and Fe along with 100per cent NPK (RDF) in terms of yield and other parameters of mustard crop. On an average highest total uptake of NPK recorded 97.54, 21.82, and 152.82 Kg ha^{-1}, respectively in treatment T_9 followed by T_7. Similarly maximum total uptake of zinc and iron were recorded 251.76 and 2314.53 g ha^{-1} respectively in T_9 followed by T_7.

Table: 1: Effect of zinc and iron application on number of primary and secondary branches/plant in mustard.

Treatment	**primary branches/plant**		**secondary branches/plant**	
	30 DAS	60 DAS	60 DAS	At harvest
T_1	1.50	4.75	11.33	13.33
T_2	1.58	5.75	23.00	25.33
T_3	1.61	7.97	23.33	25.67
T_4	1.56	6.65	20.00	23.33
T_5	1.46	7.35	22.33	25.00
T_6	1.50	6.15	20.00	22.33
T_7	1.57	10.25	24.67	27.67
T_8	1.74	8.50	22.00	24.33
T_9	1.76	11.05	31.33	34.67
T_{10}	1.72	8.17	23.67	27.00
S Em (±)	0.10	0.30	1.68	1.61
CD (P=0.05)	N.S.	0.91	5.04	4.81

Table 2: Effect of zinc and iron application on yield and yield attributes of mustard crop.

Treatment	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Plant height (cm)	No. of siliqua/ plant	No. seed/ siliqua	Length of siliqua (cm)	Seed weight/ plant (g)	1000-seed weight (g)
T_1	9.53	40.82	50.35	155.50	295.25	7.95	3.50	9.45	5.20
T_2	11.90	56.52	68.42	160.67	390.60	8.40	4.02	12.10	5.40
T_3	17.94	74.14	92.08	177.25	485.40	10.15	4.62	17.10	5.65
T_4	13.90	71.43	85.33	169.25	460.45	9.45	4.40	14.11	5.55
T_5	14.00	74.14	88.14	170.25	478.75	9.65	4.55	15.20	5.80
T_6	12.20	66.91	79.11	165.00	415.15	8.90	4.36	13.50	5.85
T_7	22.14	87.74	109.88	188.25	522.50	12.20	4.90	28.78	6.35
T_8	20.45	79.25	99.70	182.00	505.75	11.95	4.85	25.32	6.20
T_9	23.40	91.40	114.80	196.25	545.35	13.55	5.20	30.38	6.50
T_{10}	19.28	75.82	95.10	180.25	490.65	10.75	4.75	20.51	6.00
S Em ±	0.40	0.51	0.59	2.34	4.00	0.16	0.16	0.29	0.14
CD (P=0.05)	1.19	1.52	1.77	7.01	11.97	0.48	0.48	0.87	0.40

Table 3: Effect of zinc and iron application on Total NPK uptake (kg/ha) by mustard crop.

Treatments	Nitrogen uptake (kg/ha)	Phosphorus uptake(kg/ha)	Potassium uptake (kg/ha)
T_1	23.53	6.47	47.25
T_2	34.71	11.21	90.21
T_3	47.69	17.10	92.95
T_4	44.03	18.65	116.00
T_5	43.39	15.62	119.01
T_6	38.86	13.58	105.94
T_7	60.46	19.89	148.83
T_8	55.93	17.88	134.34
T_9	67.19	21.82	152.82
T_{10}	54.28	17.69	124.09
S Em ±	6.43	0.26	10.55
CD (P=0.05)	19.25	0.78	31.59

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EFFECT OF TIME AND METHOD OF BUDDING IN BER (*ZIZYPHUS MAURITIANA* LAMK.)

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Abstract: Ring budding gave better response than patch and shield budding with respect to bud take, bud sprouting and vegetative growth followed by patch budding, while shield budding showed poor response. Budding performed on 15th June showed better response with respect to all the character studied followed by 30th June and budding done on 15th April showed poor response. On the basis of the above observation, it is concluded that there is tremendous possibilities of commercialization of asexual propagation in ber by adopting ring budding performed on 15th June followed by 30th June.

Keywords: Ring budding**,** patch budding, shield budding, bud sprouting

INTRODUCTION

Ber is botanically known as *Zizyphus mauritiana Lamk*. and belongs to the family Rhamnaecae or buckthorn family, which has about 50 genera and more than 600 species. The genus *Zizyphus* has been derived from Zizoof, which is the Arabic name of the fruits (Baily, 1947). Ber fruits are within the reach of poor people. It is, therefore, rightly known as "poor man's fruit". This fact assumes greater significance in view of our determination to fight the prevailing malnutrition among the masses. Ber fruits is very nutritious and rich source of Vitamin 'C' (76-117 mg/100 g pulp) next only to Aonla and guava and also contains fair quantity of vitamin 'A' (55.0 mg/100g pulp).

Ber is propagated both by sexual and asexual or vegetative means. In India, seedling tress comprise a large population in old orchards and the fruit thus produced are inferior in size and quality. Vegetative propagation is an important method to overcome these constraints and obtain fruits of desired cultivar. Different methods of vegetative propagation such as cutting, layering and budding have been found to be the best method for propagation. Different types of budding viz. Shield, patch, ring and flute have been tried. Among various method of budding, ring, patch and 'T' budding is commonly used in Ber.

In recent years demand for ber plant has increased manifold. This has necessitated standardization of technique for commercial propagation of ber plants. In the present investigation it was tried to improve upon the budding technique in ber in different time interval.

MATERIAL AND METHOD

Experimental site

The horticulture experimental garden is located in South- Eastern part of Varanasi city at 25^0 81' North longitude and 80^0 30' East longitude and about 128.93 meters above the mean sea level.

Preparation of nursery bed

To make the condition of field nearly uniform for seed germination, sufficient amount of FYM and sand were added to the nursery bed. The height of the raised bed was kept 15 cm above ground level.

Seed showing in nursery

Before sowing the seeds were soaked in water for the 24 hours. The seed sowing was done in accordance with time of sowing in nursery beds. The seeds were sown at a depth of 5 cm at a distance of 25x15cm.

Mulching

After seed sowing the nursery bed was mulched with layer of dry grasses and sprinkler irrigation was done daily till germination of seed. After seed germination, the grass- mulch was removed carefully.

Budding: The seedling which attained budding thickness (0.5cm) after 90,120 and 150 days were considered for budding. The patch and shield methods of budding were employed all the time of budding.

Observations: The following observations were noted for experiment:-

Number of days taken by bud to sprout

The days were counted from the date of bud-sprouting from each individual plant in each treatment and the average number of days required was recorded.

Per cent of bud sprouting

To observe the percentage sprouting of bud, each plant was observed carefully and number of plant showing bud take was recorded in each treatment.

Number of leaves per shoot

The number of leaves of sprouted shoot was recorded by counting fully expanded leaves at an interval of 30 days.

RESULT AND DISCUSSION

Budding method

Plant materials consisted of 9-12 month-old uniform jamun seedlings. Plants were grown in the raised nursery beds at the Horticulture experimental garden, Banaras Hindu University. Budding operation was performed immediately after arrival of the section – shoot at the site where the budding operation was to be performed. In patch budding a rectangular patch of bark was removed completely from the root stock and a patch of bark of the same size containing a bud of the desired variety was placed there. The procedure was completed by tying the patch with polythene strip leaving the bud open to grow.

The second method of budding was shield. The "T-bud" designation arises from the T- like appearance of the incision in the stock, whereas the "shield – bud" name is derived from the shield like appearance of the bud when it is ready for insertion into the stocks. The budding was performed at a height of 18 to 20 cm from the ground on rootstock. A straight cut of the similar length as bud had, was made into the bark of the rootstock with the help of a budding knife. The bark around the cut was slightly loosened from the wood and the bud was carefully inserted into the incision. As soon as the operation was become over, the bud was tied with the polythene stripes of 150 gauge thickness and about 25 mm width. The similar budding method was employed by Singh *et al.,* (1967) and Parik (1987).

Effect of budding method and time on days required for sprouting of buds in Ber

Data pertaining to effect of budding method and time on days required for sprouting of buds in ber have been presented in Table1 clearly indicate that there was a considerable variation in main plot treatment. The budding methods were found statistically significant in affecting this character. The minimum number of 22.37 days was recorded for bud to sprout with ring budding followed by 24.33 and 26.50 days with patch and shield budding respectively. Thus, ring budding gave 1.96 days earlier bud sprouting than patch and 4.13 days earlier than shield budding was recorded. Difference between the mean values of ring, patch and shield budding was statistically significant. Time of budding also showed significant variations, which varied from 21.07 to 27.23 days. Budding performed on 15th June took minimum number of days (21.07) for sprouting followed by 30th June (22.65), 30th May (24.08). 15th May (25.10 days), 30th April (22.23 days). In all the cases significant variations were recorded. The similar results were observed by Joolka and Rindhe (2000).

The interaction effect between method of budding and different time taken in the experiment is statistically non- significant (Table 2)

Per cent bud sprouted at different methods and times of budding in ber

The data per cent bud sprouted at different methods and times of budding in ber have been presented in Table 3. The data recorded clearly indicate that maximum bud sprouting of 77.22 per cent was recorded in ring budding, followed by 66.67 and 49.94 per cent in patch and shield budding respectively. Analysed data showed significant differences in all the three cases. Time of budding varied from 36.67 to 84.44 per cent. The budding done on 15th June exhibited maximum sprouting (84.44 %), which significant differ with 30th June (80%), 30th May (70%), 15th May (63.64%), 30th April (52.22%) and 15th April (36.67%).

Interaction of method and time of budding showed significant influence on per cent bud sprouting as shown in Table 4. The ring method of budding gave maximum sprouting of 93.33 per cent which was done on 15th June as compared to other method and time ob budding. The minimum (20%) bud sprouting was observed with shield budding done on 15th April, which significantly differed with other treatments. Among the three method of budding, ring and patch budding showed significantly better response as compared to shield budding with all the timing of operations. Similar results have also been by Kaundal and Deol (1990) where 71.89 to 75.85 per cent budding success was obtained with modified ring budding method compared to 63.39 to 64.22 per cent with patch budding in guava.

Effect of methods and time of budding on number of leaves of sprouted shoot at successive stage of growth

Data pertaining to number of leaves as influenced by time and method of budding are presented in Table 5 and clearly show that ring budding produced significantly maximum number of leaves as compare to patch and shield budding at 30, 60, 90 and 120 days after budding. The time of budding also showed significant response in this respect. Significantly maximum numbers of leaves were counted, when budding was performed on 15th June followed by 30th June at all the four stages of observations. The minimum numbers of leaves were recorded in 15th April budding. The interaction on both the factors also exhibited significant response at 30,60, 90 and 120 days after budding It was found that maximum number of leaves shoot was found with ring budding, when it was done on 15th June. The similar result was observed by Mawani and Singh (1992) in ber, also reported that maximum number of leaves per shoot was found when ring, patch and shield budding was carried out on 15th June.

Table 1: Effect of budding method and time on days required for sprouting of buds in Ber.

S.no	Method of Budding	Sprouting of buds (days)
1.	Ring Budding	22.37
2.	Patch Budding	24.33
3.	Shield Budding	26.50
	SEm± CD at 5%	0.15 0.60
S.no	**Time of Budding**	**Sprouting of buds (days)**
1.	15th April	27.23
2.	30th April	26.28
3.	15th May	25.10
4.	30th May	24.08
5.	15th June	21.07
6.	30th June	22.65
	SEm± CD at 5%	0.18 0.51

Table 2: Interaction effect between method and time of budding on days required for sprouting of buds in ber

S.no	Time of budding	Ring	Patch	Shield	Mean
1.	15th April	25.26	27.31	29.12	27.23
2.	30th April	24.19	26.22	28.42	26.28
3.	15th May	23.29	24.69	27.32	25.10
4.	30th May	21.59	23.93	26.73	24.08
5.	15th June	19.10	20.89	23.23	21.07
6.	30th June	20.81	22.94	24.19	22.65
	Mean	22.37	24.33	26.50	
	SEm± CD at 5% (M x T)	0.31 N.S.			
	SEm± CD at 5% (T x M)	0.30 N.S.			

CD at 5% (M x T) = N.S. (Difference between methods of budding at same level of time of budding)
CD at 5% (T x M) = N.S. (Difference between times of budding at same level of method of budding)

Table 3: Per cent bud sprouted at different methods and times of budding in ber

S.no	Method of Budding	Per cent bud Sprouting
1.	Ring Budding	77.22 (61.48)
2.	Patch Budding	66.67 (54.76)
3.	Shield Budding	49.94 (44.94)
	SEm± CD at 5%	0.45 1.75
S.no	**Time of Budding**	**Per cent bud Sprouting**
1.	15th April	36.67 (37.29)
2.	30th April	52.22 (46.26)
3.	15th May	63.34 (52.71)
4.	30th May	70.00 (56.71)
5.	15th June	84.44 (66.74)
6.	30th June	80.00 (63.44)
	SEm± CD at 5%	0.35 1.00

Table 4: Interaction effect between method and duration of budding on per cent sprouting in ber.

S.no	Time budding	Method of budding			Mean
		Ring	Patch	Shield	
		Per cent of sprouting	Per cent of sprouting	Per cent of sprouting	
1.	15th April	53.33 (46.89)	36.67 (37.29)	20.00 (26.56)	36.91
2.	30th April	66.67 (54.76)	53.33 (46.89)	36.67 (37.29)	46.31
3.	15th May	76.67 (61.14)	66.67 (54.76)	46.67 (43.11)	53.00
4.	30th May	83.33 (65.88)	73.33 (58.89)	53.33 (46.89)	57.22
5.	15th June	93.33 (75.00)	86.67 (68.61)	73.33 (58.89)	67.50
6.	30th June	90.00 (71.56)	83.33 (65.88)	66.67 (54.76)	64.07
	SEm± CD at 5% (M x T)	0.70 2.28			
	SEm± CD at 5% (T x M)	0.60 1.73			

CD at 5% (M x T) = (Difference between methods of budding at same level of time of budding)
CD at 5% (T x M) = (Difference between times of budding at same level of method of budding)

Table 5: Effect of methods and time of budding on number of leaves of sprouted shoot at successive stage of growth.

S.no	Period of observation		T_1	T_2	T_3	T_4	T_5	T_6	Mean		SEm±	CD at 5%
1.	30 days after budding	M_1	3.67	4.12	4.42	5.10	5.87	5.31	4.75	M	0.09	0.37
		M_2	2.59	3.00	3.43	3.77	4.54	3.98	3.55	T	0.08	0.24
		M_3	2.27	2.77	3.11	3.59	4.11	3.96	3.30	M x T	0.16	N.S.
		Mean	2.84	3.30	3.65	4.15	4.84	4.42		T x M	0.14	N.S.
2.	60 days after budding	M_1	17.49	17.66	21.50	21.97	24.55	23.22	21.07	M	0.19	0.73
		M_2	16.09	16.52	19.84	21.01	23.38	21.80	19.77	T	0.08	0.24
		M_3	12.32	13.67	18.68	19.70	22.54	21.53	18.07	M x T	0.23	0.80
		Mean	15.30	15.95	20.01	20.89	23.49	22.18		T x M	0.14	0.42
3.	90 days after budding	M_1	36.12	36.86	41.19	42.01	44.59	43.32	40.68	M	0.09	0.35
		M_2	31.66	32.84	38.21	39.95	42.40	41.36	37.74	T	0.07	0.20
		M_3	27.95	29.40	35.65	37.07	39.71	38.91	34.78	M x T	0.14	0.45
		Mean	31.91	33.03	38.35	39.68	42.23	41.20		T x M	0.12	0.34
4.	120 days after budding	M_1	47.69	48.87	63.64	55.16	57.77	56.38	53.25	M	0.10	0.40
		M_2	43.65	45.31	50.15	51.68	54.94	53.67	49.90	T	0.05	0.15
		M_3	38.59	40.89	46.43	49.15	52.29	51.09	46.41	M x T	0.13	0.45
		Mean	43.31	45.02	50.07	52.00	55.00	53.71		T x M	0.09	0.25

M= Method of budding, M x T = Difference between methods of budding at same level of time of budding
T= Time of budding, T x M = Difference between times of budding at same level of method of budding
N.S. = Non significant

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RESPONSE OF HYBRID RICE (*ORYZA SATIVA* L.) TO INTEGRATED NUTRIENT MANAGEMENT (INM) IN PARTIALLY RECLAIMED SODIC SOIL

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Abstract : The field experiment was carried out at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *Kharif* season of 2010 and 2011 to study the response of hybrid rice to Integrated Nutrient Management on grain yield, nutrient uptake and economics of various treatments and their effect on physico-chemical properties of soil after harvest of the crop. The experiment was carried out on silt loam soil having pH 8.9, EC 0.4 dSm^{-1} organic carbon 3.6mg kg^{-1}, Available N 194.00, P_2O_5 14.46and K_2O 246.80 kg $ha^{-1.}$ The Seven treatments of integrated nutrient management practices (T_1 -100% NPK, T_2 -75% NPK T_3 .50% NPK, T_4 -75%NPK +25%FYM-N, T_5 -50%NPK +50%FYM-N T_6 -25%NPK+75%FYM-N and T_7 -100%FYM-N) were tested in randomized block design, replicated thrice. The maximum grain yield (69.26 qha^{-1}), straw yield (83.22qha^{-1}), nutrient uptake of N (155.32 kg ha^{-1}), P (44.15 $kgha^{-1}$), K (158.23$kgha^{-1}$) were recorded with the application of 75%NPK +25%FYM-N (T_4) which were significantly superior over 75%NPK and 50% NPK + 50 % FYM-N, minimum was recorded with 100 % N through FYM. The maximum gross income Rs. 70489.0 ha^{-1} was recorded with 75%NPK +25%FYM-N (T_4) followed by 100%NPK (T_1).

Keywords : INM, hybrid rice, sodic soil

INTRODUCTION

Rice (*Oryza sativa* L.) being one of the richest starch food is consumed by about half of the world's population. India ranks second position in production of rice among the food grain, and half of the world population subsist on rice by receiving the highest (26.2%) calories intake from it (FAO 2009). Uttar Pradesh is the largest rice growing state after West Bengal in the country, where rice grown over an area of 5.69 m ha with production and productivity of 11.80 mt and 2060 kg ha^{-1}, respectively. Area under hybrid rice in India is about 2.5 m ha which is very low as compared to other growing countries, viz China and Japan. Hybrid rice gave about 20-25% more yield than promising high yielding commercial rice varieties. Salt-affected soils are those soils, which have an excess of soluble salts or an excess of exchangeable sodium (Na^+) or both in root zone to an extent, which can adversely affect crop growth or completely inhibit production of most of the crops. Excessive amount of salts in the root zone besides inducing toxicity, create physiological imbalance in growing plants. The Use of adequate dose of organic source coupled with chemical fertilizers is expected to ensure optimum growth conditions under intensive agriculture using rice hybrid. It is well established that the applied organic resources not only increase soil fertility but also improve soil physical conditions which help for proper growth of plants. Majumdar, *et. al.* (2007) reported that Integrated use of FYM and inorganic fertilizers significantly improve the yield as well as N, P and K uptake by paddy. They also reported that the integrated use of inorganic and organic fertilizers also improve the water holding capacity, aeration, permeability, soil aggregation, nutrient availability and decreasing bulk density. Keeping in view, the present investigation was aimed to study the effect of integrated nutrient management on hybrid rice in partially reclaimed sodic soil.

MATERIAL AND METHOD

The field experiment was conducted on Silt loam (sodic soil) at Instructional Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) situated at 26.47^0 latitude and 81.12^0 longitude with an elevation of about 113m from mean sea level in the Gangetic eastern Uttar Pradesh for two consecutive years (2010 and 11) to study the effect of Integrated Nutrient Management (INM) on hybrid rice (*Oryza sativa* L.) in partially reclaimed sodic soil. The mean annual rainfall is 1200 mm. The soil of experimental site (0-15 cm) had pH (1:2.5) 8.9, EC 0.40 m dSm^{-1} at 25^0C, organic carbon 3.6 mg kg^{-1}, available N 194.0, P_2O_5 14.46 and K_2O 246.80 $kgha^{-1}$. Seven treatment combinations consisted (T_1) 100% NPK, (T_2) 75% NPK, (T_3) 50% NPK, (T_4) 75% NPK+25% FYM-N, (T_5) 50% NPK+50%FYM-N (T_6) 25% NPK+75% FYM-N and (T_7) 100% N through FYM. The experiment was laid out in a randomized block design replicated thrice. Hybrid rice variety ARIZE-6444 was taken as test crop. The total N, P and K contents in grain and straw were analyzed as per standard procedures described by *Jackson* (1973). The uptake of N, P and K were computed by multiplying with total nutrient concentration in grain and straw with corresponding yields of the crop. The soil samples were analyzed for pH, organic carbon, available N, P and K by standard methods described by Jackson, 1973.

RESULT AND DISCUSSION

Yield and yield attributes

The pooled data presented in table-1 revealed that the grain and straw yield of rice increased with the

application of NPK along with Farmyard manure. The maximum grain (69.26 qha^{-1}) and straw (83.22 qha^{-1}) were recorded with the application of 75% NPK + 25% FYM which was significantly superior to 75% NPK (54.20 qha^{-1}**),** and 50% NPK+ 50% FYM (58.48 qha^{-1}) treatment and statistically at par with the application recommended NPK (100%NPK) treatments. This may be due to fact that slowly released nutrients through FYM and applied inorganic fertilizer helped to produce higher yield of rice. The per cent increase in grain yield of rice was higher under 75% NPK+ 25% FYM- N over 100% NPK, 75% NPK, 50% NPK + 50% FYM-N 3.58 21.60 and 15.56% respectively. The yield of rice was lowest under 100% N through FYM-N. On the basis of pooled mean data of two years, the superiority of the treatment may be arranged as: $T_4 > T_1 > T_5 > T_2 > T_6 > T_3$ and T_7 in case of grain yield of rice. These results are also corroborated by majority of workers Singh *et. al.* (2004) and Sowmpya *et. al.* (2011).

Nutrient Uptake

The N, P and K uptake were improved with the application of 75% NPK+ 25% FYM-N followed by 100% NPK applied through chemical fertilizer by hybrid rice during both the year of investigation (Table 2). Minimum uptake values of the N, P and K were recorded with 100 % N through FYM. Majumdar *et al.* (2007) also reported that N, P and K uptake by paddy and various forms of N in soil increased significantly by application of fertilizer N alone with Farmyard manure.

Soil properties and Nutrients Contents in Soil

Application of 75% NPK with chemical fertilizer along with 25% N through farmyard manure slightly decreased the soil pH over 100% NPK through chemical fertilizer but the difference among these was not significant (Table 3). However, the EC value was decreased with increasing the application farmyard manure. The minimum EC (0.24 dSm^{-1}) value was observed with the application of 100 % N through farmyard manure followed by 25% NPK + 75%FYM-N. Incorporation in increasing amount of FYM with decreasing value of NPK through inorganic fertilizer slightly improved the organic carbon. The increase in soil organic carbon with the use of FYM has also been reported by Yadvinder–Singh *et al.* (2004), Balwinder–Kuamr *et al.* (2008). Available N, P and K status of soil after harvest of the crop increased considerably with the application 75% NPK through chemical fertilizer + 25% N through farmyard manure (Table 2). The maximum build up of available N,P and K (175.10, 16.75 and 251.12 kg ha^{-1} respectively) were obtained with conjunctive use of 75% NPK+ 25% FYM-N which was significantly superior over 75% NPK applied through chemical fertilizer and at par 100% NPK applied through chemical fertilizer. Dixit and Gupta (2000) reported similar increase in N, P and K contents of soil under conjoint application of FYM and inorganic fertilizers as compared to inorganic fertilizers alone. An organic material like FYM from a protective cover on sesquioxide and this facilitates reduction in the phosphate fixation capacity of soil. The beneficial effect of FYM on available potassium may be described to the reduction in potassium fixation, solubilization and release of potassium due to organic matter with clay**.**

Economics

The cost of cultivation increased when farmyard manure applied to supplement the recommended nitrogen (Table 3). The highest net return (Rs. 42024.67) and cost benefit (1.47) ratio were workout with the application of 75% NPK+ 25% FYM-N followed by 100% NPK applied through chemical fertilizer (Rs. 43242.61).The minimum net return (Rs.37528.18) and cost benefit ratio (0.12) computed with the application of 100 % N through Farmyard manure.

CONCLUSION

Incorporation of farmyard manure in combination with chemical fertilizers could maintain sustainable hybrid rice yield as well as fertility in the partially reclaimed sodic soils. Application of farmyard manure increased the availability of nutrient content of the soil as compared to the chemical fertilizer. For obtaining the higher grain yield of hybrid rice the crop may be fertilized with 75% NPK + 25 % FYM.

Table 1: Effect of various treatments on yield and f economics of various treatments of hybrid rice crop (mean of two years).

Treatments	Yield (qha^{-1})		Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
	Grain	Straw				
T_1 100% NPK	66.64	81.15	25723.60	68025.4	42301.8	1.64
T_2 75% NPK	54.20	66.52	24695.38	54424.3	29728.9	1.20
$T_3$50% NPK	43.26	54.35	23666.75	43503.0	19836.25	0.84
(T_4) 75% NPK+25% FYM-N	69.26	83.22	28465.76	70611.2	42145.44	1.48
(T_5) 50% NPK+50%FYM-N	58.48	78.25	31687.88	60567.0	28879.22	0.91
(T_6) 25% NPK+75% FYM-N	48.15	57.25	34507.13	48909.3	14402.17	0.42
(T_7) 100% N through FYM	42.40	51.15	37528.20	43256.0	5727.8	0.15
CD *(P=0.05)*	5.38	6.69				

Table 2: Effect of various treatments on uptake of nutrients by rice crop (mean of 2010& 2011).

Treatment	Nutrient uptake ($kgha^{-1}$)		
	N	P	K
T_1 100% NPK	144.83	36.44	154.01
T_2 75% NPK	104.15	26.86	113.99
$T_3$50% NPK	75.77	20.64	85.05
(T_4) 75% NPK+25% FYM-N	155.32	44.15	158.23
(T_5) 50% NPK+50%FYM-N	130.54	31.01	135.87
(T_6) 25% NPK+75% FYM-N	92.92	24.31	97.60
(T_7) 100% N through FYM	74.42	20.42	85.17

Table 3: Effect of various treatments on the soil fertility after harvest of hybrid rice (mean of 2010 & 2011).

Treatments	pH (1:2.5)	EC (dSm^{-1})	Organic carbon ($mg\ kg^{-1}$)	Available N ($kg\ ha^{-1}$)	Available P_2O_5 ($kg\ ha^{-1}$)	Available K_2O ($kg\ ha^{-1}$)
T_1 100% NPK	8.83	0.38	2.6	173.10	15.00	248.20
T_2 75% NPK	8.87	0.39	2.5	153.50	14.60	223.00
$T_3$50% NPK	8.89	0.39	2.6	136.20	13.38	206.10
(T_4) 75% NPK+25% FYM-N	8.77	0.35	3.3	175.10	16.75	251.12
(T_5) 50% NPK+50%FYM-N	8.71	0.28	3.5	156.75	16.01	239.40
(T_6) 25% NPK+75% FYM-N	8.65	0.27	3.6	141.30	15.22	234.10
(T_7) 100% N through FYM	8.60	0.24	3.8	138.00	14.02	231.85
CD (P=0.05)	0.67	0.04	0.2	1.64	2.01	2.78

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CULTIVATION OF MEDICINAL PLANTS IN NATURAL ECOSYSTEM IN GUJARAT (INDIA): CONSTRAINTS AND CONSERVATION NEED

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Abstract : The present paper deals briefly about cultivation of medicinal plant of Gujarat. The number of plant species yielding raw materials used by the industry on regular basis and/or in substantially large quantities is put at around 143 species. Among these, 78 species occur wild in forests or other forms of natural vegetation, 23 species grow as weed, 42 species are grown as cash crop for other plant based products and 22 species are cultivated as medicinal crop. There has been a tremendous increase in the production of herbal medicines and other items in recent years. These include such important sources of raw materials as *Aegle marmelos*, *Commiphora wightii*, *Emblica officinalis*, *Eucalyptus*, *Mentha viridis*, *Terminalia arjuna*, *Terminalia bellirica*, *Terminalia chebula*, *Withania somnifera* and *Zingiber officinalis.* Few effects have been made to highlight the problems encountered for necessary constraints and conservation need to medicinal plants in this state.

Keywords: Medicinal plant, conservation, cultivated, natural vegetation, Gujarat

INTRODUCTION

Gujarat State is the western-most part of India. Gujarat is situated on the western coast of the country having longest coastline. It lies between latitude 20°07" to 24°43' N and longitude 68°10" to 74°29' E. The geographical area of the State is 196,022 km^2, which constitutes 5.96% of the country's geographical area (FSI, 2009). The forest cover in the state is poor but it has fairly rich biodiversity. The state comprise of less than 10% forest land of its geographical area. According to different studies on floral diversity, 2205 species of angiospermic plants belonging to 905 genera of 156 families have been recorded so far. Out of 2205 plant species, 748 plants were identified as medicinally important (Uma Devi, 1988). According to a study conducted by the Forest Department on status of medicinal plants in different forest types and agro-climatic zones, 915 medicinal plants are distributed across the state (Anon, 2002). The World Health Organization (WHO) has estimated that 80% population of developing countries relies upon traditional medicinal-mostly plant drugs-for their primary health care needs (Fransworth and Soejarto, 1991).

MATERIAL AND METHOD

A survey was carried out during Aug., 2011 to July, 2013 to collect information on the basis of cultivated of medicinal plants in different parts of Gujarat state. While collecting information on ethno medicinal plants, parts used, main area of natural occurrence, resources and demand such information have been gathered from the village chiefs, medicine man, and even local man and women and cultivators using semi-structured questionnaires. Analysis of data was made with the help of group discussions among different age classes of local communities that include both the genders of the society.

RESULT

The number of medicinal plants in India, both indigenous and introduced, has been variously put at between 3,000 to 3,500 species of higher plants. The Glossary of Indian Medicinal Plants has listed around 3,000 plants (Asolkar *et al.*, 1992; Chopra *et al.*, 1956, 1974). Two thousand five hundred plants have been reported to be used in ethno-medicine (Jain, 1991). Out of these the plants providing largely and/or regularly used raw materials by Indian Drug and Pharmaceutical Industry restricts to 265. This figure includes the raw materials imported from other countries, some of which such as liquorices, henbane, cassia bark, galangal, ephedra, long pepper and star anise are used in appreciably large quantities. The occurrence of these medicinal plants and availability of raw materials derived from them is as follows.

Plants occurring wild in forests, grassland, aquatic and desert ecosystems or associated with other forms of natural vegetation in Gujarat (Table 01): The number of such plants is around 78. These include such important sources of raw materials as *Commiphora wightii*, *Emblica officinalis*, *Gloriosa superba*, *Pterocarpus marsupium*, *Rauvolfia serpentine*, *Terminalia arjuna*, *Terminalia bellirica* and *Terminalia chebula*. The plants where the raw materials are leaf, flower, fruit, seed, exudates or other renewable part also suffer if the collection method is destructive.

Plants growing as weed or have run wild in Gujarat state (Table 02). Twenty three species of plants in this category provide the raw materials. Some of

these such as *Abutilon indicum*, *Cassia tora*, *Ocimum basilicum*, *Phyllanthus amarus*, *Tephrosia purpurea* and various species of Datura have large demand. These plants usually occur in fallow agricultural land, along road and railway tracts, in gardens and orchards, on dust and organic dumps, ponds, marshes and other waste places. Some of these are escapes from cultivation or colonizers of secondary scrub springing up in cleared or degraded forest land.

Plants cultivated as ornamentals or as cereal, fruit, vegetable, spice, oil seed, essential oil or other cash crop: fourty two plants in this category are also the source of medicinal raw materials (Table 03 and Table 04). The raw material in these cases is either the product for which the plant is being cultivated such as clove, cinnamon, castor seed, turmeric or a by-product such as bael fruit, ashoka bark and Jamun seed.

Plants cultivated as medicinal crop: Twenty two or so medicinal plants are under regular and/or large scale cultivated (Table 05). The major among there are *Aloe vera*, *Rauvolfia serpentine* and *Withania somnifera*.

DISCUSSION

Most of medicinal plants, even today, are collected from wild. The continued commercial exploitation of these plants has resulted in receding the population of many species in their natural habitat. Vacuum is likely to occur in the supply of raw plant materials that are used extensively by the pharmaceutical industry as well as the traditional practitioners. Consequently, cultivation of these plants is urgently needed to ensure their availability to the industry as well as to people associated with traditional system of medicine. If timely steps are not taken for their conservation, cultivation and mass propagation, they may be lost from the natural vegetation forever. *In situ* conservation of these resources alone cannot meet the ever increasing demand of pharmaceutical industry (Singh and Gautam, 1997). It is, therefore, inevitable to develop cultural practices and propagate these plants in suitable agroclimatic regions. Commercial cultivation will put a check on the continued exploitation from wild sources and serve as an effective means to conserve the rare floristic wealth and genetic diversity.

It is necessary to initiate systematic cultivation of medicinal plants in order to conserve biodiversity and protect endangered species. In the pharmaceutical industry, where the active medicinal principle cannot be synthesized economically, the product must be obtained from the cultivation of plants. Systematic conservation and large scale cultivation of the concerned medicinal plants are thus of great importance. Efforts are also required to suggest appropriate cropping patterns for the incorporation of these plants into the conventional agricultural and forestry cropping systems. Initiatives have already been taken by various agencies involved in conservation activities. A National Board of Medicinal Plants has been set up; one of whose activities is conservation. The Ministry of Environment and Forestry is funding an All-India coordinated project on conservation of endangered plant species (Raghupathy, 2001). Cultivation of this type of plants could only be promoted if there is a continuous demand for the raw materials. There are 143 major medicinal plants that can be cultivated in Gujarat and have established demand for their raw material or active principles in the international trade. It is also necessary to develop genetically superior planting material for assured uniformity and desired quality and resort to organized cultivation to ensure the supply of raw material at growers end. Hence, small scale processing units too have to be established in order that the farmer is assured of the sale of raw material. Thus, cultivation and processing should go hand in hand in rural areas. The Cultivation Vrs Collection of Medicinal Plants from Forest.

Cultivation	Collection from forest
1. Cultivation of medicinal plants can be controlled according to the need of market demand.	1. Collection of medicinal forest produce depends on various agencies starting from primary collectors to stockiest. Hence there is least control over all these agencies.
2. In cultivation, use of good varieties of planting materials, use of fertilizers and insecticide yield maximum amount of produce from smaller area.	2. Here the yield is very poor and larger area involves smaller amount of medicinal produce.
3. The quality of medicinal produce can be assured by improved method of cultivation and harvesting.	3. The quality of medicinal produce cannot be achieved while collection from wild. The collectors collect the produce without seeing their maturity.
4. In cultivation the mixing of other produce with desired produce can be checked.	4. There is always chance of mixing of several other produce with desired produce.

For developing the medicinal plants sector, there is a need to: 1) document indigenous uses of medicinal plants, 2) certify raw material for quality control, 3) develop and improve the agro-technology for valuable medicinal plants, 4) officially recognize and protect the customary laws of indigenous people, 5) prepare a clear policy for granting permits for cultivation within stipulated time, 6) conduct regular research and training on better harvesting and processing techniques, 7) investigate various

pathological agents infecting medicinal plants, 8) setup a community-based management of medicinal plants farming and marketing, 9) analyze the market policies, 10) monitor and evaluate the status of medicinal plants with the assistance of local communities, 11) conserve the critical habitats of rare medicinal plant species, and 12) share benefits judiciously arising from local people's knowledge on medicinal plants. These attempts may reduce dependency on wild resource base, and generate alternative income opportunities for the rural and underprivileged communities [KIT 2003; Kala 2005; Kaushik and Dhiman 1999 and Olsen and Larsen 2003].

The medicinal plants sector can be improved if the agricultural support agencies would come forward to help strengthen the medicinal plants grower and if research institutions would help the plant growers by improving their basic knowledge about cultivation practices [Prajapati *et al*., 2003]. Awareness and interest of farmers, supportive government policies, assured markets, profitable price levels, access to simple and appropriate agro-techniques, and availability of trained manpower are some of the key factors for successful medicinal plants cultivation [KIT 2004]. The diffusion of any available scientific knowledge on medicinal plants should be made operational by a network structure of communication. Currently there are number of herbs which are used in curing diseases but are not documented in details due to a lack of communication and relatively low frequency of their uses. The traditional uses of low profile and lesser known medicinal plants should also be documented to disseminate their therapeutic efficacy by preparing well acceptable medicines and also to reduce the pressure on over-exploited species.

Gujarat is a treasure house of a wide variety of medicinal plants. Some species are found wild, while a number of species have been domesticated by the farmers. Many species have been grown in homesteads and become part of traditional home remedies. A limited number of species are commercially cultivated though a few more have potential for large-scale production. The important natural and cultivating medicinal plants are discussed here highlighting the importance, medicinal and other uses activity.

Terminalia arjuna: The bark is useful in fractures, ulcers, urethrorrhoea, leucorrhoea, diabetes, vitiated conditions of *pitta*, anaemia, cardiopathy, fatigue, asthma, bronchitis, tumours, internal and external haemorrhages, cirrhosis of the lever and hypertension. It is used in fractures and the powdered bark is taken with milk. The bark powder is diuretic and has a general tonic effect in cases of cirrhosis of liver. The bark has been considered by the ayurvedic physicians as well as by modern practitioners as a cardiac tonic. It is given as a decoction with milk (NRF, 1998).

T. bellirica : The fruit is used in bronchitis, strangury, sore throat, diseases of eye, nose, heart and bladder, hoarseness and piles. It forms an important constituent of the ayurvedic drug '*triphala*'. Furit has anticancerous and flower has spermicidal activity. Bark is mild diuretic. Fruit is astringent, antidropsical, antileprotic, antiinflammatory, antidiarrhoeal, antibilious, stomachic, antiasthmatic, tonic, anticephalgic, bechic, anthelmintic and attenuant. Kernel is narcotic. Semi-ripe fruit is purgative. Gum is demulcent (Husain *et al*, 1992).

Terminalia chebula: In unani system, it is used as a blood purifier. The pulp of the fruit is given in piles, chronic diarrhoea, dysentery, costiveness, flatulence, asthma, urinary disorders, vomiting, hiccup, intestinal worms, ascites and enlarged spleen and liver. Powder of the fruit is used in chronic ulcers and wounds, carious teeth and bleeding ulceration of the gums. The bark is a good cardiac tonic. Fruits are astringent, purgative, tonic, carminative, alternative and antispasmodic. Flowers and fruits are antiviral and hypoglycaemic. Wood is oxytocic and hypothermic (Husain *et al*, 1992). Similar study of 'Haritaki' (fruits of Terminalia chebula) can be cited as an example where seven varieties originated from different parts of India have been attributed with different types of therapeutic properties (Pandey and Chunekar, 1995).

Asparagus racemosus: Asparagus is a climbing undershrub with widespread applications as diuretic, cooling agent and an excellent safe herbal medicine for ante-natal care. It is useful in nervous disorders, dyspepsia, diarrhoea, tumours, inflammations, vitiated conditions of *vata* and *pitta*, burning sensation, hyperdipsia, ophthalmopathy, nephropathy, hepatopathy, strangury, scalding of urine, throat infections, tuberculosis, cough, bronchitis, gleet, gonorrhoea, leucorrhoea, leprosy, epilepsy, fatigue, hyperacidity, colic haemorrhoids, hypertension, abortion, agalactia, cardiac and general debility (Warrier *et al*, 1993). Its powder boiled with milk is generally used to prevent abortion. It increases milk production in cows and buffaloes. It preparations in milk helps in increasing breast milk in lactating women. Its proper use helps in avoiding excessive blood loss during periods. It clears out infections and abnormalities of uterine cavity and hence it is used to rectify infertility in women. The leaves are used to prepare toilet soaps. The plant has also ornamental value both for indoor and out door decorations (Syamala, 1997).

Datura metel: The plant and fruit are spasmolytic, anticancerous and anthelmintic. Leaves and seeds are inhaled in whooping cough, asthma and other respiratory diseases. Root, leaf and seed are febrifuge, antidiarrhoeal, anticatarrhal and are used in insanity, cerebral complications and skin diseases. Datura is the chief commercial source of hyoscine available from natural source. Hyoscine, in the form

of hyoscine hydrobromide, is used as a pre-anaesthetic in surgery, child birth, ophthalmology and prevention of motion sickness. It is also employed in the relief of withdrawal symptoms in morphine and alcoholic addiction, paralysis agitans, postencephaletic parkinsonianism and to allay sexual excitement. Hyoscyamine and its salt hyoscyamine sulphate and hyoscyamine hydrobromide are used in delerium, tremour, menia and parkinsonianism (Kaul and Singh, (1995).

Piper longum: Its roots also have several medicinal uses. The root is useful in bronchitis, stomach ache, diseases of spleen and tumours . The root and fruit decoction are used in acute and chronic bronchitis and cough. It contains the alkaloid piperine which has diverse pharmacological activities, including nerve depressant and antagonistic effect on electroshock and chemo-shock seizures as well as muscular incoordination. Piperine is hypotensive, antipyretic, analeptic, and nerve stimulant (Warrier *et al*, 1995).

Rauvolfia serpentine: In Ayurveda it is also used for the treatment of insomnia, epilepsy, asthma, acute stomach ache and painful delivery. It is used in snake-bite, insect stings, and mental disorders. It is popular as "*Madman's medicine*" among tribals. '*Serpumsil'* tablet for high blood pressure is prepared from *Rauvolfia* roots. Reserpine is a potent hypotensive and tranquillizer but its prolonged usage stimulates prolactine release and causes breast cancer. The juice of the leaves is used as a remedy for the removal of opacities of the cornea. Serpentine group comprising serpentine, sepentinine, alstonine *etc* is mostly antihypertensive. (Husain, 1993).

Aegle marmelos: Every part of the tree is medicinal and useful. The roots are used in many Ayurvedic medicines for curing diabetes and leprosy. It is an ingredient of the '*dasamoola*'. The Bark is used to cure intestinal disorders. Leaves contain an alkaloid rutacin which is hypoglycaemic. '*Two leaves before breakfast'* is said to keep diabetes under control. Leaves and fruits are useful in controlling diarrhoea and dysentery. Fruit pulp is used as '*shampoo*' and cooling agent. '*Bael sharbat*' is prepared by mixing the fruit pulp with sugar, water and tamarind juice, which is very useful for stomach and intestinal disorders. The rind of the fruit is used for dyeing and tanning. The aromatic wood is used to make pestles in oil and sugar mills and also to make agricultural implements (Rajarajan, 1997).

Phyllanthus emblica: It goes in combination in the preparation *of triphala, arishta, rasayan, churna* and *chyavanaprash.* Seed is used in asthma, bronchitis and biliousness. Tender shoots taken with butter milk cures indigestion and diarrhoea. Leaves are also useful in conjunctivitis, inflammation, dyspepsia and dysentery. The bark is useful in gonorrhoea, jaundice, diarrhoea and myalgia. The root bark is astringent and is useful in ulcerative stomatitis and gastrohelcosis. The dried fruits have good effect on hair hygiene and used as ingredient in shampoo and hair oil. The fruit is a very rich source of Vitamin C (600mg/100g) and is used in preserves as a nutritive tonic in general weakness (Dey, 1980).

Withania somnifera: Its roots, leaves and seeds are used in Ayurvedic and Unani medicines, to combat diseases ranging from tuberculosis to arthritis. Roots are prescribed in medicines for hiccup, several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammations and skin diseases. Its roots and paste of green leaves are used to relieve joint pains and inflammation. It is also an ingredient of medicaments prescribed for curing disability and sexual weakness in male. Aswagandha powder (6-12g) twice a day along with honey and ghee is advised for tuberculosis in Sushruta Samhita. It also provides sound sleep (Prakash, 1997).

Azadirachta indica: Every part of the tree, namely root, bark, wood, twig, leaf, flower, fruit, seed, kernel and oil has been in use from time immemorial in the Ayurvedic and Unani systems of medicine. It is valuable as an antiseptic, used in the treatment of small pox. Small twigs are used as tooth brushes and as a prophylactic for mouth and teeth complaints. Extract from the leaves are useful for sores, eczema and skin diseases. Boiled and smashed leaves serve as excellent antiseptic. Decoction of leaves is used for purifying blood. Neem oil is used in soaps, toothpaste and as a hair tonic to kill lice. Seed is used in snake bite. Extracts of neem seed oil and bark check the activity of male reproductive cells and prevents sperm production. Neem seed oil is more effective than the bark for birth control. Neem based commercial products are also available for diabetes treatment (Nimbola, JK-22), contraceptive effect (Sensal, Nim-76) and mosquito/ insect repelling (Tewari, 1992; Parmer and Katkar, 1993; Pushpangadan *et al*, 1993; Mariappan, 1995).

Gloriosa superba: The roots and rhizomes are used in traditional system of medicine. A paste of the root is also used as an anodyne; applications in bites of poisonous insects, snake bites, scorpion sting, parasitic skin diseases and leprosy (Nadkarni, 1954; Chaudhuri and Thakur; 1994).

Gmelina arborea: The whole plant is medicinally very important. It promotes digestive power, improves memory, overcomes giddiness and is also used as an antidote for snake bite and scorpion sting. Roots are useful in hallucination, fever, dyspepsia, hyperdipsia, haemorrhoids, stomachalgia, heart diseases, nervous disorders, piles and burning sensation. Bark is used in fever and dyspepsia. Leaf paste is good for cephalagia and leaf juice is a good wash for foul ulcers and is also used in the treatment of gonorrhoea and cough. Flowers are recommended for leprosy, skin and blood diseases. In south India the bark of the tree is used by arrack manufacturers to regulate the fermentation of toddy. The plant is also grown in garden or avenues (Dey, 1984; Sivarajan and Indira, 1994).

Bauhinia variegate: In traditional medicine, Bauhinia is extensively used in glandular diseases and as an antidote to poison. The drug is also reported to be useful in dysentery, diarrhoea, piles and worms (Kurup *et al*, 1979). Root is carminative and antidote for snakebite. Bark, flower and root promote suppuration. Bark and bud are astringent and vermifuge (Husain *et al*, 1992).

Constraints

The Gujarat Forest Department has identified some constraints in the development of medicinal plant sector. These are as follows;

Inadequate information on availability on selected species and resource assessment.

Lack of scientific farming for authentic source of raw material and bulk availability.

Poor interest in the people regarding conservation issues and scope of sustainable development due to lack of awareness.

Lack of marketing avenues and infrastructure. There is also a total absence of processing and manufacturing units.

Lack of proper survey of medicinal plants and documentation of local health traditions and practices.

Inadequate financial support for commercial ventures.

Absence of Non- Government Organizations working exclusively on this field and an effective extension service.

Lack of Directory of village/ traditional medicinal men/farmers/ traders/entrepreneurs involved in medicinal plant sector in different parts of the state for networking and co-ordination.

Inadequate trained and skilled manpower for medicinal plant related activities.

Conservation needs

With the impact of various influencing factors the medicinal flora of the Gujarat is on the decline in terms of Biological, (physiological, phonological, regeneration) ecological (habitat-genepool, modification and alteration, hotspots, phytogeography) and conservation aspects (*ex-situ, in-situ, in-vitro*). With regards to this significant group of plants adequate research and development (R & D) support using recent techniques of scientific and technological advances (S & T) is required. Following provides the various aspects and priorities.

1. Inventorization and characterization
- Development of baseline database on species and genetic diversity of specific sites.
- Taxonomic characterization using recent trends (biochemical, DNA, RFLP, PCR, etc. Cytological Palynological tools).
- Manpower (capacity building).
- Funding mechanism (collaborative).

2. Monitoring and Assessment
- Development of cost effective methodology for quantitative assessment of specific site.
- Application of remote sensing (RS) and GIS (Geographic Information System) technology in identifying critical habitats at landscape level. Conforming RS and GIS database with ground truthing.

3. *Ex-situ* conservation
- Development of nursery and planting technology for rare and threatened taxa.
- Development of gene bank (field oriented) on targer species.
- Networking for coordination and collaboration at inter disciplinary and inter institutional levels.
- Application of cost effective ways of conserving biological parts of medicinal flora (possibly through innovations and inventions at grassroots level).

4. *In-situ Conservation*
- Development of microhabitats, endemic centres, hotspots. A separate Working Plan Circle in forest Department may be constituted.
- Application of recent trends in the field of biodiversity conservation to the existing preservation plots, sacred gives and specific sites falling under various other key area o9f conservation, for example, 86 National Parks (PKs) and 480 Wildlife Sanctuaries (WLs) of the country.

Table 1: Medicinal plants growing in forests, grasslands, running or stationary water bodies, deserts and other forms of natural vegetation.

Name of the plants	Part used	Main area of natural occurrence	Resources	Demand
1	2	3	4	5
Acacia catechu	STBK, EXT	North, West & Central India; upto 800m	Poor (VU)	Med
Acacia nilotica	GM, BK	Maharashtra, Gujarat, Pajab and Rajasthan	Good	High
Ailanthus excelsa	STBK	West Bengal, Bihar, Orissa and Gujarat	Fair	Med
Aegle marmelos	FR/RT	Central & South India; upto 1000m	Good (*)	High
Alangium salvifolium	SD	Rajasthan, Gujarat,	Poor	Low

		Maharashtra		
Albizia lebbek	STBK	Throught India upto 1500m	Fair	High
Alhagi pseudalhagi	WP	Haryana, Rajasthan, Gujarat; arid plains	Poor (VU)	Low
Argyriea nervosa	RT	Throught India, sun-hill regions	Good	Med
Azadirachta indica	Panchang	Maharashtra, Gujarat and Madhya Pradesh	Good	V. High
Bacopa monnieri	WP	Throught Indian plains	Fair	Med
Bambusa arundinacea	Vanshlochan	Gujarat, Assam	Good	Med
Bauhinia variegata	STBK	Central & South India; Uttar Pradesh & Tamil Nadu	Good	V. High
Bombax ceiba	Mochras (GM)	Throught India upto 1200m	Fair	High
Butea monosperma	RT, FL	West Bengal, Madhya Pradesh and Rajasthan	Good	V. High
Caesalpinia crista	SD	Throught India upto 1000m	Good	Med
Careya arborea	STBK	Rajasthan, Gujarat	Good	Med
Casearia esculenta	STBK	Madhya Pradesh, Gujarat	Fair	Low
Cassia fistula	FR, LF	Throught India upto 1250m	Good	High
Celastrus paniculata	FR	Throught India upto 1200m	Good	Med
Centella asiatica	WP	Throught India upto 1000m	Good	V. high
Chlorophytum spp.	RT	Western and Central India, arid plains	Poor (VU)	Med
Cocus nucifera	FR (Endosperm)	Kerala, Andhra Pradesh, Karnataka and Gujarat	Fair	High
Coleus forskoholii	RT	Kumaon hills (UA), 600-1200m	Fair	Med
Commiphora wightii	GM	Rajsthan, Gujarat, arid hills and bet	V. Poor (EN)	High
Crateva nuevala	STBK, FR	Saputara (Gujarat), Maharashtra	Fair	Mar
Desmodium gangeticum	RT	North and Central India, sub-hills	Good	Med
Dioscorea bulbifera	RH	Throught India, sub-hill regions	Good	Low
Dioscorea deltoidea	RH	J&K, HP. UA, 1500-2500m	Poor (VU)	V. high
Dolichandrone falcata	STBK	Western and Central India, arid plains	Poor	Mar
Emblica officinalis	FR	Northern and Central India,upto 1000m	Good	V. high
Fagonia cretica	WP	Haryana, Rajasthan, Gujarat, arid plains	Fair	Mar
Ficus benghalensis	BK, HB	Northern and Central India, upto 1000m	Good	Med
Ficus racemosa	STBK	Northern and Central India, upto 1000m	Good	Med
Ficus tsiela	STBK	Banascatha (Gujarat)	V. Poor	Mar
Garcinia indica	FR	Maharashtra, Karnataka, W. Ghats	Fair	Med
Gloriosa superba	RT/ SD	Throught India upto 1000m	Good (*)	High
Gmelina arborea	RT, BK, ST	Sikkim, Assam and Central India	Good	V. High
Gymnema sylvestre	LS/RT	Andhra, Karnataka, TN, Kerala Plains	Fair (*)	Med
Helicteres isora	FR	Northern and Central India, upto 1000m	Good	mar
Hemidesmus indicus	RT	Karnataka, Kerala; Ghat, Coastal forest	Fair (*)	Med
Holarrhena	STBK	Throughout India, Sub-hill	Good	High

antidysenterica		regions		
Leptadenia reticulata	RT	Gujarat, Rajasthan, Maharashtra, arid plains	Fair	High
Limonia acidum	FR	Gujarat, Rajasthan	Fair	Med
Madhuca indica	FR, FL	Bihar, UP, MP	Good	High
Madhuca longifolia	FR/SD	Central and South-eastern India	Good	High
Mallotus philippensis	FR hair	Throught India upto 1100m	Good	Med
Melia azedarach	STBK	Throught India upto 1800m	Good	V. High
Mimusops elengi	STBK	South India and North-eastern	Fair	High
Moringa concanensis	STBK	Throught India upto 1200m	V. Poor (*)	Med
Moringa oleifera	STBK	Billawar (J & K), Dhinodar hill (Gujarat) and Ganjam (Orissa)	Good	V. High
Mucuna pruriens	SD	Throught India upto 1500m	Fair	High
Oroxylum indicum	RT	UP,Bihar, Gangetic Plains	Good	Low
Phoenix dactylifera	FR	Throught India upto 1500m	Poor	Low
Pongamia pinnata	SD	Throught India upto 1200m	Fair	Med
Pterocarpus marsupium	WD	UP, MP, Bihar, Jharkhand and Chattisgarh	Fair	Med
Putranjiva roxburghii	RT, SD	Gujarat, Maharashtra	Fair	Low
Pterocarpus santalinus	WD	Andhra, TN, Eastern Ghats, Dry hills	V. Poor (EN)	High
Rauwolfia serpentina	RT	Throughout India, sub-hill regions	Fair (*)	High
Santalum album	Heartwood	Mysore (Karnataka), Andhra Pradesh and Tamil Nadu	V. Poor (*)	V. High
Sapindus laurifolius	FR	Gujarat, Madhya Pradesh	Fair	Low
Semecarpus anacardium	FR	Tamil Nadu, Gujarat, Kerala	Fair	Low
Shorea robusta	GM	Madhya Pradesh, Gujarat	V. Poor	High
Sterculia urens	GM	Andhra, Maharashtra and Gujarat	Good	Med
Sterospermum personatum	RT, BK	Throught India upto 1500m	Good	Low
Strychnos potatorum	SD	Throught India upto 1000m	Rare	Low
Syzygium cumini	SD	Karnataka, Bihar, Gujarat and Madhya Pradesh	Good	V. High
Tamarindus indica	FR	Karnataka, Tamil Nadu, Gujarat and Andhra Pradesh	Good	Med
Tecomella undulata	STBK	West Rajasthan, Gujarat and Maharashtra	Poor (VU)	Med
Tectona grandis	STBK, FR	Central and Southern India	Good	High
Terminalia arjuna	STBK	Throught India upto 1000m	Good	Med
Terminalia bellirica	STFR	Throught India upto 600m	Good	Med
Terminalia chebula	FR	HP, UA, UP, Jharkhand and MP upto 800m	Good	V. high
Tinospora cordifolia	ST	Throught India upto 800m	Good (*)	V. high
Thespesia populnea	STBK	Coasts of Indian Peninsula and in mangrove swamps	Fair	Low
Vitex negundo	LS/FR	Throught India upto 1000m	Good	High
Woodfordia fruticosa	FL	Throughout India, foothills upto 1500m	Good	High
Wrightia tomentosa	SD	Throughout India, upto 1000m	Fair	Mar
Zanthoxylum armatum	FR	J&K, HP, UA, Upto 800-1300m	Poor (VU)	Med

Abbreviations and legends to tables 01 to 05.
Vegetative parts used: RT- Root; BK- bark; RTBK- root bark; ST- stem; STBK- stem bark, LF- leaf; FL- flower; FR- fruit; SD- seed; GM- gum,oleoresin; WP- whole plant; HB- herb (aerial parts).
Resources: Good- No decline foreseen; Fair- May decline if there is increase in current rate of collection; Poor- Already declining; V. Poor- Declining sharply and may exhaust shortly; Rare- Almost exhausted in the wild; (*)- Declined in wild but progressively cultivated.
Threat categories (IUCN): CR- Critically Endangered; EN- Endangered; VU- Vulnerable.
Demand (in Drug & Pharmaceutical and export industry): Mar (Marginal)- less than 100 MT per annum (P.a.); Low- between 100 to 500 MT P.a. ; Med (Medium)- 500 to 2500 MT P.a.; High- 2500-5000 MT P.a.; V. High (Very High)- above 5000 MT P.a.

Table 2: Medicinal Plants growing as weed or under run wild conditions in secondary forest scrub, fallow agricultural land, orchards, organic dumps, along rail track or roads, in and around stagnant water bodies and other waste places

Name of the plants	**Part used**	**Main area of natural occurrence**	**Resources**	**Demand**
1	2	3	4	5
Abution indicum	WH, SD	Throughout Indian plains	Good	Med
Acalypha indica	WP	Throughout Indian plains	Good	Mar
Achyranthus aspera	WP	Throughout Indian plains	Good	Low
Andrographis paniculata	HB	UP, Bihar, W. Bengal, Gangetic plains	Fair (VU) (*)	High
Boerhavia diffusa	RT	Throughout India, asending to 1000m	Good	High
Calotropis gigantea	RTBK	West Rajasthan, Gujarat & South India	Poor	Mar
Cassia occidentalis	SD	Throught India upto 1200m	Good	Med
Cassia tora	SD	Throught India upto 1200m	Good	Med
Curculigo orchioides	RT	Throughout India, under mango groves	Fair (VU)	High
Cyperus rotundus	Tuber	Throught India upto 1200m	Good	High
Datura strantonium	LS/SD	W. Himalayas, Southern hills upto 1500m	Good	Med
Eclipta prostrata	WP	Throughout India, moist & marshy loc.	good	High
Justicia adhatoda	LF, WP	Throught India upto 1800m	Fair	Low
Gymnema sylvestre	RT/LS	Andhra, TN & Kerala upto 1000m	Fair	Med
Lepidium sativum	SD	Throughout India,often cultivated	Good	Low
Mimosa pudica	SD	Northern & Central Himalayan foothills	Fair	Mar
Ocimum basilicum	HB	Throught India upto 1200m	Fair	Med
Ocimum canum	SD	Throught India upto 1000m	Good	High
Phyllanthus amarus	HB	Peninsular & South India, plains	Good	High
Psoralea crylifolia	SD	UP, Bihar, Chattisgarh, plains	Fair (*)	High
Solanum surattense	WP/RT	Throught Indian plains	Good	High
Sphaeranthus indieus	FL	Bihar, Jharkhand, Chattisgarh, plains	Fair	Low
Tephrosia purpurea	WP	Northern & Western plains	Good	Low

Table 3: Plants cultivated as avenue trees, embankment stabilizers, hedges or ornamentals in parks and gardens and yielding herbal raw materials

Plant	Part	Areas where cultivated	Demand
Abution indicum	SD	Throughout India as flowering herb	High
Acacia nilotica	STBK/GM	North, West & Central India on embankments	High
Aegle marmelos	RT/FR	Throughout India, around temples & villages	High
Alstonia scholaris	STBK	Throughout India as avenue tree	Mar
Annona squomosa	LF, SD	Throughout India as flowering herb	Med
Azadirachta indica	LS/STBK/SD	Throughout India as avenue tree	High

Cassia fistula	FR (pulp)	Throughout India as avenue tree	High
Cassia occidentalis	LF, SD	Throughout India	Med
Catharanthus roseus	HB/RT	Throughout India as flowering herb	V. High
Clitorea ternatea	FL/FR	Southern & Eastern India as flowering shrub	Mar
Clerodendron serratum	RT	Throughout India as flowering herb	Med
Clerodendron multiflorum	RT, LF	Throughout India as flowering herb	High
Commiphora wightii	GM	Throughout India	V. High
Euphoebia nerifolia	WP	Throughout India as flowering herb	Low
Gmelina arborea	RT	Throughout India as avenue tree	Med
Helicteres isora	FR	Throughout India as flowering tree	Low
Holarrhena antidysenterica	BK, SD	Throughout India as flowering tree	Low
Lawsonia alba	LF, SD	Throughout India as flowering herb	High
Moringa oleifera	FR/SD	Throughout India as avenue tree	Med
Nyctanthes arbortristis	LS,FL	Throughout India as flowering tree	Low
Saraca india	STBK	TN, Karnataka & Kerala as flowering tree	High
Syzygium cumini	SD	Throughout India as avenue tree	High
Terminalia arjuna	LS, STBK	Throughout India as avenue tree	High
Thespesia populnea	FL, FR	As flowering tree in Indian gardens	Low
Vitex negundo	LF	Gujarat, Madhya Pradesh, Karnaatakaa	Low
Woodfordia fruticosa	FL	West Bengal, Gujarat	Low
Xeromphis spinosa	FR	Andhra Pradesh, Western India	Low
Zizyphus spp.	RT	Hotter parts of northern and peninsular india	Med

Table 4: Plants grown as agricultural, horticultural or industrial or industrial crops and also yielding important herbal raw materials

Plant	Crop	Medical part	Demand
Allium sativa	Garlic (Lahsun)	Bulb/Oil	V. High
Amorphophalus campanulatus	Sooran	Corm	Mar
Anethum sowa	Indian Dill (Sowa)	Seed, Seed oil	V. High
Carica papaya	Papaya (Papita)	Latex (Pepain)	V. High
Cocos nucifera	Coconut (Narial)	Kernel,Oil	High
Curcuma longa	Turmeric (Haldi)	Root	High
Foeniculum vulgare	Fennel (Saunf)	Fruit	Med
Lawsonia inermis	Mehndi (Henna)	Leaf	High
Memordica charantia	Karela	Leaf, Seed	Low
Ricinus communis	Eranda (Castor)	Root/Oil	Med
Sesamum indicum	Sesamum (Til)	Seed/Oil	High
Trichosanthes dioica	Patol, Parval	Leaf/Fruit	Low
Trigonella foenum-graceum	Fenugreek (Methi)	Seed	Low
Zingiber officinalis	Ginger (Sonth)	Rhizome	V. High

Table 5: Plants cultivated exclusively as medicinal crop

Plant	Part used	Areas where cultivated	Demand
Alpiania galanga	Rhizomes	Bhuj (Gujarat)	Med
Aloe vera	LF (Juice)	Coastal areas of Saurashtra (Gujarat)	V. High
Asparagus racemosus	RT	Anand (Gujarat)	Med
Brassica nigra	SD	Waghai (Gujarat)	High
Chlorophytum boriwilianum	RT	Waghai (Gujarat)	V. High
Cichorium intybus	SD	Amreli (Gujarat)	Low
Citrus medica	FR	Valsad (Gujarat)	V. High
Curcuma zedearia	Rhizomes	Amreli, Mesana (Gujarat)	Med
Cymbopogon martinii	WP	Anand (Gujarat)	High
Dioscorea floribunda	RH	Dang (Gujarat)	High

Eucalyputus spp.	LF, Oil	South Gujarat	V. High
Gloriosa superba	RT/SD	Dang (Gujarat)	Med
Hibiscus rosasinensis	FL	Surat, Navsari (Gujarat)	High
Mentha viridis	WP	Bhavnagar (Gujarat)	V. High
Momordica charantia	FR	North and Central Gujarat	Med
Nerium indicum	RT	Junagadh (Gujarat)	Med
Piper longum	FR, RT	Surat, Navsari (Gujarat)	V. High
Rauwolfia serpentina	RH	Navsari, Bhavnagar (Gujarat)	Low
Ricinus communis	RT, LF	Surendranagar (Gujarat)	Med
Trapa bispinosa	FR	Bharuch, Kheda (Gujarat)	Low
Trichosanthus dioica	WP	Banaskantha (Gujarat)	Low
Withania somnifera	RT	Ratanmahal (Gujarat)	High
Zingiber officinalis	HB	Navsari, Bhavnagar (Gujarat)	V. High

CONCLUSION

The observations made in the foregoing discussion indicate that through there are problems facing the medicinal plant raw material resource in Gujarat; there is enough scope for its development to meet the requirements of Drug and Pharmaceutical Industry. Concerted multi-disciplinary efforts are required to execute large scale production of materials from both wild and cultivated sources. The augmentation and supplies of raw materials obtained from the plants growing in forests, specially those originated from trees and shrubs, may better be left with the foresters who may undertaken in-situ conservation, restocking and forestation with desirable species. Medicinal and aromatic plants play a very important role in the life support systems and well being of mankind. In Dang forest division there is an over-exploitation of forest area specially the medicinal aromatic plant species and a large number of species are endangered due to a combination of over-harvesting and habitat destruction. MAP's are being overused and degraded due to lack of local control over the resources, social and cultural traditions. However, with the increase in population and associated poverty in the present area, people are compelled to over harvest resources for commercial purpose and also for their traditional use. Research and development studies on domestication of wild plants and introduction on certain exotics have been going on at a number of governments, non-government and academic agencies since long but the success in large scale cultivation could be obtained in only a few cases. There appears to be a lack of coordination among various workers and between organizations engaged in the development of medicinal plant resources as also between these and the farmer who is the ultimate agency to undertake the job and deliver the goods.

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Summary

Gujarat has on floral diversity, 2205 species of angiospermic plants belonging to 905 genera of 156 families have been recorded so far. Out of 2205 plant species, 748 plants were identified as medicinally important. The number of plant species yielding raw materials used by the industry on regular basis and/or in substantially large quantities is put at around 143. Among these, 77 occur wild in forests or other forms of natural vegetation, 23 grow as weed, 42 are grown as cash crop for other plant based products and 22 are cultivated as medicinal crop. There has been a tremendous increase in the production of herbal medicines and other items in recent years. This paper makes an appraisal of present status of raw material resources and discusses prospects of its development. Effects have been made to highlight the problems encountered for necessary constraints and conservation need to medicinal plants in Gujarat state.

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RESPONSE OF PHOSPHORUS AND WEED CONTROL MEASURES ON YIELD AND YIELD CONTRIBUTING CHARACTERS OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract: The field experiment was conducted during the rabi season of 2005-06 at Agronomy Research Farm at Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj) Faizabad, U.P. to, study the "Effect of phosphorus and weed control measures on growth and yield of chickpea (*Cicer arietinum* L.)" variety udai (KPG-59). Sixteen-treatment combinations comprised of four levels of phosphorus (control, 20, 40 and 60 kg P2 O5 ha-1) and four treatment of weed control measures (weedy check, Hand weeding at 30 DAS, pendimethline at 1 kg ha^{-1} and rice straw mulch) were tested in Randomized Block design with three replications . Growth and yield attributes as well as root length, number of take were affected significantly due to increase the phosphorus levels. However, weed density and weed dry weight were decreased significantly with increasing levels of root nodules and nodules dry weight, nitrogenase activity and nitrogen and phosphorus up phosphorus. Among the weed control measures, hand weeding at 30 DAS found promising to reduce the weed density as well as weed dry weight. Hand weeding at 30 DAS proved its superiority over other methods of weed control in respect of all the growth characters and yield attributes as well as grain and straw yield of chickpea crop followed by pendimethline at 1.0 kg ha-1. On the basis of economics the highest net return was recorded under the effect of Hand weeding at 30 DAS alone has been found most remunerative which was recorded the highest net income rupee invested of Rs 3.52

Keyword: Chickpea, phosphorus levels, weeds control measures

INTRODUCTION

The pulses in the dietary to the mankind make high edible protein which contains essential amino acid to meet the optimum protein requirement of vegetation population. The pulses fix the atmospheric nitrogen into the soil thereby enriching the soil with nitrogen at no extra cost among the winter season pulses. Chickpea has diversified use such as dal, basan, fresh green seeds for vegetable and fresh green leaves for sag for human consumption and feeding to animals. It is considered to have medicinal effect and it is used for blood purification, chickpea contains 18- 22 % protein, 52-70 % carbohydrate, 4- 10 % fat and sufficient quantity of minerals and vitamins. Besides, being a rich source of protein it is also considered important for sustainable agriculture, improves the physic-chemical characteristics and biological properties of soil and function as mini nitrogen factory. Chickpea (*Cicer arietinum* L) is one of the important pulse crops of rabi season. The chickpea is grown in India on an area of 8.81 mha, with production of 6.68 mt.which amounts 65 and 68 per cent of the global area and production respectively (Ali *et al*., 2003). In Uttar Pradesh, it is cultivated on an area of 868 lakh hectares with an annual production of 828.4 lakh tones. Thus, the average productivity of chickpea in Uttar Pradesh is very low out of several reasons for low productivity, soil fertility status and inadequate weed management may be considered are major constraints. Phosphate fertilization of chickpea of promotes of growth nodulation and enhance yield. Phosphorus imparts hardiness to shoots, improves grain quality, regulate the photosynthesis govern physio-biocamical processes and also helps in root enlargement, nodule production and there by increases nitrogen fixation. Weed control is achieved through direct methods and by adopting indirect methods such as altered land preparation, soil moisture regulation, planting methods and fertility management, manual weeding at 25 and 40 days after sowing increased seed yield of chickpea by 170 per cent over weedy check (Shekhawat and Sharma, 1988). Mulch also increased the grain yield and straw yield of Gram as reported by (Chaudhary *et al.* 2003).

MATERIAL AND METHOD

The field experiment was conducted during rabi season, 2005-2006 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj) Faizabad (U. P.) India. The field study was planned and layout in randomized block design. Chickpea was sown in second fortnight of October and was harvested in the second fortnight of March. The soil of the experimental field was poor in available nitrogen and medium in phosphorus and potassium with alkaline in reaction. The organic carbon content in the soil was 0.34 per cent. During crop season, the maximum

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temperature varied from 21.8^{0}C to 35.0 ^{0}C. The maximum rainfall of 24.2 mm was recorded in the month of October and total rainfall received during the crop period was 69.5 mm. The sunshine hours ranges from October 2.6 to 9.9 hours. Relative humidity was the maximum 78% in the month of October respectively. Chickpea variety Udai (KPG-59) was sowing in furrows opened by Kudal at the spacing of 30 cm apart using 80 kg seed ha^{-1}. Soil of the experimental site has been classified as sandy loam and field was drained and leveled. Soil samples were collected at random from different parts of experimental field (16 places) with the help of a soil auger to a depth of 0-22.5 cm prior to the fertilizer application. The collected soil samples were mixed together and a composite sample was drawn and analyzed. A basal dose of 20 kg nitrogen through urea was applied uniformly to all plots. The observations pertaining to yield and yield contributes were recorded at harvest. Weed population was studied with the help of a quadrate (50cm x 50cm) placed in second row in the different corners of the plot in different observations. The populations counts were taken at different stages of crop growth i.e. 30, 60, 90 DAS and at harvest sampled plants were dried in sun and subsequently into oven at 70^{0}C till constant weight were obtained.

RESULT AND DISCUSSION

Growth attribute

Plant height : Phosphorus levels per hectare and weed control measures markedly influenced the plant height at all the crop growth stages in the year (Table 1). The plants grow slowly up to 60 days and there after a fast growth rate was observed up to 90 days stage. Plant height was affected significantly by different phosphorus levels, except at 20 kg P_2O_5 ha^{-1} (P_1) at all the stages of crop growth except 30th and 60th day stages. At30th and 60th day stages plant height was recorded at par due to various phosphorus levels. Among all the phosphorus treatments, higher plant height was recorded at w_0(P_3) at all the stages and lowest with control (P_0). Phosphorus 60 kg P_2O_5 ha^{-1} (P_3) recorded significantly higher plant height on all the lower levels of phosphorus at 90 and at harvest stages of crop growth.

The effect of different weed control measures on plant height is depicted. Plant height was affected significantly due to various weed control measures at all the stages of crop growth, except at 30th day crop stage. Among all the weed control treatments, height was recorded in mulch (w_3) and lowest in weedy check (w_0) treatments at all the stages of crop growth. All the weed control measures did not observe significant difference as compare to weedy check (w_0) at all the stages. Hand weeding (w_1) and pendimethaline @1.0 kg ha^{-1} (w_2) being at par with weedy check (w_0) at 90 day of crop growth. Mulch (w_3) recorded significantly higher plant height as compare to all the weed control measure at all the stages of crop growth except at 30 day stage.

Dry matter accumulation plant^{-1} (g)

Phosphorus levels per hectare and weed control measures markedly influenced the dry matter accumulation (gm.) at all the crop growth stages in the year (Table 2). In general, dry matter accumulation increased with increased with increasing in crop age. Lower doses of phosphorus resulted in substantially less dry matter as compared to all other treatments. Phosphorus at 20 kg P_2O_5 ha^{-1} (P_1) being at par with other higher level of phosphorus at 30th and at harvest recorded significantly more crop dry matter as compared to weedy check (w_0). Phosphorus 40 kg P_2O_5 ha^{-1} (P^2) being at par with 60 kg P_2O_5 ha^{-1} (P_3) recorded significantly more crop dry matter as compared to lower phosphorus levels at 60 DAS. At 60 kg P_2O_5 ha^{-1} (P_3) recorded significantly more crop dry matter as compared to lower phosphorus levels at 90 DAS. Among weed control measures, weedy check (w_0) resulted in significantly less dry matter accumulation as compared to all other treatments, at all the stages of crop growth. All the weed control measures being at par resulted in significantly higher dry matter accumulation at all the stages of crop growth as compared to weedy check (w_0).

Yield attributes

Number of pods plant^{-1}: The number of pods plant^{-1} was affected significantly by different phosphorus levels of phosphorus. Among all the phosphorus levels, highest number of pods plant^{-1} was recorded at 60 kg P_2O_5 ha^{-1} (P_3) which was significantly higher as compare with all lower levels, varying weed control measures recorded more number of pods plant^{-1} as compared to weedy check. Among weed control measures, hand weeding (W_1) being at par with pendimethaline 1.0 kg ha^{-1} (W_2) recorded significantly higher number of pods plant^{-1} as compare to mulch (W_3) and weedy check (W_0) treatments.

Number of grains pod^{-1}: Number of grains pod^{-1} was affected significantly by different phosphorus levels. Among all phosphorus levels, maximum number of grains pod^{-1} was recorded at 60 kg P_2O_5 ha^{-1} (P_3) which was significantly higher as compare to other lower levels. All the weed control measures resulted in significantly higher number of grains pod^{-1} as compared to weedy check (W_0) where all the weed control measures found at par.

Grain weight plant^{-1}: The perusal of data revealed that phosphorus at 60 kg P_2O_5 ha^{-1} (P_3) recorded significantly higher grain weight plant^{-1} as compare to lower levels of phosphorus. It is evident from the data given in table-1 that different weed control measurers did not influence the grain weight plant^{-1} significantly.

Test weight (100 grain weight (g): It is evident from the data given in table -1 that different level of phosphorus and weed control measures did not influence the test weight significantly.

Number of pods plant^{-1}, number of grains pod^{-1} and grain weight plant^{-1} only were influenced significantly by various levels of phosphorus and weed control measurers (table-1). Phosphorus at 60 kg P_2O_5 ha^{-1} (P_3) recorded significantly higher number of pods plant^{-1}, number of grains pod^{-1} and grain weight plant^{-1} than lower levels of phosphorus. These treatments may provide sufficient phosphorus for the growth of crop as well as yield contributing characters like number of pods plant^{-1} , number of grains pod^{-1} and grain weight plant^{-1} . saraf *et al*., (1997), Saini and Faroda (1998), Amar Nath *et al.* (2004), Meena *et al.* (2006) reported similar result.

Effect on yield: The perusal of the data revealed that phosphorus 40 kg P_2O_5/ha (P_2) being at par with 60 kg P_2O_5/ha (P_3) resulted in significantly higher grain yield as compared to lower phosphorus levels. Among weed control measures, weedy check (W_0) resulted significantly less grain yield as compared to rest of the treatments. Among weed control measures, hand weeding (W_1) showed significantly higher grain yield as compared to other weed control measures. The perusal of the data revealed that phosphorus 40 kg P_2O_5/ha (P_2) being at par with 60 kg P_2O_5/ha (P_3) resulted in significantly higher straw yield as compared to lower phosphorus levels. The control (P_0 recorded) the significantly less straw yield among all the treatments. Among weed control measures, weedy check (W_0) resulted in significantly less straw yield as compared to all other weed control measures while hand weeding (W_1) treatments being at par with pendimethaline 1.0 kg/ha (W_2) showed significantly higher straw yield as compared to other weed control measures. The different levels of Phosphorus weed control measures did not influence the harvest index of chickpea.

Phosphorus 40 kg P_2O_5/ha (P_2) being at par with 60 kg P_2O_5/ha (P_3) was found most promising and significant increase in the grain yield of crop as compared with other phosphorus treatments. The positive response of chickpea crop to phosphorus 40 kg P_2O_5/ha (P_2) in most of the yield contributing characters has reflected to obtaining higher grain yield (table-2). This may also be due to provide sufficient phosphorus for required growth factors under these treatments resulted in higher grain yield. Similar result also reported by Parihar (1990), Enania and Vyas (1995), Saraf *et al.* (1997). Bahadur *et al.* (2002), Meena *et al.* (2003), Amar Nath *et al.* (2004), Pyare and Dwivedi (2005), Khan *et al.* (2005), Meena *et al.* (2006).

Table 1: Effect of phosphorus and weed control measures on weed density (m^{-2})

	Crop growth stage (DAS)		
Treatment	60	90	At harvest
Phosphorus (Kg P_2O_5/ha)			
P_0	6.61(44.25)	7.21(56.25)	6.44(44.75)
P_1	6.25(39.50)	6.49(45.75)	5.24(29.25)
P_2	5.22(27.50)	5.65(33.75)	4.55(22.00)
P_3	4.90(24.25)	4.46(21.25)	3.83(15.75)
SEm±	0.01	0.20	0.21
CD (0.05)	0.29	0.58	0.60
Weed control measures			
W_0	6.59(44.25)	7.84(63.75)	6.45(44.25)
W_1	5.21(27.50)	4.10(17.50)	3.56(13.25)
W_2	5.49(30.75)	4.90(24.50)	4.25(18.50)
W_3	5.69(33.00)	6.97(51.25)	5.81(35.75)
SEm±	0.10	0.20	0.21
CD (0.05)	0.29	0.58	0.60

Table-2: Effect of phosphorus and weed control measures on weed dry weight accumulation (g m^{-2})

	Crop growth stage (DAS)		
Treatment	60	90	At harvest

Phosphorus (Kg P_2O_5/ha)			
P_0	9.65	10.98	12.41
P_1	8.06	9.13	10.34
P_2	7.80	8.90	10.14
P_3	7.44	8.48	9.94
SEm±	0.36	0.44	0.54
CD (0.05)	1.03	1.27	1.56
Weed control measures			
W_0	9.82	11.13	12.49
W_1	7.73	8.49	9.77
W_2	7.67	8.72	10.00
W_3	7.67	9.16	10.57
SEm±	0.36	0.44	0.54
CD (0.05)	1.03	1.27	1.56

Table-3: Effect of phosphorus and weed control measures on yield contributing character of chickpea.

Treatment	Number of pod^{-} plant^{-1}	Number of grains pod^{-1}	Grain weight plant^{-1}	Test weight (100 grain weight (g)
Phosphorus (Kg P_2O_5/ha)				
P_0	35.04	1.40	9.30	19.25
P_1	39.42	1.54	10.15	19.25
P_2	44.00	1.55	10.50	19.35
P_3	50.42	1.70	11.44	19.62
SEm±	1.25	0.04	0.24	0.18
CD (0.05)	3.62	0.12	0.68	NS
Weed control measures				
W_0	30.17	1.39	10.17	19.22
W_1	49.92	1.65	10.48	19.59
W_2	46.42	1.61	10.40	19.41
W_3	42.37	1.54	10.34	19.37
SEm±	1.25	0.04	0.24	0.18
CD (0.05)	3.62	0.12	NS	NS

Table-4: Effect of phosphorus and weed control measures on grain and straw yield and harvest index of chickpea.

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Phosphorus (Kg P_2O_5/ha)			
P_0	16.19	24.09	40.01
P_1	19.26	26.94	41.21
P_2	21.28	30.75	41.74
P_3	22.93	31.42	42.61
SEm±	0.67	0.93	
CD (0.05)	1.94	2.67	
Weed control measures			

W_0	17.15	24.5	40.21
W_1	22.24	31.52	41.99
W_2	20.88	29.38	41.06
W_3	19.38	27.8	40.86
SEm±	0.67	0.93	
CD (0.05)	1.94	2.67	

P_{0-0} kg P_2O_5, P_{1-} 40 kg P_2O_5, P_{3-} 60 40 kg P_2O_5,
W_{0-} weedy check, W_{1-} Hand weeding 30 DAS, W_{2-}Pendimethalin 1.0 kgha^{-1} (pre-Em.),W_{4-} Rice straw mulch 5 cm thick (post Em.)DAS- Days After Sowing.

CONCLUSION

It may be concluded that for achieving higher yield and better weed management of the chickpea, the crop may be fertilized with 40 kg P_2O_5 ha^{-1} and weeded manually at 30 days after sowing.

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VARIABILITY AND GENETIC PARAMETERS FOR GRAIN YEILD AND ITS QUALITY ATTRIBUTES IN CMS BASED RICE HYBRIDS (*ORYZA SATIVA* L.)

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Abstract: The present investigation is carried out to the genetic parameters for yield and its quality attributes in eighteen rice hybrids. Analysis of variance revealed significant differences for all traits under study. The characters *viz.* biological yield per plant(g), grain yield per plant(g), number of unfilled spikelet/plant, number of filled spikelet/plant, productive tiller/plant, spikelet fertility%, pollen fertility %, kernel length breadth ratio and harvest index. High GCV and PCV were recorded for traits *viz.*, followed by biological yield/plant, grain yield/plant, number of unfilled spikelet/plant, number of filled spikelet/plant, productive tiller/plant, spikelet fertility%, pollen fertility%, kernel length breadth ratio and harvest index. High heritability coupled with high genetic advance as percent of mean was registered for grain yield/plant(g), number of unfilled spikelet/panicle, number of filled spikelet/panicle, productive tiller/plant, tiller/plant, spikelet fertility %, pollen fertility %, kernel length breadth ratio, harvest index, brown rice length breadth ratio, flag leaf area(cm^2), hundred seed weight(g), plant height(cm), head rice recovery percentage, flag leaf length(cm), kernel length(cm), brown rice(cm), leaf area index, paddy length breadth ratio, paddy breadth(cm) suggesting preponderance of additive gene action in the expression of these characters.

Keywords: Variability, Heritability, Genetic advance, Hybrid rice

INTRODUCTION

Rice is one of the most important cereal crops of the world meeting the dietary requirements of the people living in the tropics and sub-tropics. Quantum jumped in yield improvement has been achieved in rice with the development of high yielding heterotic hybrids under commercial cultivation. However, being the staple food of the population in india, improving its productivity has become a crucial importance. Knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for effecting genetic improvement. A critical analysis of genetic variability is a prerequisite for initiating any crop improvement programme and for adopting of appropriate selection techniques.(Ravindra *et al.*,2012).

A paradigm shift in the rice (*Oryza sativa* L.) breeding strategies from quantity centered approach to quality oriented effort was inevitable, since India has not only become self sufficient in food grain production but also is the second largest exporter of quality rice in the world (Sreedhar *et al*.,2005). Improvement in grain quality that does not lower yield is the need of hour at present context in order to benefit all rice grower and consumers. Like grain yield, quality is not easily amenable to selection due to its complex nature. Lack of clear cut perception regarding the component traits of good quality rice is one of the important reasons for the tardy progress in breeding for quality rice varieties. For the development of high yielding varieties with good quality the information on variability and genetic parameters of grain quality attributes and their association with each other including grain yield is necessary to formutate suitable breeding strategies for grain quality improvement. In the present investigation, an attempt has been made to elucidate information on nature and magnitude of genetic variation observed for yield and yield component and quality attributes in certain parents and rice hybrids.(Venkata Subbaiah *et al*., 2011).

MATERIAL AND METHOD

The experimental material used in the study consisted of nine parents and 18 F_1 hybrid combinations of rice grown in a completely randomized block design with two replications at Research Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. About 21 days old seedling of each genotype were transplanted in single row a standard spacing 20 × 20 cm was adapted for planting and ten plants were planted. Single plant per hill was planted. Recommended package of practices were followed during the crop growth period.

The treatment means for all the characters were subjected to analysis of variance technique on the basis of model proposed by Panse and Sukhatme(1961).The genotypic (GCV) and Phenotypic (PCV) coefficient of variation was calculated by the formulae given by Burton (1952).Heritability in broad sense[$h^2_{(b)}$] was calculated by the formula given by Lush (1940) as suggested by Johnson *et al.*(1955). From the heritability estimates, the genetic advance (GA) was estimated by the following formula given by Johnson *et al*. (1955).

RESULT AND DISCUSSION

Analysis of variance revealed the significant differences among the genotypes for all the traits

indicating the sufficient scope for further improvement (Table 1 and 2).The range of mean variation observed among yield components and kernel quality characters in parents revealed that highest range of mean variation was noticed for biological yield per plant and head recovery rice%, whereas the range was found to least for hundred seed weight and elongation ratio, respectively(Table 1 and 2).

The PCV estimates were higher than GCV for all the traits, indicating the influence of environment for the expression of these traits. The difference between PCV and GCV estimates were relatively low for traits viz., days of 50% flowering, panicle length(cm), hulling %, milling %, paddy length(cm), brown rice length(cm), brown rice breadth(cm), kernel length(cm), elongation ratio(cm) indicating less environmental influence on these traits. The characters viz., tiller per plant, productive tiller per plant, no. of filled spikelet per panicle, no. of unfilled spikelet per panicle, spikelet fertility %, pollen fertility %, biological yield per plant(g), grain yield per plant(g), harvest index, kernel length breadth ratio, showed higher estimates of GCV and PCV therefore, simple selection can be practiced for further improvement of these characters. This was in conformity with the finding of Sharma *et al.*(2006) for total number of productive tillers per plant and Singh *et al.*(2000) for harvest index in rice. Moderate estimates of PCV and GCV values were recorded for plant height(cm), flag leaf length(cm), flag leaf area(cm^2), leaf area index, hundred seed weight(g), head recovery rice %, paddy length(cm), paddy breadth(cm), brown rice length breadth ratio, kernel breadth(cm). These results were in consonance with the findings of Kundu *et al.*(2008) for hundred seed weight.

High heritability values were recorded for all the characters except elongation ratio(cm) in the generation indicating the least influence of environment on expression of kernel quality characters. These findings were in consonance with the reports made earlier in rice by Kundu *et al.* (2008) and Deepa Sarkar *et al.* (2006). High heritability coupled with high genetic advance as per cent of mean were recorded for plant height(cm), tiller per plant, productive tiller per plant, flag leaf length(cm), flag leaf area (cm^2), leaf area index, number of filled spikelet per panicle, number of unfilled spikelet per panicle, spikelet fertility %, pollen fertility %, hundred seed weight(g), biological yield per plant(g), grain yield per plant (g), harvest index, head recovery rice %, paddy breadth(cm), paddy length breadth ratio, brown rice breadth(cm), brown rice length breadth ratio, kernel breadth(cm), kernel length breadth ratio, in case of hybrids indicating the additive gene effects in the genetic control of these traits and can be improved by simple selection in the present breeding material. Similar kind of observations were reported by Kundu *et al.*(2008) for number of grains per panicle, Deepa Sankar *et al.*(2006) for plant height, total number of productive tillers per plant, number of grains per panicle, test weight and grain yield per plant. The present study revealed that, days of 50% flowering, panicle length(cm), hulling %, milling %, paddy length(cm), brown rice length(cm), brown rice breadth(cm), kernel length(cm), elongation ratio(cm) were less influenced by environment and high heritability coupled with high genetic advance indicating that most likely the heritability is due to additive gene effects and selection may be effective for these characters based on phenotypic values in order to obtain maximum genetic gain for yield improvement in rice by simple selection process.

Table 1: Analysis of variance for grain yield and its contributing characters in rice

Source of variation	df	DF	PH	TP	PTP	FLL	FLA	LAI	PL
R eplications	**1**	0.19	0.35	1.89	3.63	5.76	2.76	0.004	1.01
Genotypes	**26**	24.01**	449.41**	26.78**	26.94**	31.34**	70.54**	1.420**	7.62**
Error	**26**	0.68	1.86	1.70	1.28	0.90	1.38	0.042	1.12

*****Significant at P= 0.05 level;**Significant at 0.01 level

DF:Days of 50%Flowering; PH:Plant height; TP:Tiller per plant; PTP:Productive tiller per plant; FLL:Flag leaf length; FLA:Flag leaf area; LAI:Leaf area index; PL:Panicle length

Source of variation	df	NFP	NUP	PF%	SF%	HW	BY	GY	HI
Replications	**1**	322.63	263.88	1.27	0.79	0.000062	0.1	0.7	0.594
Genotypes	**26**	7479.67**	3525.33**	631.59**	619.90**	0.33**	12023.1**	1049.5**	138.150**
Error	**26**	69.01	84.68	5.15	4.63	0.02	1.4	0.5	0.60

*Significant at P=0.05 level;**Significant at 0.01 level.

NFP:no.of filled spikelet per panicle; NUP:no. of unfilled spikelet per panicle; PF%:Pollen fertility %; SF%:Spikelet fertility %; HW:Hundred seed weight; BY: Biological yield per plant; GY:Grain yield per plant; HI:Harvest index.

Table 2: Analysis of variance for kernel quality characters in rice

Source of variation	df	H%	M%	HRR%	PL	PB	PLBR	BL	BB
Replications	**1**	2.85	4.54	3.54	0.0025	0.00080	0.0060	0.00074	0.00017
Genotypes	**26**	7.65**	18.99**	192.39**	0.5480**	0.13498**	0.3249**	0.77322**	0.13438**
Error	**26**	1.07	3.74	14.07	0.0019	0.00036	0.0004	0.00060	0.00019

*Significant at P=0.05 level;**Significant at 0.01 level.

H%:Hulling %; M%: Milling %; HRR%:Head recovery rice%; PL:Paddy length;
PB:Paddy breadth; PLBR:Paddy length breadth ratio; BL:Brown rice length; BB:Brown rice breadth.

Source of variation	df	BLBR	KL	KB	KLBR	ER
Replications	**1**	0.00025	0.0048	0.0008	0.00055	0.00857
Genotypes	**26**	0.78951**	0.4016**	0.1400**	1.060**	0.03172**
Error	**26**	0.00084	0.0012	0.0016	0.00657	0.00998

*Significant at P=0.05 level;**Significant at 0.01 level.

BLBR:Brown rice length breadth ratio; KL:Kernel length; KB: Kernel breadth; KLBR:Kernel length breadth ratio; ER: Elongation ratio.

Table 3: Estimation of genetic variability and genetic parameters for different charcters

Character	GCV %	PCV %	h^2	GA
Days of 50% flowering	3.61	3.71	94.5	7.23
Plant height (cm)	15.85	15.92	99.2	32.52
Tiller per plant	31.01	33.03	88.1	59.57
Productive tiller per plant	34.73	36.42	90.9	67.70
Flag leaf length (cm)	15.20	15.63	94.5	30.39
Flag leaf area (cm^2)	18.84	19.21	96.2	37.96
Leaf area index	11.95	12.30	94.3	23.72
Panicle length (cm)	7.34	8.50	74.5	13.05
No. of filled spikelet per panicle	41.35	41.73	98.2	84.39
No. of unfilled spikelet per panicle	46.24	47.37	95.3	92.99
Spikelet fertility %	28.68	28.92	98.4	58.52
Pollen fertility %	24.34	24.52	98.5	49.74
Hundred seed weight (g)	18.74	19.82	89.4	36.20
Biological yield per plant (g)	69.66	69.66	100.0	143.35
Grain yield per plant (g)	54.25	54.27	99.9	111.71
Harvest index	21.07	21.16	99.1	43.21
Hulling %	2.28	2.62	75.5	4.08
Milling %	3.98	4.86	67.1	6.72
Head recovery rice %	16.21	17.44	86.4	31.02
Paddy length (cm)	5.93	5.95	99.3	12.03
Paddy breadth (cm)	10.82	10.79	99.5	21.20
Paddy length breadth ratio	10.97	10.84	97.6	22.17
Brown rice length (cm)	9.39	9.38	99.8	19.11
Brown rice breadth (cm)	12.81	12.80	99.7	25.24
Brown rice length breadth ratio	18.82	18.80	99.8	37.95
Kernel length (cm)	7.58	7.56	99.4	15.34
Kernel breadth (cm)	14.51	14.35	97.9	28.43
Kernel length breadth ratio	22.01	21.87	98.8	43.83
Elongation ratio (cm)	9.54	6.89	52.1	9.38

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IDENTIFICATION OF COLD TOLERANT GENOTYPESAT SEEDLING STAGE IN RICE (*ORYZA SATIVA* L.)

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Abstract: In Chhattisgarh, rice is also grown during summer season in about 2 lakh hectares, mainly in areas with canal irrigation. Usually the productivity during summer is higher than *Kharif* season. However, in this season the sowing is usually done in the month of December or January during which the minimum temperature is low, which results in poor seedling establishment, stunting, yellowing and mortality. To overcome the problem of damage caused by low temperature, rice breeders have been making efforts to develop more cold-tolerant cultivars mainly at seedling stage.In this study, 17 different genotypes, including commonly grown varieties, were screened under field condition during December-January 2011 and 2012 during seedling stage at Research cum Instructional Farm, IGKV,Raipur (C.G.). The minimum temperature during this period was below 10^{o}C at-least for a12 days. Lines were evaluated on 1-9 score according to SES of rice, IRRI.GenotypesSamleshwari,Annadaand R-RF-75 showed dark green leaf colourwith score 1, while Sahbhagidhan and IR-84887-B-15 exhibited yellowing of leaf with score of 9 and 7, respectively. The result of this study is discussed in context of breeding value and practical significance from farmers' point-of-view.

Keywords: Rice *Oryza sativa* L., cold tolerance, seedling stage screening

INTRODUCTION

Rice is important crop grown in different sets of condition. The optimum temperature for seed germination and early seedling growth is from 25 to 35^{0}C. Early seedling stage is important for subsequent growth. In India when rice is grown during *Rabi* season, there have a problem of low temperature.Chhattisgarh is popularly recognized as rice bowl of the country as rice is the principal crop of thisstate but also grown during summer season in about 2 lakh hectares where canal is used for irrigation. Productivity of summer rice is usually more than *Kharif* season. During summer season sowing is usually done in the month of December to January, where minimum temperature is low.Under low temperature conditions, some common injuries include poor germination, seedling stunting, yellowing or withering, reduced tillering, delayed heading, and sterility (Kaneda and Beachell, 1974; Mackill and Lei, 1997; Nakagahra*et al.*, 1997;Andaya and Tai, 2007). To overcome the problem of damage caused by low temperature, rice breeders have been making efforts to developmore cold-tolerant cultivars at seedling stage, mainly in context of off-season crop in Chhattisgarh. Selection of high cold tolerance genotypes is the most effective way to prevent damage of the low temperature.This study was therefore undertaken to screen selected genotypes under low temperature during seedling stage.

MATERIAL AND METHOD

In this study seventeen rice genotypes (table 1), including commonly grown varieties, were evaluated under field conditions during December / January 2011-12 and 2012-13, in RCBD with three replications at Research cum Instructional Farm, IGKV, Raipur(21^{0} 16' N and 81^{0} 36' E at altitude of 289.6 meter above sea level). One row of each genotype was sown on raised nursery bed with row length of 75 cm and spacing of 10 cm between rows. The minimum and maximum temperature during this period, along with soil temperature is presented in fig 1. Lines were evaluated on 1-9 score according to SES of rice, IRRI. Observations were recorded when Sahbhagidhan exhibited the score of 9, at about 20-25 days old seedlings.

SCALE (for seedling stage)

1	Seedlings dark green
3	Seedlings light green
5	Seedlings yellow
7	Seedlings brown
9	Seedlings dead

RESULT AND DISCUSSION

The analysis of variance indicated significant variation in the reaction of genotypes to low temperature. The genotype by year interaction was non-significant, which indicated that the performance of the genotypes were almost same during both the years. The minimum temperature during the experiment reached up to 6^{O}C for 4-6 days, which could clearly discriminate the genotypes for reaction to low temperature at seedling stage. Screening at this temperature is very much relevant for Chhattisgarh state as the crop during *Rabi*/Summer is usually exposed to around this temperature only. The overall reaction of genotypes to low temperature is presented in table 1. A perusal of table 1 revealed that Samleshwari, Annada and R-RF-75 were tolerant with dark green leaf color, while Sahbhagidhan and IR-84887-B-15 exhibited

yellowing of leaf with score of 9 and 7, respectively(See fig 2). Sahbhagidhan showed very high susceptibility to cold and exhibited more than 90 percent seedlings mortality. IR-64, MTU 1010, IBD-1, Vandana andPoornima exhibited score of 3. Because of cold, germination of these genotypes (except Swarna and Swarna Sub-1) were not affected and cold injury was observed only after about 15 day of germination.

The tolerant genotypes can be promoted among the farmers for *Rabi*/Summer season cultivation. Farmers can use these genotypes for cultivation during *Rabi*/Summer where temperature is very low at the time of nursery preparation. The inheritance of cold tolerance has been reported to be quantitative in nature (Andaya and Mackill, 2003; Kuroki*et al*., 2007; Shirasawa*et al*., 2012), so the populations should be developed from these reported tolerant and susceptible genotypes for identification of QTLs and markers for further MAS based selections.

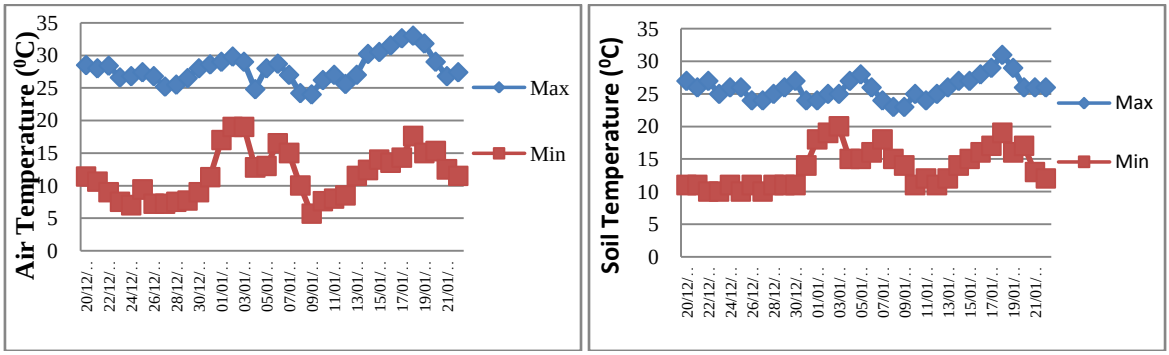

Fig. 1 Minimum and maximum temperature of air and soil during experimentin 2012-13

IR-84887-B-15 Sahbhagidhan Samleshwari

Fig. 2 Genotypes and its interaction with cold

Table 1. Reaction of genotypes to low temperature

S. No.	Name of Genotypes	Mean Cold Score (2011-12)	Mean Cold Score (2012-13)
1	Danteshwari	3.0	2.3
2	Dagaddeshi	2.7	3.0
3	Mahamaya	2.0	2.3
4	Annada	1.0	1.0
5	Vandana	3.0	3.0
6	Poornima	3.0	3.0
7	Swarna	4.3	4.3
8	SwarnaSub-1	3.6	4.3
9	R-RF-69	3.0	2.3
10	R-RF-75	1.0	1.0
11	IR-84887-B-15	7.0	7.0
12	IR-83381-B-B-55-4	2.3	2.3
13	Sahbhagidhan	9.0	9.0
14	MTU 1010	3.0	3.0
15	IR 64	3.0	3.6
16	Samleshwari	1.0	1.6
17	IBD-1	4.3	3.7

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INFLUENCE OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH, YIELD AND ECONOMICS OF POTATO CROPS UNDER CHHATTISGARH PLAINS

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Abstract: The field experiment was conducted at the All India Coordinated Research Project on Potato , Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during *Rabi* 2013-2014 in factorial randomized block design with fifteen treatment combinations consisting of different levels of RDF as (75%, 100% and 150% NPK) and different organic fertilizers as (FYM, PSB and *Azotobacter*) were replicated three times. Among the inorganic fertilizer treatments 150% RDF performed better over other treatments, while in case of organic fertilizer treatments PSB + *Azotobacte*r was found superior than others. The interaction between organic and inorganic fertilizers was found differ non significantly. The results indicated that the highest gross return (Rs 271480 ha^{-1}), net return (Rs 192827.52 ha^{-1}) and benefit: cost ratio (Rs 2.45) was obtained under 150% RDF with PSB + *Azotobacte*r.

Keywords: Potato, fertilizers, biofertilizers, yield

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops having high production per unit area and time. It can fulfill the requirement of food for human consumption to a greater extent. It is a rich source of carbohydrates (22.6 g/ 100g) as well as starch (16.3 g/ 100 g) and protein. It is good source of raw material for processing industries.

Potato produce higher yield from lesser span of time resulting soil exhausting very rapidly. The repeatedly cultivation of potato needs profuse application of nutrients, currently most of the nutrient requirements have fulfilled through inorganic fertilizers. The continuous application of inorganic fertilizers affects the soil health adversely whereas combination of inorganic and organic fertilizer or pure organic fertilizers may maintain soil health properly and subsequentely improve soil quality, health in sustainable manner (Densilin *et al*., 2010).

MATERIAL AND METHOD

The experiment was conducted at the All India Coordinated Research Project on Potato, Indira Gandhi Krishi Vishwavidylaya, Raipur (C.G.), in winter season of 2013-14 to study the influence of organic and inorganic fertilizers on growth and yield of potato under Chhattisgarh plains. Fertilizer was applied in the three level F1- 75%, F2- 100% and F3- 150% RDF, nitrogen was applied in the form of urea 75%, 100% and 150% N, half at planting and the remaining half 30 days after planting the first earthing up. Phosphorus in the form of single super phosphate and potassium in the form of muriate of potash were applied as basal dose. The organic fertilizers were also used as per treatments. In treatment O1- no organic manure, O2 - FYM @ 20 t/ha, O3 - PSB@ 5kg/ha, O4 – *Azotobacter* @ 5kg/ha and O5 -PSB @ 5kg/ha + *Azotobacter* @ 5kg/ha. It was applied in ridges and furrows area then tuberlets were immediately planted in the field at spacing of 60 X 20cm. Data were taken on the plant emergence, plant height, number of shoots, number of leaves, number of stolons, no of tubers per plant, fresh weight and dry weight of tubers per plant, marketable tuber yield and total tuber yield.

RESULT AND DISCUSSION

Influence of inorganic fertilizers

Results of investigation under inorganic fertilizer treatments revealed that growth parameters like plant emergence at 30 DAP (%), plant height (cm), number of shoots plant $^{-1}$, number of compound leaves plant^{-1}, fresh weight of shoot plant $^{-1}$, dry weight of shoot plant $^{-1}$ were influenced with the increased per cent of RDF. The highest values for all the above parameters were recorded under the treatment in which 150% RDF was applied (F_3) and lowest value recorded under the treatments 75% RDF. Higher dose of NPK significantly increased the plant height. Nitrogen is an essential element for cell division, cell enlargements and it increases the protoplasm. Phosphorus has got direct impact on shoot growth and root development whereas, potassium is one of the important constituents of cell and helps to provide resistance against disease and pests. Similar results had also been reported by Al Moshileh *et al.* (2005), *Banafar et al*. (2005), Alam *et al.* (2007), Singh *et al.* (2007), Nag *et al.* (2008), Najm *et al.* (2010), Patel *et al.* (2010), Yadu (2011) and Baishya *et al.* (2013).

Yield parameters like number of tubers plant $^{-1}$, fresh weight of tubers plant $^{-1}$, dry weight of tubers plant $^{-1}$, marketable tuber yield and total tuber yield were also influenced with the increased per cent of RDF. The highest values for all the yield parameters were recorded under the treatment in which 150% RDF was applied (F_3) and lowest value recorded under 75% RDF.. This might be due to the optimum vegetative growth with the application of higher level

of RDF, which ultimately responsible for accumulation of higher photosynthetes in the developing tubers and produced higher fresh weight of tubers per plant. The results are conformity with the findings of Al-Moshileh *et al*. (2005) and Yadu (2011) observed that with the increase in RDF application from 50 to 150 % brought about 176 and 119% increase in marketable tubers, respectively over the control.

Influence of organic fertilizers

Results of investigation under organic fertilizer treatments revealed that growth and yield parameters like plant emergence at 30 DAP (%), plant height (cm), number of shoots plant $^{-1}$, number of compound leaves plant $^{-1}$, fresh weight of shoot plant $^{-1}$, dry weight of shoot plant $^{-1}$, number of tubers plant $^{-1}$, fresh weight of tubers plant $^{-1}$, dry weight of tubers plant $^{-1}$, marketable tuber yield and total tuber yield were found highest under the treatment O_5 (PSB @ 5 kg/ha+ Azotobacter @ 5 kg/ha) and lowest value recorded under no organic manure. This may be due to the application of biofertilizers (PSB and Azotobacter). *Azotabacter* fixed the nitrogen and increased the availability of nitrogen from soil, crop residue, as it was associated with crop. As phosphorus is very less available to plant due to its high fixation in soil, the PSB increases the availability of soil P and also increases the release efficiency of P from the organic resource. Due to this a sufficient amount of P is made available to plant, which increase the tuber yield. Similar results have been reported by Singh *et al*. (2002), Nag (2008) and Verma *et al*. (2011).

The interaction between organic and inorganic fertilizers was found differ non significantly.

Economics

Table 3 indicates highest net return (Rs 192827.52/ha) and B:C ratio (2.45) in treatment combination F3O5 followed by F3O4 with corresponding values of Rs 187312.52/ha and 2.38 respectively. The minimum net return (Rs 63319.62/ha) and B:C ratio (0.93) was calculated for F1O1. On the basis of the present results, it can be stated that the combined application of PSB @ 5 kg/ha+ *Azotobacter* @ 5 kg/ha has may be the best approach among all the treatments to increase tuber yield and therefore, economic return for the farmer. It can, therefore, be concluded that the biofertilizers (PSB and *Azotobacter*) are a beneficial sources of nutrients for sustainable organic agriculture in crop that requires, high amounts of nutrients, like potato.

Table1: Influence of organic and inorganic fertilizers on growth parameters of potato crops

Treatments	**Per cent emergence at 30 DAP**	**Plant height (cm)**	**Number of compound leaves plant^{-1}**	**No of shoots plant^{-1}**	**Fresh weight of shoots plant^{-1} (g)**	**Dry weight of shoots plant^{-1} (g)**
INORGANIC FERTILIZER						
F_1 – 75 % RDF	89.33	36.52	42.61	4.93	91.30	13.09
F_2 – 100 % RDF	91.48	40.03	48.91	5.11	96.35	13.42
F_2 – 150 % RDF	94.77	46.51	53.61	7.08	111.41	17.87
SEM±	**1.02**	**0.98**	**1.64**	**0.18**	**3.37**	**0.42**
CD	**2.97**	**2.85**	**4.75**	**0.53**	**9.75**	**NS**
ORGANIC FERTILIZER						
O_1 – No organic manure	88.11	36.27	40.90	4.48	86.33	11.47
O_2 – Organic manure (FYM) @ 20 t/ha	91.47	38.99	47.31	5.36	94.37	14.24
O_3 – PSB @ 5kg/ha	90.55	41.21	48.43	5.81	99.46	14.65
O_4 – Azotobacter @ 5kg/ha	92.03	43.39	50.89	6.16	106.72	16.10
O_5 – PSB @ 5 kg/ha+ Azotobacter @ 5 kg/ha	93.35	45.24	54.33	6.74	111.57	17.53
SEM±	**1.32**	**1.27**	**2.12**	**0.24**	**4.35**	**0.54**
CD	NS	**3.68**	**6.14**	**0.69**	**12.59**	**NS**
INORGANIC X ORGANIC FERTILIZERS						
SEM±	**2.28**	**2.19**	**1.64**	**0.41**	**7.53**	**0.94**
CD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table2: Influence of organic and inorganic fertilizers on yield parameters of potato crops

Treatments	No of tubers plant^{-1}	Fresh weight of tubers plant^{-1} (g)	Dry weight of tubers plant^{-1} (g)	Marketable tuber yield q/ha	Total tuber yield q/ha
INORGANIC FERTILIZER					
F_1 – 75 % RDF	7.68	221.70	49.63	164.23	177.91
F_2 – 100 % RDF	8.50	299.79	54.47	202.44	211.81
F_2 – 150 % RDF	10.58	348.38	63.51	237.88	244.83
SEM±	**0.19**	**14.20**	**1.91**	**6.09**	**6.18**
CD	**0.54**	**41.13**	**5.55**	**17.63**	**17.89**
ORGANIC FERTILIZER					
O_1 – No organic manure	7.75	223.60	48.13	158.43	170.46
O_2 – Organic manure (FYM) @ 20 t/ha	9.18	264.13	53.22	181.19	190.79
O_3 – PSB @ 5kg/ha	7.50	300.50	55.24	210.20	220.20
O_4 – Azotobacter @ 5kg/ha	8.84	316.51	59.80	226.06	234.54
O_5 – PSB @ 5 kg/ha+ Azotobacter @ 5 kg/ha	11.32	345.01	62.97	231.70	241.60
SEM±	**0.24**	**18.33**	**2.47**	**7.86**	**7.97**
CD	**0.69**	**53.09**	**7.16**	**22.76**	**23.09**
INORGANIC X ORGANIC FERTILIZERS					
SEM±	**0.41**	**31.74**	**4.28**	**13.61**	**13.81**
CD	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3: Economics of potato as influenced by different organic and inorganic fertilizer treatments

Treatments	Yield (q/ha)	Cost of cultivation per ha			Cost per ha		Sale price (Rs/q)	Net returns* (Rs/ha)	B:C Ratio
		Seed	Fertilizer	Cultivation	Inputs	Produce			
F1O1	131.29	40000	5232.08	22738.30	67970.38	131290	1000	63319.62	0.93
F2O1	172.87	40000	6976.12	22738.30	69714.42	172870	1000	103155.58	1.47
F3O1	207.22	40000	10464.18	22738.30	73202.48	207220	1000	134017.52	1.83
F1O2	155.37	40000	10232.08	22738.30	72970.38	155370	1000	82399.62	1.12
F2O2	183.61	40000	11976.12	22738.30	74714.42	183610	1000	108895.58	1.45
F3O2	233.37	40000	15464.18	22738.30	78202.48	233370	1000	155167.52	1.98
F1O3	191.25	40000	10457.08	22738.30	73195.38	191250	1000	118054.62	1.61
F2O3	223.00	40000	12201.12	22738.30	74939.42	223000	1000	148060.58	1.97
F3O3	246.34	40000	15689.18	22738.30	78427.48	246340	1000	167912.52	2.14
F1O4	205.88	40000	10457.08	22738.30	73195.38	205880	1000	132684.62	1.81
F2O4	231.99	40000	12201.12	22738.30	74939.42	231990	1000	157050.58	2.09
F3O4	265.74	40000	15689.18	22738.30	78427.48	265740	1000	187312.52	2.38

F1O5	205.70	40000	10682.08	22738.30	73420.38	205700	1000	132279.62	1.80
F2O5	247.59	40000	12426.12	22738.30	75164.42	247590	1000	172425.58	2.29
F3O5	271.48	40000	15914.18	22738.30	78652.48	271480	1000	192827.52	2.45

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EFFECT OF DIFFERENT LEVELS OF FYM, PRESS MUD AND ZINC SULPHATE APPLICATION ON SOIL PROPERTIES

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Abstract: An experiment was conducted during the years 2006-2007 and 2007-2008 at farmers field to find out the effect of farm yard manure (FYM), press mud and in combination of inorganic fertilizer zinc sulphate. The rice variety PRH 10 was grown with thirteen treatments *i.e.*T_1 = Control; T_2 = FYM 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_3 = FYM 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_4 = FYM 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_5 = FYM 5 t ha^{-1} +7.5 kg $ZnSO_4$; T_6 = FYM 10 t ha^{-1} +0kg $ZnSO_4$; T_7 = FYM 10 t ha^{-1} +2.5 kg $ZnSO_4$; T_8 = FYM 10 t ha^{-1} +5.0 kg $ZnSO_4$; T_9 = FYM 10t ha^{-1} +7.5 kg $ZnSO_4$; T_{10} = Press mud 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_{11} = Press mud 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_{12} = Press mud 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_{13} = Press mud 5 t ha^{-1} +7.5 kg $ZnSO_4$. After the crop harvest soil samples were analyzed for physico-chemical parameters. The results showed that application of FYM and press mud in combination enhanced the soil organic carbon, available N, available P, available K and DTPA extractable Zn in soil solution. The highest increment was observed in the application of FYM 10t ha^{-1} +7.5 kg $ZnSO_4$ compared to rest of the treatments. In conclusions, use of FYM and press mud with inorganic fertilizers enhanced the plant nutrient level in soil solution for better crop yield.

Keywords: Farm Yard Manure (FYM), press mud, soil properties, zinc sulphate

INTRODUCTION

For India with a population of 17 percent of the world's population (1.1 billion) spread across only 2.3% (329 m ha) of world's area, this problem has been giving a far greater challenge. Fertilizer have played very important role in achieving the objective of food security in India. Positive interventionist policies of the government have promoted consumption of fertilizer and production of fertilizers. But irrational use of chemical fertilizers gave up poor soil physical, chemical and biological properties. In many cases agricultural productivity stagnates or decline productivity, which is a challenge for scientific community to solve the problem (Dotaniya et al., 2014c). So, the researchers think back old practices like use of crop residue, farm waste, compost to maintain soil health and sustainable crop yield. Use of sugarcane industry byproduct for crop production, solve the storage problem at industry level and improve the soil properties (Dotaniya and Datta, 2014). The annual availability sugarcane by-products is more than 45-55 million tons bagasse and 8-10 million tons press mud in India. On an average it contains, 2.5-5% in bagasse and 5-15% sugar in press mud with significant amount of Si, Ca, P_2O_5, MgO, Fe and Mn, etc (Yadav and Solomon, 2006). Use of chemical fertilizers in combination of organic waste, enhanced the plant nutrients and enhanced the crop yield (Meena et al., 2014). Sharma et al. (2000) stated that the organic C content increased significantly (6.8 g kg^{-1}) in cultivated soil over uncultivated (5.19 g kg^{-1}) under long-term of different cropping system. Singha (2003) reported a decline in organic carbon as a result of continuous application of N fertilizer alone irrespective of cropping system and soil type. Balanced use of NPK fertilizers either maintained or slightly enhanced the organic C level over the initial values while the beneficial effect of farmyard manure (FYM) in improving organic C over control, N, NP and NPK fertilizers was more pronounced on vertic Ustocherpt (Coimbatore) Chromustert (Jabalpur) and Haplustert (Bhubaneswar). Bhat *et al.* (1991) observed that continuous recycling of crop residue (wheat straw 6 t ha^{-1} and rice straw 12 t ha^{-1}) for seven year in rice-wheat crop sequence significantly increased the available nitrogen content of soil. In these views, we have conducted a field study to find out the long term effect of FYM and press mud on soil properties.

MATERIAL AND METHOD

The experiment was conducted during 2006-07 at progressive farmer's field at Dharki village of District Saharanpur. Saharanpur district lies between $77^0$15'E longitude and $27^0$10' N altitude and is situated at the attitude of about 275.05 meters above mean sea level. The rice variety PRH 10 was crop with thirteen treatments i.e.T_1 = Control; T_2 = FYM 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_3 = FYM 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_4 = FYM 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_5 = FYM 5 t ha^{-1} +7.5 kg $ZnSO_4$; T_6 = FYM 10 t ha^{-1} +0kg $ZnSO_4$; T_7 = FYM 10 t ha^{-1} +2.5 kg $ZnSO_4$; T_8 = FYM 10 t ha^{-1} +5.0 kg $ZnSO_4$; T_9 = FYM 10t ha^{-1} +7.5 kg $ZnSO_4$; T_{10} = Press mud 5 t ha^{-1} +0.0 kg $ZnSO_4$; T_{11} = Press mud 5 t ha^{-1} +2.5 kg $ZnSO_4$; T_{12} = Press mud 5 t ha^{-1} +5.0 kg $ZnSO_4$; T_{13} = Press mud 5 t ha^{-1} +7.5 kg $ZnSO_4$.

FYM and Press mud in different treatments were applied 10 days before transplanting. The initial soil properties like pH 7.86, organic carbon 0.63%, phosphorus, potassium and zinc in low category. The nutrient content of press mud and FYM was analyzed and described in Table 1& 2. Different doses of zinc sulphate were applied at the time of transplanting by hand broadcasting in each plot. Recommended doses of NPK were applied in all plots including control. Half of dose of nitrogen was applied at the time of planting and rest half dose was applied at 30 and 70 days after transplanting as topdressing in two installments. While, total P and K were applied before transplanting. All standard agronomic practices were adopted to raise the rice crop.

Table 1 Chemical composition of FYM

Property	Values %
Organic matter	31.67
Organic carbon	11.84
Nitrogen	0.93
Phosphoric acid	1.00
Potassium	1.31
Calcium oxide	5.74
Magnesium	1.14
Copper	0.40
Mangnese	0.83
Zinc	0.52
C:N ratio	9.5
pH	7.0

Table 2: Chemical characteristics of Press mud

Property	Value
Moisture %	74.0
Available N%	0.95
Available P %	0.27
Available K %	0.19
CaO %	2.38
MgO %	1.73
DTPA Ext. Zn mg/Kg	68

Statistical analysis

The experiment laid out in Randomized Block Design (RBD) design with three replications The soil samples was collected from each treatment after harvesting of rice crop in 2006-07 and 2007-08 and analyzed for different physico-chemical properties viz. pH, EC, organic carbon, available N, available N, available K and DTPA extractable Zn. The data collected from field and laboratory was analyzed statistically at 5% level of significance using standard statistical programmes (Snedecor and Cochran, 1967).

RESULT AND DISCUSSION

Before transplanting soil pH in 2006-07 was 6.80 while after harvesting the pH was significantly decreased in the plots treated FYM 10 t ha^{-1} with Zinc sulphate @ 2.5, 5.0 and 7.5 Kg ha^{-1} with 6.71, 6.75 and 6.60, respectively. Press mud 5 t ha^{-1} without zinc sulphate significantly reduced the pH (Table 3). In 2007-08 the soil pH before transplanting was 6.70. The soil pH was significantly increased in control. FYM 10 t ha^{-1} reduced pH to 6.61, 6.65 and 6.50 when applied with zinc sulphate @ 2.5, 5.0 and 7.5 Kg ha^{-1}, respectively. Press mud alone and with zinc sulphate @ 2.5 Kg ha^{-1} also significantly reduced the soil pH (Table 4). The addition of FYM 10 t ha^{-1} with $ZnSO_4$ @ 2.5, 5.0 and 7.5 Kg ha^{-1} significantly reduced the pH in comparison to pre-planting condition in both the years of 2006-07 and 2007-08. Addition of press mud @ of 5 t ha^{-1} with 2.5 Kg $ZnSO_4$ also reduced the pH in 2007-08. The decrease in pH with addition of FYM increase the production of carbonic acids and it also improve the soil permeability due this basic cations leached and creates acidity up to some extant. The reduction in pH with the addition of press mud also reported by Rai *et al.* (1980). Borde *et al.* (1984) also reported that the application of press mud with P fertilizer reduced soil pH.

ECe of composite sample before transplanting in 2006-07 was 0.25 dSm^{-1}, while after harvesting was lowest (0.17 dSm^{-1}) in T_9 followed by T_8 (0.18dSm^{-1}). While, in the rest all treatments ECe was ranged from 0.21 to 0.30 dSm^{-1} (Table 3). Similarly, in 2007-08 ECe was lowest in T_6 (0.16 dSm^{-1}) followed by 0.19 in T_8, while in rest of all treatments, ECe was ranged from 0.21 to 0.31 dSm^{-1} (Table 4). There was no clear cut trend of increase or decrease observed except in T_9 and T_8 where significant reduction in ECe was observed in comparison to pre-transplanting condition of 2006-07. In 2007-08 lowest ECe was recorded in T_6 (0.16 dSm^{-1}) followed by T_8. The reduction in electrical conductivity was also reported by Rai *et al.* (1980) and Borde *et al.* (1984).

Organic carbon was significantly increased by all organics treatments in 2006-07 (Table 3). The maximum increment was observed by application of FYM 10 t ha^{-1} (0.90 to 1.00 per cent) followed by FYM 5 t ha^{-1} (0.76-0.85 per cent), while, least increase in per cent in organic carbon by press mud 5 t ha^{-1} (0.74 to 0.78 per cent). However in control (T_1) the organic carbon was at par (0.68 per cent) with pre- transplanting condition (0.65 per cent). Similar trend was also observed in 2007-08 (Table 4) but the per cent organic carbon was higher than 2006-07 in all treatments.

Table 3: Effect of different levels of organics and zinc sulphate soil properties 2006-2007

Treatments	pH 1:2 soil : water	ECe dSm^{-1}	Organic carbon%	Av. N $mgkg^{-1}$	Av. P $mgkg^{-1}$	Av. K $mgkg^{-1}$	DTPA Ext. Zn $mgkg^{-1}$
Pre-Transplanting	6.80	0.25	0.65	140	15.0	091.6	1.53
T_1 = Control	6.92	0.30	0.68	140	16.1	093.0	1.56
T_2 = FYM 5 t ha^{-1} +0.0 kg Zn SO_4	6.87	0.28	0.76	142	17.3	094.3	1.59
T_3 = FYM 5 t ha^{-1} +2.5 kg Zn SO_4	6.85	0.24	0.80	145	18.6	095.2	1.63
T_4 = FYM 5 t ha^{-1} +5.0 kg Zn SO_4	6.78	0.22	0.83	146	19.5	096.0	1.66
T_5 = FYM 5 t ha^{-1} +7.5 kg Zn SO_4	6.85	0.23	0.85	147	20.0	098.4	1.71
T_6 = FYM 10 t ha^{-1} +0kg Zn SO_4	6.78	0.21	0.90	154	22.5	104.0	1.61
T_7 = FYM 10 t ha^{-1} +2.5 kg Zn SO_4	6.71	0.26	0.91	158	22.7	104.4	1.68
T_8 = FYM 10 t ha^{-1} +5.0 kg Zn SO_4	6.75	0.18	0.93	160	23.0	105.6	1.73
T_9 = FYM 10t ha^{-1} +7.5 kg Zn SO_4	6.60	0.17	1.00	165	23.5	107.0	1.80
T_{10} = Press mud 5 t ha^{-1} +0.0 kg Zn SO_4	6.69	0.24	0.75	141	17.0	095.2	1.56
T_{11} = Press mud 5 t ha^{-1} +2.5 kg Zn SO_4	6.79	0.25	0.77	144	18.4	096.8	1.60
T_{12} = Press mud 5 t ha^{-1} +5.0 kg Zn SO_4	6.75	0.28	0.78	145	19.0	099.0	1.63
T_{13} = Press mud 5 t ha^{-1} +7.5 kg Zn SO_4	6.81	0.29	0.74	147	19.6	100.0	1.70
F-Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
CD at 5%	0.127	0.0497	0.0491	3.237	1.144	2.719	0.0823
C.V	1.117	12.434	3.615	1.302	3.507	1.643	2.983

Table 4: Effect of different levels of organics and zinc sulphate on soil properties 2007-2008.

Treatments	pH 1:2 soil : water	ECe dSm^{-1}	Organic Carbon%	Av. N $mgkg^{-1}$	Av. P $mgkg^{-1}$	Av. K $mgkg^{-1}$	DTPA Ext. Zn $mgkg^{-1}$
Pre-Transplanting	6.70	0.26	0.70	145	15.5	91.0	1.58
T_1 = Control	6.94	0.31	0.67	141	16.2	93.0	1.60
T_2 = FYM 5 t ha^{-1} +0.0 kg Zn SO_4	6.73	0.28	0.79	144	17.8	96.0	1.63
T_3 = FYM 5 t ha^{-1} +2.5 kg Zn SO_4	6.75	0.24	0.83	146	19.1	98.1	1.66
T_4 = FYM 5 t ha^{-1} +5.0 kg Zn SO_4	6.62	0.23	0.85	149	20.2	99.5	1.70
T_5 = FYM 5 t ha^{-1} +7.5 kg Zn SO_4	6.75	0.22	0.87	150	20.8	100.0	1.74
T_6 = FYM 10 t ha^{-1} +0kg Zn SO_4	6.65	0.21	0.92	157	23.1	106.3	1.67
T_7 = FYM 10 t ha^{-1} +2.5 kg Zn SO_4	6.61	0.20	0.95	160	23.4	109.5	1.73
T_8 = FYM 10 t ha^{-1} +5.0 kg Zn SO_4	6.65	0.19	0.97	163	23.8	109.7	1.78
T_9 = FYM 10t ha^{-1} +7.5 kg Zn SO_4	6.50	0.16	1.02	170	24.0	110.0	1.85

T_{10} = Press mud 5 t ha^{-1} +0.0 kg Zn SO_4	6.65	0.23	0.77	143	17.5	99.8	1.60
T_{11} = Press mud 5 t ha^{-1} +2.5 kg Zn SO_4	6.49	0.24	0.80	148	18.9	100.0	1.64
T_{12} = Press mud 5 t ha^{-1} +5.0 kg Zn SO_4	6.60	0.28	0.82	151	19.5	103.5	1.66
T_{13} = Press mud 5 t ha^{-1} +7.5 kg Zn SO_4	6.65	0.29	0.78	153	20.1	105.8	1.73
F- test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
CD at 5%	0.106	0.0466	0.0482	4.505	1.074	3.443	0.0501
C.V.	0.952	11.631	3.429	1.772	3.202	2.109	1.777

The increase in the level of organic carbon per cent by application of FYM and press mud was because of these both are rich source of carbon. When level of FYM increase from 5t ha^{-1} to 10 t ha^{-1} maximum increase (0.90 to 1.00 per cent) followed by FYM 5 t ha^{-1} (0.76 to 0.85 per cent) and press mud 5t ha^{-1}. The increase in organic carbon per cent with the application of FYM and press mud earlier reported by Tiwari and Nema (1999). Singh *et al*. (1990) also reported that application of 8.5 to 17 t ha-1 FYM ha^{-1} in maize-wheat rotation also increase the organic carbon in soils. The use of organic amendment enhanced the soil organic C and other plant nutrients like N, K, P in soil (Shukla et al., 2013).

The available N in control after harvesting was equal to pre- transplanting conditions (Table 2). The available N was significantly increased when FYM 5 t ha^{-1}, FYM 10 t ha^{-1} and press mud 5 t ha^{-1} was applied with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} zinc sulphate except in T_2 where only FYM 5 t ha^{-1} was applied. The maximum available N was observed in plots treated with FYM 10 t ha^{-1} (154 to 165mg Kg^{-1}). Perusal of (Table 3) reveled that available N was decreased in control (141 mg Kg^{-1}) and FYM 5 t ha^{-1} + 0.0 Kg $ZnSO_4$ ha^{-1} (144 mg Kg^{-1}). Press mud + 0.0 Kg $ZnSO_4$ ha^{-1} (143 mg Kg^{-1} than the pre-transplanting condition (145 mg Kg^{-1}). Furthermore as the dose of $ZnSO_4$ was increased with FYM 5 and 10 t ha^{-1} or press mud 5 t ha^{-1} the values of available N was also increased in both the years of the experiment. The available nitrogen also increases with increasing levels of FYM and $ZnSO_4$ and the rate of increase in nitrogen with the application of press mud was less than the FYM. The trend was similar to as was in case of organic carbon. This is because of organic carbon works as pool source of organic nitrogen which converts in available form. Singh *et al*. (1985) reported similar results increase in the level of available nitrogen when they applied FYM in maize- wheat rotation. Indulkar and Malewar (1996) also reported increase in available N content over control in sorghum.

The available phosphorus was lowest in 16.1 mg Kg^{-1} in control and at par with pre-transplanting condition (Table 2). All organic treatments significantly increased the available P after harvest, the 10 t ha^{-1} FYM with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} $ZnSO_4$ significantly increased the amount of available P compared to 5 t ha^{-1} FYM and 5 t ha^{-1} press mud with corresponding doses of $ZnSO_4$ in 2006-07. In 2007-08 the available P in composite sample of pre-transplanting was 15.5 mg Kg^{-1} and at par with control (16.2mg Kg^{-1}). The maximum available P was observed in treatments of 10 t ha^{-1} FYM with 0.0 to 7.5 Kg ha^{-1} $ZnSO_4$ (23.1 to 24.0 mg Kg^{-1}). Similar in case of nitrogen, available phosphorus content also increase as level of FYM increases and maximum increase was observed at the level of FYM 10 t ha^{-1} with 7.5 Kg $ZnSO_4$. Organic residue released organic acids, which solubilize the insoluble soil P, and enhanced the P availability in soil solution (Dotaniya et al., 2014a; Dotaniya, 2013)

Perusal of data on available K in Table 3 revealed that the lowest available K observed in control (93.0 $mgkg^{-1}$) which was at par with pre-transplanting sample and T_2 where FYM 5 t ha^{-1} was applied without $ZnSO_4$ (T_3). Rest of all treatment significantly increased the available K as compare to Pre-transplanting composite sample. FYM 5t ha^{-1} with all doses of $ZnSO_4$. Further more FYM 10 t ha^{-1} with different doses of $ZnSO_4$ significantly increased the available K over FYM 5 t ha^{-1} and press mud 5t ha^{-1} with different doses of $ZnSO_4$. The available K in 2007-08 in pre-transplanting sample was 97.0 mg Kg^{-1} and was at par with control. But among organic treatments the highest K was observed in different treatments of $ZnSO_4$ with 10 t ha^{-1} FYM followed by 5 t ha^{-1} press mud and 5 t ha^{-1} FYM (Table 3). The per cent of available K observed to increase over control which was also at par with pre-transplanting condition. When we increase the FYM level concentration of K also increase and it was maximum in T_9. Crop residues having significant amount of potassium, it was released due to microbial decomposition during the study and enhanced the available K in soil (Dotaniya et al., 2014b)

DTPA Ext. Zn in 2006-07 was minimum (1.56 mg Kg^{-1}) in control and press mud 5 t ha^{-1} without $ZnSO_4$ treatment (Table 3) while, in pre-transplanting composite sample it was 1.53 mg Kg^{-1}. Zn concentration was significantly increased by application of FYM 10 t $ha^{-1}$with 2.5, 5.0 and 7.5Kg $ZnSO_4$(1.68, 1.73 and 1.80 mg Kg^{-1}) FYM 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ (1.63, 1.66 and 1.71 mg Kg^{-1}) and press mud 5 t ha^{-1} with 5.0 and 7.5 Kg $ZnSO_4$ (1.63 and 1.70 mg Kg^{-1}). But in 2007-08 FYM 10 t ha^{-1} with 0.0, 2.5, 5.0 and 7.5 Kg ha^{-1} $ZnSO_4$. FYM 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ and press mud 5 t ha^{-1} with 2.5, 5.0 and 7.5 Kg $ZnSO_4$ significantly increased the DTPA ext. Zn (Table 4). The amount of DTPA ext. Zn in pre-

transplanting sample and all other treatment samples were higher in 2007-08 than 2006-07.The minimum concentration of Zn was in control followed by 5 t ha^{-1} press mud without $ZnSO_4$. Concentration of Zn increases as level of $ZnSO_4$ and FYM increase. This is because of $ZnSO_4$ is the direct source of Zn and FYM and press mud works as pool of most of the micronutrients. Sakal *et al*. (1981) reported that $ZnSO_4$ application raised level of available Zn in soils and left substantial amount of Zn for succeeding crop.

CONCLUSION

Use of crop residue for agricultural crop production was an old practice. But during the green revolution inorganic fertilizer consumption high and farmers mostly dependent only on chemical fertilizers, without applying organic manure. The increasing population growth, enhanced the pressure to produce more from limited land. So to overcome the crop yield stagnation and improve the soil health, farmers again applying the organic manure in combination to inorganic fertilizers. it improved the soil physico-chemical properties. In this experiment application of FYM 10t ha^{-1} +7.5 kg $ZnSO_4$ improved the soil OC, available N, P and K in soil compared to rest of the treatments.

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GENETIC VARIABILITY, CORRELATION AND PATHCOEFFICIENT ANALYSIS OF SOME YIELD COMPONENTS OF MUNGBEAN (*VIGNARADIATA* L.)

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Abstract: Genotypic and phenotypic coefficient of variation, heritability, genetic advance was evaluated for yield and its contributing characters in 30 moonbeam genotypes significant variations among the genotypes were observed for all the characters. Analysis of variance revealed that mean sum of squares due to genotypes were highly significant for all the characters except number of pod per clusters, 100 seed weight whereas, pod length shown significant differences thus revealing the existence of considerable variability in the material studied. Analysis of Variance was given in table no.4. High heritability coupled with high genetic advance was recorded for seed yield per plant, number of pod per cluster, plant height and days to 50% flowering. Indicating these characters would be best for phenotypic selection. The correlation coefficient analysis revealed high significant positive association of plant height, number of flower per raceme, number of seed per pod, petiole length, number of pod per clusters, pod length, days to 50% flowering and days to maturity and significant positive association of 100 seed weight with seed yield per plant. The path coefficient analysis showed that, days to 50% flowering had the highest direct effect on seed yield. The estimated Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) helped in getting a clear understanding of the variability present among the various genotypes. The GCV was maximum for seed yield per plant (32.70%). The phenotypic coefficient of variation was high for seed yield/plant (35.43%), number of pod per cluster (21.62%) and plant height (20.64%).

Keyword: Mungbean**,** correlation, variability, path analysis

INTRODUCTION

Mungbean (*Vignaradiata* L. Wilczek) is an important pulse crop which is annual legume. As compared to other legumes, these edsofmung bean are tasty, easily digestible and having more nutritional values. Its seed contains 24.7% protein, 0.6% fat, 0.9% fiber and 3.7% ash (Potter and Hotchkiss, 1997). Sprouts of mungbean are an important source of food and are very commonly used to protect from scurvy. The path analysis helps in partitioning the correlation coefficient of yield components with seed yield into its direct and indirect effects to ensure the actual contribution of an attribute as well as its influence through other traits. Correlation analysis provides the information of interrelationship of important plant characters and hence, leads to a directional model for direct or indirect improvement in seed yield per plant (Khan *et al*., 2004). Genetic variability with the help of suitable parameters such as genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance are absolutely necessary t o start an efficient breeding programme.

MATERIAL AND METHOD

Field experiments were conducted in 20012-2013 and was laid out in a Randomized Complete Block Design (RCBD) with three replication in spacing of 30 ×10 cm between rows and plants respectively Each genotype was represented by 4 rows of 4 m length with guard rows at either side. All the agronomical package of practices recommended for crop health stand was adopted. At instructional farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), to estimate genetic variability, heritability Genotypic and phenotypic coefficients of variance, heritabilityand genetic advance wereevaluatedforyieldanditscontributingcharactersin 30Mungbean genotypes. Details of the genotypes included in the experiment are given below in table no.1.Dataonfive randomly selected plant were recorded on ten characters *viz*., daysto50%flowering(days), days tomaturity (days), plant height (cm), number of pods per cluster, pod length (cm), number of seeds per pod, 100 seed weight (g) and yield per plant (g). Genotypic and phenotypic coefficient of variations, heritability and genetic advance were estimated as per Singh and Chaudhury (1985) and Johns on *et al*. (1955). Details of the Genotypic (G), phenotypic (P) and environmental (E) correlation coefficients among different yield traits in mungbean given below in table no. 2.

RESULT AND DISCUSSION

Analysis of variance presented in Table 2 revealed that mean sum of squares due to genotypes were highly significant for all the characters except number of pod per clusters, 100 seed weight whereas, pod length shown significant differences. The estimate of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability (h^2), genetic advance (GA), for ten different characters are presented in table no.5. The highest genotypic coefficient of variation was found for seed yield per plant followed by number of pod per cluster and the lowest for number of seeds

per pod indicating higher degree of genetic variability for these characters. A higher heritability estimate associated with good estimates of genetic advance expected in the next generation for seed yield per plant, number of pod per cluster, plant height, number of seeds per pod and 100 seed weight suggesting these characters are governed by additive genetic effect to a great extent and improvement of these characters would be effective through phenotypic selection. Similar results were found by Vikas *et al*. (1998) for plant height, Sharma (1999) for 100-seed weight and seed yield per plant. High heritability estimates has been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance. Johanson *et al. (*1955). Seed yield per plant exhibited highly significant positive correlation with number of pod per cluster at all phenotypic (0.814), genotypic (0.866) and environmental (0.491) level which were in accordance with the findings of Yaqoob *et al.* (1997), Sadiq and Abbas (2007) and Verma and Garg (2007). The character number of pod per cluster was identified as selection criteria for improving seed yield in mungbean as this character recorded strong positive correlation with seed yield. Days to 50% lowering had the highest direct effect (1.061) on seed yield per plant. It also had highly significant positive association with seed yield, complied with high heritability and high genetic advance. Hence, this character seems to be important contributor of seed yield and must be considered in selection for high seed yield details of the genotypic path coefficient of various characters influencing seed yield per plant in mungbeangiven below in table no. 3.

CONCLUSION

Analysis of variance revealed that, mean sum of squares due to genotypes were highly significant for all the characters except pod length showing significant difference while, number of pod per cluster and 100 seed weight were non-significant. Thus revealing that the existence of considerable variability in the material studied**.** The Genotypic Coefficient of Variation (GCV) was noted high for seed yield per plant and number of pod per cluster while, the Phenotypic Coefficient of Variation (PCV) was high for number of seed yield per plant, number of pod per cluster and plant height. GCV for seed yield recorded high which shows considerable scope for yield improvement. However, plant height has considerable genetic variability which can also be exploited for yield improvement. High heritability was found in all the character while high genetic advance was found in all the character also. The path coefficient analysis showed that, days to 50% flowering had the highest direct effect on seed yield. The correlation coefficient analysis revealed high significant positive association of plant height, number of flower per raceme, number of seed per pod, petiole length, number of pod per clusters, pod length, days to 50% flowering and days to maturity and significant positive association of 100 seed weight with seed yield. Hence, improvement of seed yield per plant can be achieved by improving these characters.

Table 1: Designation of Mungbean germplasms

S. No.	Genotype	Source
1	Pusa Vishal	IARI, New Delhi
2	MalviyaJyoti	BHU Varanashi
3	Pragya	IGKV, Raipur
4	Pairymung	BARC/IGKV,Raipur
5	TM-99-2	BARC, Trombay
6	TM 2000-1	BARC, MUMBAI
7	K-851	IIPR, Kanpur
8	TARM-1	BARC/Akola
9	RM-03-71	IGKV, Raipur
10	RM-03-79	IGKV, Raipur
11	BM-4	ARS, Badanpur
12	AKM 8802	POKV, Akola
13	PKVAKM 4	POKV, Akola
14	KM 2293	CSA, Kanpur
15	GM-04-02	SDAV, S.K.Nagar
16	PM-09-11	GBPAUT,Pantnagar
17	RVSM 11-9	Sehore
18	MH 805	Hisar
19	NVL 638	Nirmal seeds
20	DGG - 1	Dharwad
21	UANNATI	MSSCL, Akoa
22	SKUA-M-300	SKUA&T, Srinagar

23	IPM 2K 15-4	IIPR, Kanpur
24	PUSA 1271	IARI, New delhi
25	TMB-36	BARC, Mumbai
26	ML-1907	PAU, Ludhiana
27	RMG-1004	ARS, Durgapura
28	AKM 10-13	POK, Akola
29	COGG 979	Coimbtore
30	VGG 04-011	NPRC, Vamban

Table 2: Genotypic (G), phenotypic (P) and environmental (E) correlation coefficients among different yield traits in mungbean**.**

Character		No. of flower per raceme	No. of seeds per pod	No. pod per cluster	Petiole length	Seed yield	100 seed weight (gm)	Pod length (cm)	Days to 50% flowering	Days to maturity
Plant height	P G E	0.646** 0.744** -0.069	0.595** 0.627** 0.292	0.681** 0.745** 0.213	0.616** 0.670** 0.123	0.568** 0.648** 0.032	-0.137 -0.181 0.122	0.361* 0.405* -0.077	0.648** 0.694** 0.024	0.632** 0.684** -0.163
No. of flower per raceme	P G E		0.687** 0.775** -0.090	0.756** 0.817** 0.340	0.771** 0.892** -0.216	0.805** 0.851** 0.526	0.193 0.246 -0.095	0.610** 0.679** 0.000	0.859** 0.945** -0.216	0.862** 0.939** -0.123
No. of seeds per pod	P G E			0.686** 0.743** 0.183	0.675** 0.745** -0.120	0.743** 0.812** 0.211	0.180 0.226 -0.148	0.792** 0.860** -0.069	0.719** 0.753** 0.047	0.679** 0.714** -0.059
No. pod per cluster	P G E				0.660** 0.755** -0.133	0.814** 0.866** 0.491**	0.048 0.112 -0.310	0.554** 0.631** -0.151	0.701** 0.768** -0.149	0.688** 0.753** -0.178
Petiole length	P G E					0.680** 0.788** -0.131	0.188 0.232 -0.099	0.610** 0.662** 0.016	0.870** 0.922** -0.007	0.841** 0.890** -0.033
Seed yield	P G E						0.326 0.400* -0.052	0.696** 0.768** 0.133	0.712** 0.788** -0.125	0.687** 0.758** -0.107
100 seed weight (gm)	P G E							0.510** 0.543** 0.321	0.242 0.272 -0.015	0.272 0.303 0.008
Pod length (cm)	P G E								0.625** 0.649** 0.162	0.568** 0.593** 0.056
Days to 50% flowering	P G E									0.978** 0.982** 0.772**

Table 3: Genotypic path coefficient of various characters influencing seed yield per plant in mungbean

Character	Plant height	No. of flower per raceme	No. of seeds per pod	No. of pod per cluster	Petiole length	100 seed weight (gm)	Pod length (cm)	Days to 50% flowering	Days to maturity	Genotypic correlation coefficient
Plant height	**0.140**	0.556	0.400	0.383	0.073	-0.120	-0.296	0.737	-1.224	0.648**
No. of flower per raceme	0.104	**0.747**	0.494	0.420	0.097	0.164	-0.497	1.002	-1.682	0.851**
No. of seeds per pod	0.088	0.579	**0.638**	0.382	0.081	0.151	-0.629	0.799	-10278	0.812**
No. pod per cluster	0.105	0.610	0.474	**0.514**	0.082	0.075	-0.462	0.815	-1.348	0.866**

Petiole length	0.094	0.666	0.475	0.388	**0.109**	0.154	-0.484	0.979	-1.594	0.788**
100 seed weight (gm)	-0.025	0.184	0.144	0.058	0.025	**0.666**	-0.397	0.288	-0.542	0.400*
Pod length (cm)	0.057	0.507	0.548	0.325	0.072	0.362	**-0.731**	0.689	-1.061	0.768**
Days to 50% flowering	0.097	0.706	0.481	0.395	0.101	0.181	-0.475	**1.061**	-1.759	0.788**
Days to maturity	0.096	0.702	0.455	0.387	0.097	0.202	-0.433	1.042	**-1.790**	0.758**

Table 4: Analysis of Variance

Source of variation	D.F.	Plant height	No. of flower per raceme	No. of seeds per pod	No. pod per cluster	Petiole length	Seed yield	100 seed weight (gm)	Pod length (cm)	Days to 50% flowering	Days to maturity
Replication	2	27.421*	1.106*	0.021	0.102	0.114	0.348	0.796**	0.511	2.359	1.250
Treatment	29	179.21**	5.491**	2.991**	1.127	3.043**	4.217**	0.499	1.83*	275.07**	281.12**
Error	58	7.143	0.260	0.076	0.052	0.095	0.231	0.034	0.046	2.114	1.715

*Significant at 5% probability level
** Significant at 1% probability level

Table 5: Genetic parameter of variation

Character	GCV (%)	PCV (%)	h^2 (%)	GA	GA as % of mean
Plant height	19.47	20.64	88.9	14.71	37.81
No. of flower per raceme	14.55	15.60	87.0	2.54	28.00
No. of seeds per pod	10.11	10.50	92.7	1.96	20.10
No. pod per cluster	20.20	21.62	87.3	1.15	38.85
Petiole length	13.02	13.63	91.2	1.95	25.62
Seed yield	32.70	35.43	85.2	2.19	62.21
100 seed weight (gm)	11.36	12.55	81.9	0.73	21.09
Pod length (cm)	12.51	12.99	92.8	1.53	24.79
Days to 50% flowering	17.12	17.32	97.7	19.43	34.87
Days to maturity	11.16	11.26	98.2	19.70	22.77

GCV= Genotypic Coefficient of Variation, PCV= Phenotypic Coefficient of Variation
h^2= heritability, GA= Genetic Advance

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REPORT

METHODS AND PRACTICAL ASPECTS IN MUNGBEAN HYBRIDIZATION

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Abstract: Mungbean [*Vigna radiata* (L.) Wilczek] is one of the short duration pulse crop predominantly cultivated in Asia. It is a self pollinated crop where crossing or hybridization is tedious. Under field conditions easy and efficient crossing technique is needed to exploit genetic potential of mungbean. Due to complexity and lack of appropriate crossing technique, outcomes achieved have been less in mungbean. From last five decades scientists were developing different methods of hybridization to accelerate the success rate of crossing in mung. However Khattak and co-researchers developed efficient new technique where more pod setting was observed. Based on limited available information, this review summarizes the methods of crossing techniques and practical measures followed during hybridization in mungbean.

Keywords: *vigna radiata*, mungbean, crossing, hybridization

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is third important pulse crop after chickpea and pigeon pea in India. It is widely cultivated throughout the Asia. It belongs to the family order leguminoseae and papilionoidae family. Inflorescence is axillary or terminal raceme and flowers are cleistogamous, papilionaceous flowers consists of five sepals, five petals consisting of one standard, two wing and two keel petals. Stamens are ten which may occur in two bundles 9+1 (diadelphous) condition. Style is up curved and stigma is bearded.

Crossing techniques: Crossing or hybridization plays a crucial role in manipulation of genetic architecture of any crop. Generally effecting cross-pollination in a strictly self-pollinating species is more difficult than vice-versa because for instance preventing self-pollination occurring inside the unopened flowers is cumbersome. To the knowledge of the authors, the techniques used to hybridize mungbean only few members were reported and concise here.

Boling *et al* (1961) introduced crossing technique in mungbean. In this method the young bud was grasped between the thumb and forefinger of the left hand. The point of a dissecting needle was inserted just under the standard in an oblique position along the top of the bud. The left side of the standard and the left wing petal were pushed outward away from the bud and held with the thumb of the left hand. The left half of the keel was removed in pieces with forceps. Extreme care was necessary in removing the left half of the keel to prevent injury to the delicate stigma. The pistil and stamens were then exposed and the anthers were removed with forceps. After emasculation, the pistil was pollinated immediately with desired pollen as the stigma appeared to be receptive. Pollination should be done by applying slight pressure at the base of the pollen flower; the stigma at the end of the keel was exposed with pollen. This stigma was brushed lightly against the stigma of the emasculated flower and pollination was completed. The left wing and standard were then closed to their original position on the bud. This served to protect the stigma from drying out and prevented damage by insects

Singh and Malhotra (1975) suggested high percentage of pod setting can be obtained by following emasculation of yellowish green buds in the evening (4:00pm to 6:30pm) and pollination of blossomed flowers in the next day morning(8:00am to 11:00am).However, simultaneous emasculation and pollination done during morning or evening shown low pod setting. Park and Yang (1978) also reported same procedure where emasculation in evening and pollination in the following morning gives maximum seed set. But simultaneous emasculation and pollination during morning 8:00am to 11:00am. Which results 3-4 seed pods normally. Due to less time period of crossing it limits the number of flowers to be pollinated which gradually results low pod set. It may be useful for researchers who require less quantity of seeds.

Cupka and Edwards (1986) introduced new technique where female bud was grasped between thumb and fore finger and right side of the standard was gripped with forceps approximately two-thirds the distance from the base along the ventral edge of the bud. The standard was then torn upward towards dorsal edge of the bud and removed. The wing petal if in the way was removed similarly in order to remove the keel petal. Using the point of the forceps, one side of the keel was slit open. By grasping the loosened flap. By grasping the loosened flap with forceps, the loosened tip of the keel was then removed and then stamens are removed. To pollinate the female parent, the pollen landed stigma of the

male parent gently brushed against the female parent. The pollinated flower was tagged and sealed by closing the opening of the standard petal with cellophane tape which helped the control of loss of moisture in the stigma by resealing the opening. The success rate of this technique is 60% with an average six seeds per pod per successful cross. But this technique is tedious and cellophane tape may stick to pollen used for pollination and the pollinated stigma.

Khattak *et al.*, (1998) developed new technique where only upper half of the floral bud was opened to expose stigma and lower half helps to protect the ovary and style in natural conditions. High pod setting was observed during summer and spring by emasculating at 5:00pm to 7:00pm and pollinating in following morning at 7:00am to 9:00am. The high success rate is mainly due to less disturbance on style and ovary in the bud during emasculation.

Some of the practical measures which may helpful during crossing

1. Plan the crossing programme during *rabi* season where monsoons may not obstruct. If green house is available it may possible at any season.
2. Sowing of parents should be done based on their maturity dates, so that flowering period may coincide. Follow staggered sowing for continuous supply of pollen.
3. Practice wide spacing (>40cm) between the rows helps in easy crossing. Paired row planting may be better than unpaired row of planting. Tagging of each row should be done for easy identification.
4. Select the yellowish green colour bud for emasculation. Observe the style should not be up curved. Mostly up curved style indicates matured bud.
5. Emasculation must be done carefully because flower buds of some varieties are very delicate. Care should be taken to remove 2/3 rd portion of the bud during emasculation. Follow ring cut method or keel rupture method for emasculation.
6. Select the flowers having abundant pollen for pollination and use one flower to pollinate each emasculated bud.
7. Crossing should be done without contacting other already pollinated flowers and keep only 2-3 crossed flowers in each inflorescence and remove the remaining flowers so that grain filling will be more.
8. Pollination should be done early in the morning 6:00am to 9:00am. However it may be extended during winter because of cool climate. After pollination use coloured threads to tie the pedicle.
9. In some situations like rainy days, crossing may not possible at that time remove the buds or flowers which we want to do on that day.
10. Fertilizers should be applied slightly more than recommended dose to supply nitrogen, phosphorus and potassium. Especially potassium may helps to increase disease tolerance.
11. Flower shedding is common and more during higher temperature. So during summer frequent irrigation helps in more pod setting
12. Knapsack sprayer or foot sprayer are better than power sprayer for spraying chemicals because power sprayer may drops or disturbs the crossed flowers.

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SHORT COMMUNICATION

ASSESSMENT OF INTERNET USING BEHAVIOR OF POST GRADUATE AGRICULTURE STUDENTS IN CHHATTISGARH

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Abstract: The present investigation entitled "Study on Utilization Pattern of Information and Communication Technology (ICT) By the Agriculture Post Graduate Students" was conducted in India Gandhi Agriculture University, Raipur (C.G.). There are around 380 students studying in P.G. (M.Sc. 340 and M.Tech. 40) in faculty of Agriculture and Agriculture Engineering during the session of 2013-1014. Out of them 50% students were selected randomly for this study. The findings of this study revealed that maximum number of students were medium extent of utilization of internet

Keywords: Internet utilization, behavior, Chhattisgarh

INTRODUCTION

In India, the need for reforms in education by harnessing new ICTs is increasingly being accepted as essential by universities and cultural organizations across India. The developments in Information Communication Technology (ICT) should be put into service, both to improve the quality of learning and access to learning. The possibilities of e-learning have to be exploited to the fullest extent, even as we continue to improve the quantity and quality of education through the face-to-face mode. Similarly the traditional face-to-face mode can be further improved by integrating internet into the curriculum. This would require a continual programme of intensive and extensive exposure to the new pedagogy of learning to teachers as well as students and also additional investment for providing new infrastructure (Panikker, 2007).Estimates from the International Telecommunications Union (ITU) indicate that only 6 percent of the population in India accessed Internet in 2007 (Veeramacheneni*et al.*, 2008).The Agriculture sector is gearing itself to make optimal use of the new information and communication technologies. The diffusion of internet has contributed enormously to the growth of economies in developed nations and developing nations and is earnestly facilitating policy framework to ensure an equitable diffusion of new technologies.The Internet usage in India has been improved significantly, especially recent few years. Five years ago, there was limited Internet access in some major cities only. Today, the Internet represents the new wealth frontier for the India middle class - a good salary and an honorable job, and for a few, the opportunity to go abroad.Internet adoption is continuous growing rapidly in India. According to IAMAI (The Internet & Mobile Association of India), because of low cost, broadband use in the Internet is increasing.

METHODOLOGY

The study was conducted in the faculty of Agriculture and Agriculture Engineering atIGKV, Raipur (CG). The study consisted of Post Graduate students including M.Sc. /M. Tech. during the session of 2013-1014. Out of total 380 students, 50 percent students were selected randomly for this study. In this way total 190 (170+20) post graduate students were considered as respondent for the present study. Our educational sector must use internet led ICT tools to replace or supplement the classroom teaching. The data were collected by personal interview method.

RESULT AND DISCUSSION

1. Purpose of using internet

The data compiled in Table 1 represents the purpose of using internet by the respondents. The result revealed that the majority of respondents (70.53%) used internet for getting information, followed by entertainment (64.21%), academic purpose (61.05%), news (58.95%), E-mail (57.37%), job search (55.26%), chatting and game (47.89%), downloading softwares (42.10%), buying tickets (40.52%), spend leisure or free time (35.78%), shopping (10.52%) and others purposes (3.31%), respectively. Mishra *et al*. (2005) and Dash *et al*. (2012) also noted almost similar findings

Table 1: Distribution of respondents according to purpose of using internet (n=190)

Purpose	Frequency*	Percentage
▪ News	112	58.95
▪ Entertainment	122	64.21
▪ Spend leisure or free time	68	35.78
▪ Information	134	70.53
▪ Games	91	47.89

▪	Academic purpose	116	31.05
▪	e-mail	109	57.37
▪	Downloading software	80	42.10
▪	Buying tickets	77	40.52
▪	Chatting	91	47.89
▪	Job search	105	55.26
▪	Shopping	20	10.52
▪	Others	12	3.31

*Data are based on multiple responses

2. Frequency, time spent and place of using internet

The findings related to frequency, time spent and place of using internet are presented in the Table 2. It is evident from this table that the majority of students (69.4%) used Internet daily, followed by 1-2 days in a week (14.73%), 2-4 days a week (14.21%) and only 1.6 per cent of the respondent were using internet rarely.

As regard to time spent in a day, 40.52 per cent of the respondents spent 30 minutes to1 hr / day for using internet, followed by 35.26 per cent respondents spent 1 to 2 hr/day,17.36 per cent respondents spent up to 30 minutes per day.

Table 2: Distribution of respondents according to frequency of using internet, time spent and place of using internet (n=190)

Particular		Frequency	Percentage
(A)	**Frequency of using internet**		
▪	Daily	132	69.4
▪	2-4 days in a week	27	14. 21
▪	1-2 days in a week	28	14. 73
▪	Rarely	3	1.57
(B)	**Time spent (per day)**		
▪	Up to 30 Minutes/day	33	17.36
▪	30 minutes to 1 hr./day	77	40.52
▪	1-2 hr./day	67	35.26
▪	More than 2 hr./day	13	6.84
(C)	**Place of using internet**		
▪	At home	79	41.57
▪	At institute	114	60
▪	At hostel	160	84.21
▪	At cyber café	57	30
▪	Others	16	8.42

About 7 per cent respondents spent more than 2 hr/ day time for using internet. Mishra *et al*. (2005), Kumar (2009) and Dash and Mishra (2012) also noted almost similar findings

3. Place of using internet

Table 2 reveals findings regarding place of using internet, majority of students (84.21%) used internet in hostel, followed by at institute (60%), at home (41.57%), cyber café (30%) and other places (8.42%). It seems from the result that good internet facility is available in the hostel for the students. Bisht*et al*. (2007) and Mishra *et al*. (2011) also noted almost similar findings.

4. Sites mostly used for searching

Table 3: Distribution of respondents according to sites mostly used (n=190)

Sites		Frequency*	Percentage
▪	Google	178	93.68
▪	Yahoo	61	32.10
▪	Rediff	23	12.10
▪	Webdunia	55	28.95
▪	Khoj	51	26.84
▪	ICAR	66	34.73
▪	Indiatimes.com	31	16.32

▪ Facebook	165	86.84
▪ Others	55	28.95

*Data based on multiple responses

As regards to sites mostly used, the data presented in Table 3 indicates that, 93.68 per cent respondents used Google for searching information, followed by facebook (86.84%), ICAR (34.73%), yahoo (32.10%), webdunia (28.94%), khoj (26.84%), indiatimes.com (16.32%) and Rediff (12.10). Other sites were also used by 28.95 per cent respondents, respectively. Kaur and Manhas (2008) and Mishra *et al.* (2011) also noted almost similar findings.

5. Pattern of utilizing information retrieved from internet

The data regarding pattern of utilizing information retrieved from Internet are presented in Table 4. It reveals that the majority of the respondent (68.94%) retains the information by downloading it into the CD, pen drive, computer, mobile etc., followed by noting down useful information (58.94%), retain in the memory (47.80%), by discussing it with friends (37.89%). Some of the students were taking a printout instantly (15.78%) and other patterns are used for information retrieving from internet (12.11%). Dash and Mishra (2012) also noted almost similar findings.

Table 4: Distribution of respondents according to pattern of utilizing information retrieved from internet (n=190)

Utilizing Pattern	Frequency*	Percentage
▪ By noting down	112	58.94
▪ By discussing it with friend	72	37.89
▪ Retain in the memory	91	47.80
▪ Download in the CD/Pen drive/Computer/ Mobile	131	68.94
▪ Taking a print out instantly	30	15.78
▪ Others	23	12.11

*****Data are based on multiple responses

6. Extent of utilization of information and communication technology

The findings regarding extent of utilization of internet are present in Table 5. As regard to email, 42.63 per cent of students utilize rarely, followed by regular utilize (34.21%) and never utilize (23.16%). Regarding information, 45.26 per cent of students regular utilize for information, followed by rarely (32.63%) and never utilize for information (22.11%). Regarding knowledge of current affairs, 53.68 per cent of students rarely utilize, followed by regular (25.19%) and never utilize (20.53%). Regarding career opportunities, 63.16 per cent of students rarely utilize, followed by never utilize (16.84%) and regular utilize (16.84%).

Regarding preparation of resume, 63.68 per cent of students never utilize, followed by rarely (28.95%) and regular utilize (7.14%). Table 6 represents the data on distribution of respondents according to extent of utilization of ICT tools.Regarding extent of utilization of Internet, 49.47 per cent students were medium extend ofutilization, followed by 28.95 per cent students had low extent of utilization and 21.58 per cent students had high extent of utilization.

Table 5: Distribution of respondents according to extent of utilization of selected ICT tools (n=190)

Particulars	Regular	Rarely	Never
▪ E-mail	65(34.21)	81(42.63)	44(23.16)
▪ Information	86(45.26)	62(32.63)	42(22.11)
▪ Knowledge of current affairs	49(25.19)	102(53.68)	39(20.53)
▪ Career Opportunities	32(16.84)	120(63.16)	38(20)
▪ Preparation of Resume	14(7.37)	55(28.95)	121(63.68)
▪ Entertainment	61(32.11)	100(52.63)	29(15.26)
▪ Academic Purpose	25(13.25)	94(49.47)	71(37.37)

Table 6: Distribution of respondents according of extent of utilization of selected ICT tools (n=190)

ICT tools	Frequency	Percentage
Internet		
• Low (0-4 score)	55	28.95
• Medium (5.9 score)	94	49.47
• High (10-14 score)	41	21.58

CONCLUSION

The present study reveal that the majority (70.53%) of respondents used internet for getting information, majority (69.4%) of the students used Internet daily, 40.52 per cent of the students spent time 30 minutes - 1 hr./ day for using internet, maximum number of students (84.21%) used internet in hostel, 93.68 per cent respondent used Google for searching information, followed by facebook (86.84%) and majority (68.94%) of the respondent utilizing information retrieved from internet retain in the information by downloading it into the CD, pen drive, computer, mobile etc. 49.47 per cent students were medium extent of utilization,

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SHORT COMMUNICATION

YIELD AND ECONOMICS OF FINGER MILLET INFLUENCED BY POST EMERGENCE HERBICIDES

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Abstract : Finger millet (*Eleusine coracana* L.) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. It is used both as medicinal and traditional purposes. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield up to 20 to 50 per cent (Kushwaha *et al*., 2002). The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav, 1982). Manual weed management, which is the most prevalent method for weed management in finger millet, requires a lot of labour. Now a day, due to the scarcity of labours, chemical weed management is considered as better option than the hand weeding. It may increase over all benefit of finger millet cultivation. The work on effect of post emergence herbicides in weed management of finger millet is very limited; therefore, keeping these points in view the present investigation was carried out for evaluation of post-emergence herbicides for weed management in direct sown finger millet.

Keywords: Weed management, finger millet, herbicide

INTRODUCTION

The present investigation was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season 2012. The soil of experimental field was Clayey *(Vertisols)*, which was low in nitrogen, medium in phosphorus and high in potassium contents with neutral in pH. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, using seed rate of 10 kg/ha at 25 cm distance and gaps were maintained by thinning to obtain proper plant population. Sowing was performed manually and crop was fertilized with 60:40:40 N: P_2O_5:K_2O kg/ha. Application of herbicide was done at 20 DAS. Plant protection measures were followed as per recommendation. The treatments were T_1- Fenoxaprop-p-ethyl (37.5 g/ha), T_2- Fenoxaprop-p-ethyl (45.0 g/ha), T_3- Metsulfuron methyl + Chlorimuron ethyl, T_4- Ethoxysulfuron, T_5 – Cyhalofop-butyl, T_6- Fenoxaprop-p-ethyl (37.5 g/ha) + metsulfuron methyl + chlorimuron ethyl, T_7- Fenoxaprop-p-ethyl (45.0 g/ha) + metsulfuron methyl + chlorimuron ethyl, T_8- Fenoxaprop-p-ethyl (37.5 g/ha) + ethoxysulfuron, T_9- Fenoxaprop-p-ethyl (45.0 g/ha) + ethoxysulfuron, T_{10}- Cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl, T_{11}- Cyhalofop-butyl + ethoxysulfuron, T_{12}- Hand weeding twice and T_{13}- Weedy check. Grain yield of the net plot was noted after threshing, winnowing and drying, and then calculated in kg/ha with appropriate multiplication factor. The harvested produce from each net plot was tied in bundles separately. Straw yield of plot was noted down after subtraction of grain yield from bundle weight. Weed index expressing the reduction in yield due to presence of weeds in comparison with weed free situation was calculated using the formula given below as suggested by (Reddy, 2007).

$$\text{Weed Index} \quad \% \quad = \frac{\text{Sw} - \text{St}}{\text{Sw}} \times 100$$

Sw = Seed yield from weed free plot

St = Seed yield from treated plot

The major weed flora of experimental field consisted of *Echinochloa colona, Phyllanthus urinaria, Eclipta alba, Alternanthera triandra and Cyperus iria* and other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Cyperus rotundus, Euphorbia hirta, Euphorbia geniculata, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum. All the weed management practices caused significant reduction in density, dry weight of weeds in comparison to weedy check plot.

Grain yield and straw yield of finger millet was significantly influenced by different weed management practices. Among different herbicidal weed management practices, application of ethoxysulfuron alone recorded the highest grain yield which was at par with that of metsulfuron methyl + chlorimuron ethyl alone and significantly better than rest of the treatments including weedy check. The application of fenoxaprop-p-ethyl and cyhalofop-butyl alone or in combination with metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron caused severe reduction in grain yield due to their phytotoxicity effect on finger millet and hardly 77 kg/ha to 191 kg/ha grain yield was achived. Weed free treatment recorded the highest grain yield. Weed caused 55.4% reduction in grain yield of finger millet. It is in conformity with Prasad *et al*. (1991). Similarly the highest straw yield was noted with weed free treatment. Among herbicidal treatments straw yield of finger millet was observed high with application of metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron alone. The straw yield was

significantly reduced with application of fenoxaprop-p-ethyl and cyhalofop-butyl due to phytotoxicity. Weed index (loss of yield due to weeds) was found to be minimum with application of ethoxysulfuron (34.37 %) followed by metsulfuron methyl + chlorimuron ethyl (36.23 %). Weedy check registered 55.40 per cent weed index. The maximum weed index was found with application of fenoxaprop-p-ethyl (93.62 %) at higher level (45.0 g ha^{-1}) followed by cyhalofop-butyl + ethoxysulfuron (90.22%). Weed index in rest of the herbicidal treatments ranged between 84.23% to 88.47%.

Hand weeding twice recorded the highest gross return. Among herbicides, ethoxysulfuron gave maximum gross return which was at par with that of metsulfuron methyl + chlorimuron ethyl. In other herbicidal treatments *viz.* fenoxaprop-p-ethyl, cyhalofop-butyl alone or in combination with metsulfuron methyl + chlorimuron ethyl or ethoxysulfuron gross return was drastically reduced due to lower seed yield which was affected due to phytotoxicity. Fenoxaprop-p-ethyl (45.0 g/ha) gave minimum gross return. The maximum net return was observed in hand weeding twice which was at par with application of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl other herbicidal treatments were uneconomical due to lower seed yield. The highest B:C ratio was observed with application of ethoxysulfuron which was at par with that of metsulfuron methyl + chlorimuron ethyl and hand weeding twice. These results were in conformity with Kumara *et al*. (2007) reported that the herbicides are economical and cost effective in managing weeds as compared to hand weeding.

Table 1. Grain yield, straw yield and weed index of finger millet as influenced by different herbicidal treatments

Treatment	Dose (g/ha)	Grain yield (Kg/ha)	Straw yield (Kg/ha)	Weed index (%)
T_1 : Fenox		140	1395	88.47
T_2 : Fenox	45.0	77	637	93.62
T_3 : MSM+CME	2.0+2.0	771	6155	36.23
T_4 : Ethox	15.0	794	5479	34.37
T_5 : Cyhalo	62.5	188	1217	84.53
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	191	1427	84.23
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	188	1219	84.52
T_8 : Fenox+Ethox	37.5+15.0	180	966	85.15
T_9 : Fenox+Ethox	45.0+15.0	165	819	86.37
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	163	1328	86.53
T_{11} : Cyhalo+Ethox	62.5+15.0	119	1276	90.22
T_{12} : Weed free (HW at 20 and 40 DAS)		1210	6363	-
T_{13}: Weedy check		540	3737	55.40
SEm ±		**21.58**	**310.86**	**-**
CD at 5 %		**63.00**	**907.34**	**-**

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

Table 2. Economics of different post emergence herbicides for weed management in finger millet

Treatments	Total Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
T_1 : Fenox	12028	2863	-9165	0.24
T_2 : Fenox	12162	1551	-10611	0.13
T_3 : MSM+CME	11662	15417	3755	1.32
T_4 : Ethox	11795	15662	3867	1.33
T_5 : Cyhalo	12706	3682	-9023	0.29
T_6 : Fenox+MSM+ CME	12328	3801	-8527	0.31
T_7 : Fenox+MSM+ CME	12462	3689	-8773	0.30
T_8 : Fenox+Ethox	12548	3488	-9060	0.28
T_9 : Fenox+Ethox	12682	3199	-9483	0.25

T_{10} : Cyhalo+MSM+ CME	13006	3260	-9746	0.25
T_{11} : Cyhalo+Ethox	13226	2467	-10759	0.19
T_{12} : Weed free (HW at 20 and 40 DAS)	18370	23377	5007	1.27
T_{13}: Weedy check	11070	10648	-422	0.96
SEm ±		**451.39**	**451.39**	**0.03**
CD at 5 %		**1317.5**	**1317.5**	**0.10**

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

SUMMARY

The experiment comprising single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on *Vertisols* of Instructional cum Research Farm at College of Agriculture, Raipur during *kharif* season of 2012. *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra*, *Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Hand weeding twice recorded the highest grain yield and net return however application of ethoxysulfuron registered the highest B:C ratio which was at par with metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

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SHORT COMMUNICATION

PROSPECTS OF UTILIZING WATER CABBAGE (*LIMNOCHARIS FLAVA* (L.) BUCHENAU) BIOMASS AS AN ALTERNATE ORGANIC MANURE SOURCE

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Abstracts : Water cabbage (*Limnocharis flava* (L.) Buchenau) (Malayalam name: *Malamkoovalam / Nagapola*), an aquatic invasive alien weed was introduced as an ornamental plant in India. Now it has invaded vast tracts of low lying wetland system in Kerala and has become a serious threat to paddy cultivation. The weed clogs irrigation tanks and drainage channels, resulting in poor drainage. The luxuriant vegetative growth coupled with the fast spreading root systems extract large quantities of nutrient elements from the soil. Sannigrahi *et al.* (2002) reported that large scale utilization is the only way to control noxious aquatic weeds which require no tillage, fertilizer or nourishment for their proliferation. Non availability of good organic source at cheaper rates is another serious problem faced by farmers interested in organic crop production. Information on quality of the weed biomass as a source of manure would motivate farmers to manage such weeds through utilization. The present study was conducted to assess the possibility of utilizing the luxuriant weed biomass of water cabbage through vermicomposting.

Keywords : Water, cabbage, utilization, fertilizer

INTRODUCTION

The experiment was conducted at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during 2012. Water cabbage plants were collected from the field and vermicompost was prepared using standard techniques, with weed biomass alone or weed biomass mixed with crop residues in 1:1 proportion on weight basis. The weed plants collected were shade dried for 7 days and were chopped to 5 to 7 cm size. The weed biomass alone or combined with the crop residue was mixed with cow dung in the ratio 8: 1 (water cabbage / water cabbage + crop waste: cow dung) on weight basis. The composting was done in cement rings of 1.0 m diameter and 30 cm depth. Earth worms (*Eudrilus eugeniae*) were introduced after 10 days when the thermophilic stage of composting was over. Adequate moisture was maintained by watering regularly and fortnightly turning was given for proper aeration. The compost maturity was judged by its physical appearance such as the development of dark brown to black colour with uniformly disintegrated structure and C: N ratio. The N content (Modified microkjeldahl method), P content (Vanado-molybdo phosphoric yellow colour method), K content (Flame photometer method), and Fe, Mn and Zn content (Diacid digestion method) were estimated for compost samples (Jackson, 1973; Chesnin and Yien, 1951). Heavy metal content in the digested sample (DTPA extractant) were determined by using Atomic Absorption Spectrophotometer and expressed as ppm (Lajunen, 1992).

RESULT AND DISCUSSION

The physical characteristics of the vermicompost prepared from water cabbage biomass were found promising. The product developed greyish brown colour when composted alone while the compost had brownish black colour when composted along with crop residues. The product did not have any foul smell and had an earthy or humus like odour when composted alone or as 1:1 combination with crop residue. When the weed biomass was vermicomposted alone, the composting required 80 days for maturity while mixed with crop residue (1:1) the compost was ready by 50 days. The recovery percentage was 33 and 45 percent respectively. The population of earthworms in the former was also lower. The NPK content, EC and pH were favorable for using the product as an alternate organic source (Table.1). Moreover, there was no weed seed germination when random samples from the compost were tested for weed seed germination.

The chemical analysis of the product revealed that the content of copper in vermicompost was much higher than the maximum permissible limit of 400 ppm as described by Canadian Council of Ministers of the Environment (2005) (Table 2). However concentration of the other heavy metals were quite less than the limits prescribed for vermicompost internationally. Thus it might be inferred that the luxuriantly growing weed is promising for bioremediation but its use as an organic manure is debatable due to the very high content of some of the heavy metals.

Table 1. Chemical properties of water cabbage vermicompost

Material	pH	EC	OC%	N%	P%	K%	C:N Ratio	C:P Ratio
Before composting	6	-	48	1.6	0.13	2	30:1	369:1
Weed biomass alone	7.12	4.2	32.2	1.4	0.48	1.3	23:1	67:1
Weed : crop residue (1:1)	7.59	0.2	32.4	1.8	0.44	1.17	18:1	73.6:1

Table 2. Micronutrient composition of water cabbage vermicompost (ppm)

Elements	Weed biomass alone	Weed : crop residue (1:1)
Iron	2820	2990
Manganese	1175	1135
Copper	18435	10965
Zinc	220	195
Lead	0.007	0.021
Mercury	0.054	0.023
Cadmium	0.1	0.11
Nickel	0. 04	0.05
Chromium	0.15	0.13
Cobalt	0. 015	0.01

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SHORT COMMUNICATION

ANALYSIS OF FACTORS ASSOCIATED WITH THE PRODUCTIVITY OF SCENTED RICE VARIETIES AMONGST THE TRIBAL FARMERS OF JASHPUR DISTRICT (CHHATTISGARH)

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Abstract: The present study was conducted in Jashpur district (Chhattisgarh) among scented rice growing tribal farmers. Total 4 blocks were purposively selected for the study and three villages were selected randomly from each selected block. Twelve scented rice growing tribal farmers were selected randomly from each selected village. Thus the total 144 scented rice growing farmers (12X12=144) were considered as respondent for this study. The results of the study revealed that the productivity of scented rice varieties of respondents was found to be positively and high significantly related with the three variables viz. extension participation, source of information and contact with extension personnel at 0.01 per cent level of probability.

Keywords: Scented rice, productivity, adoption, factors

INTRODUCTION

Rice is one of the important cereal crops of the world and forms the staple food for more than 50 per cent of population and is known as "king of cereals". It provides staple diet to 2.7 billion people in different parts of the world. It is grown in the entire world, except Antarctica. It is occupying 150 million ha of area, producing 573 million tones rice with an average productivity of 3.83 tones ha. (Singh *et al.,* 2013). The United Nations General assembly, in a resolution declared the year of 2004 as the "International Year of Rice", which has tremendous significance to food security. It very eloquently upheld the need to heighten awareness about the role of rice in alleviating poverty and malnutrition (Manjunath, 2010).

Indian subcontinent is well known for its native wealth of aromatic rice, of which basmati rice are inexplicably exclusive. Many other traditional rice varieties are also grown in some specific pockets of the country. Scented rice occupies an important status in domestic as well as in International market due to its several outstanding qualities and therefore they earn premium price. These indigenous tall varieties possess some special characteristics, like grains of some varieties are very small, some are fine and some of them have peculiar fragrance and colour. In addition to long grain Basmati type that has high export potential, there are large number of indigenous short-grained aromatic varieties cultivated in Chhattisgarh and different pockets of other states.

RESEARCH METHODOLOGY

The study was conducted during the year 2013-14 in the Jashpur district of the Chhattisgarh state. Out of total 8 blocks namely; Jashpur, Bagicha, Pathalgaon, Pharsabahar, Kansabel, Kunkuri, Duldula and Manora; 4 blocks (50% blocks) Pharsabahar, Jashpur, Duldula and Bagicha blocks were selected purposively. Thereafter, 12 tribal villages namely, Garighat, Bhagora, Sikirma, Galonda, Lodam, Rengola, Bamhani, Patratoli, Sirimkela, Jujgu, Jurgum and Kurdeg were selected for this study on the basis of maximum area under scented rice varieties. In this way the 12 villages were selected for the study. From each village, 12 scented rice growers were selected randomly for collection of data. In this way (12 X 12 = 144) a total of 144 scented rice growing farmers were selected for the study. The data were collected personally through pre-tested interview schedule. Collected data were tabulated and processed by using appropriate statistical tools and methods.

RESULT AND DISCUSSION

Correlation analysis of independent variables with the productivity of scented rice varieties

Correlation coefficient between the selected characteristics of the respondents with productivity of scented rice varieties among scented rice growing farmers was worked out and the values of correlation coefficient are presented in Table 1.

It was found from the data that out of all selected fifteen characteristics, the three variables viz. extension participation, source of information and contact with extension personnel were found to be positive and high significantly correlated with productivity at 0.01 per cent level of probability. Whereas, the variables credit acquisition was found to be positively and significantly correlated with the productivity of scented rice at 0.05 per cent level of probability. It shows that the productivity of scented rice varieties increase by the increasing of participation, source of information and contact with extension personnel and credit acquisition.

The other eleven variables *viz.* age, education, family size, social participation, occupation, land holding, annual income, economic motivation, scientific

orientation, risk orientation and cultivation practices has no statistically significant correlation with productivity of scented rice varieties. So it is required to intervene the significant factors for enhancing the productivity of scented rice varieties.

Table 1: Coefficient of correlation of independent variables with the productivity of scented rice varieties

S. No.	Independent Variables	Coefficient of correlation "r" value
1	Age	0.032 NS
2	Education	-0.027 NS
3	Family size	0.019 NS
4	Social participation	0.116 NS
5	Extension participation	0.412**
6	Occupation	-0.052 NS
7	Land holding	0.036 NS
8	Annual income	0.035 NS
9	Credit acquisition	0.177*
10	Source of information	0.364**
11	Contact with extension personnel	0.402**
12	Economic motivation	0.034 NS
13	Scientific orientation	-0.090 NS
14	Risk orientation	-0.089 NS
15	Sowing method	-0.111 NS

*Significant at 0.05 level of probability ("r" value = 0.162)
** Significant at 0.01 level of probability ("r" value = 0.212)
NS = Non-Significant

It can be concluded that the highly positive significant correlation coefficient was found to be in extension participation (r = 0.412), in source of information (r = 0.364) and in contact with extension personnel (r = 0.402) respectively as compared to other variables.

Multiple regression analysis of independent variables with the productivity of scented rice varieties

The results of multiple regression analysis are presented in Table 2. The results of multiple regression analysis reveals that, out of 15 independent variables, three variables extension participation, land holding and scientific orientation contributed significantly towards productivity at 0.05 per cent level of probability.

The variables age, education, family size, social participation, occupation, land holding, annual income, credit acquisition, source of information, contact with extension personnel, economic motivation, risk orientation and cultivation practices had no significant contribution in productivity of scented rice varieties.

Table 2: Multiple regression analysis of independent variables with the productivity of scented rice varieties

S. No.	Independent variables	"t" value	Regression coefficient "b" value
1	Age	1.67946	0.06679
2	Education	-0.31743	-0.08746
3	Family size	-0.74836	-0.48420
4	Social participation	1.03043	0.46021
5	Extension participation	2.15034	0.81583*
6	Occupation	0.20087	0.09253
7	Land holding	-2.01382	-0.43144*
8	Annual income	0.13516	0.00000
9	Credit acquisition	0.19500	0.14097
10	Source of information	0.19422	0.02883
11	Contact with extension personnel	1.41878	0.41168
12	Economic motivation	0.09642	0.02221
13	Scientific orientation	-2.01132	-0.27855*
14	Risk orientation	-0.85164	-0.14217
15	Sowing method	-0.56129	-0.40477

** Significant at 0.01 level of probability ('t' value = 2.610) R^2 = 0.295
*Significant at 0.05 level of probability ('t' value =1.97) F value of r = 3.56
NS = Non-significant

CONCLUSION

From the study, according to the correlation analysis, it was found from the data that out of all selected characteristics, the three variables viz. extension participation, source of information and contact with extension personnel were found to be positive and high significantly correlated with productivity of scented rice varieties at 0.01 per cent level of probability. While multiple regression analysis reveals that, out of 15 independent variables, three variables namely extension participation, land holding and scientific orientation contributed significantly towards productivity at 0.05 per cent level of probability.

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SHORT COMMUNICATION

ANALYSIS OF FACTORS ASSOCIATED WITH THE TECHNOLOGICAL GAP IN ADOPTION OF RECOMMENDED PRODUCTION TECHNOLOGY OF BLACK GRAM AMONG TRIBAL FARMERS OF JASHPUR DISTRICT (CHHATTISGARH)

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Abstract: Present study was conducted in Jashpur district (Chhattisgarh) among tribal farmers. Total three blocks were purposively selected for the study; four villages were selected randomly from each selected block to make a total of 12 villages in the sample. Ten black gram producing tribal farmers were selected randomly from each selected village. Thus the total 120 black gram growers (10X12=120) were considered as respondent for this study. The results of the study revealed that the technological gap of respondents was found to be negatively and significantly related with the independent variables viz.:- extension participation, land holding, annual income, credit acquisition, source of information, contact with extension personnel, knowledge level.

Keywords: Technological gap, black gram

INTRODUCTION

Though India is the world's largest producer of pulses but still it imports a large amount of pulses to meet the growing domestic needs. During 2009-10, India imported 3.5 million tons of pulses from the countries like Australia, Canada and Myanmar. (FAOSTAT 2010), Black gram (*Vigna mungo*) which belongs to Fabaceae (Leguminoceae) family, originated from India. Urd is an important food legume widely consumed in India. It is one of the most widely cultivated pulse crops in the country. It is grown over an area of about 30 lakh ha with a production of about 13 lakh tones, the average productivity of about 0.4 t/ha. Is still a challenge which has to be increased, Black gram is mainly cultivated in Indian subcontinent. Black lentil is nothing but the split black gram and after removing black skin it is sold as white lentil. In India Black gram is popular as "Urad dal" and it is highly prized pulse among all the pulses. Black gram, also known as urdbean, mash, black maple etc. an important short-duration pulse crop grown in many parts of India. This crop is grown in cropping systems as a mixed crop, catch crop, sequential crop besides growing as sole crop under residual moisture conditions after the harvest of rice and also before and after the harvest of other summer crops under semi-irrigated and dry land conditions. Its seeds are highly nutritious with protein (25-26%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins. Seeds are used in the preparation of many popular Indian dishes. It is one of the most important components in the preparation of famous south Indian dishes, e.g. dosa, idli, vada etc. besides, it adds about 42 kg Nitrogen per hectare in soil. It is also valued as a green manure crop. Its dry stalks along with pod husk forms a nutritive fodder especially for milch cattle. Black gram possesses deep root system, which binds soil particles and thus prevents soil erosion.

In Chhattisgarh, black gram is cultivated in 177.77 thousand ha area with production of 73.51 tons in the year 2011 (Agridept.cg.gov.in), Raigarh is 1st rank in cultivating area of 17.30 thousand ha with production of 4 thousand metric tons, Surguja accounts 14.81 thousand ha with 4.01 metric tons production followed by Jashpur district with area 14.42 thousand ha and production of 5.11 metric tons. The productivity of black gram in the state is only 0.41 t/ha which is far behind than the potential. The study is therefore concerned about assessment of such technological gap in production of black gram particularly among tribal farmers and the findings will throw light on these aspects to meet out the challenges in Jashpur district.

RESREARCH METHODOLOGY

The study was conducted in Jashpur district of Chhattisgarh, during the year 2013-14. Out of total 8 blocks in the district (Jashpur, Bagicha, Pharsabahar, Pathalgaon, Kunkuri, Kansabel, Manora and Duldula), only three blocks i.e, Pharsabahar, Bagicha and Jashpur were selected purposively because of maximum area under black gram cultivation. Villages were selected randomly from each selected block to make a total of 12 villages in the sample. Randomly selected villages are following: Baro, Mahuwadih, Khutsera, Jamtoli, Kutma, Bamba, Pasiya, Sanna, Lodam, Putrichaura, Koleng and Jabla. Ten black gram producing tribal farmers were selected randomly from each selected village. Thus the total 120 black gram growers (10X12=120) were considered as respondent for this study. The data were collected personally through pre-tested interview schedule. Collected data were tabulated and processed by using appropriate statistical tools and methods.

RESULT AND DISCUSSION

Correlation analysis of sixteenth independent variables i.e.: age, education, family size, social participation, extension participation, farming experience, occupation, land holding, annual income, credit acquisition, irrigation facility, source of information, contact with extension personnel, scientific orientation, risk orientation and knowledge level with technological gap in adoption of recommended production technology of black gram.

Table 1 depicts that out of sixteen variables only seven variables were negatively and significantly correlated at 0.01 level of probability with technological gap in production of production technology of black gram among tribal farmers these variables are: - extension participation, land holding, annual income, credit acquisition, source of information, contact with extension personnel and knowledge level of recommended production technology of black gram, of which only occupation had positively and significantly correlated with technological gap. It's meant technological gap in adoption of recommended production technology of black gram decrease by increasing of extension participation, land holding, annual income, and credit acquisition, source of information, contact with extension personnel and knowledge level of recommended production technology of black gram, where as occupation and technological gap increase or decrease in similar direction. Whereas remaining eight variables i.e. age, education, family size, social, participation, farming experience, irrigation facility, scientific orientation and risk orientation non-significantly correlated with technological gap in adoption of recommended production technology of black gram. It is therefore required to intervene the significant factors for reducing the technological gap in adoption of blackgram production technology.

Table 1: Coefficient of correlation of independent variables with the Technological gap in adoption of recommended production technology of black gram (n=120)

S.N.	Independent variables	Coefficient of correlation "r" value
1.	Age	-0.058NS
2.	Education	-0.047NS
3.	Family size	-0.006NS
4.	Social participation	-0.050NS
5.	Extension participation	-0.434**
6.	Farming experience	-0.128NS
7.	Occupation	0.381**
8.	Land holding	-0.338**
9.	Annual income	-0.445**
10.	Credit acquisition	-0.363**
11.	Irrigation facility	0.012NS
12.	Source of information	-0.266**
13.	Contact with extension personnel	-0.597**
14.	Scientific orientation	-0.162NS
15.	Risk orientation	-0.112NS
16.	Knowledge level	-0.702**

**Significant at 0.01 level of probability *Significant at 0.05 level of probability NS=Non significant

Multiple regression analysis of independent variables with the technological gap in adoption of recommended production technology of black gram is compiled in Table 2. It revealed that out of the sixteen variables under study, two variables viz. contact with extension personnel and knowledge level had significant contribution with technological gap at 0.01 per cent level of probability. Whereas age, education, family size, social participation, extension participation, farming experience, occupation, land holding, annual income, credit acquisition, irrigation facility, source of information, scientific orientation and risk orientation had shown non-significant contribution to the technological gap in adoption of recommended production technology of black gram.

Table 2: Multiple regression analysis of independent variables with the technological gap in adoption of recommended production technology of black gram (n=120)

S.N.	Variables	"t' value	Regression coefficient "b" value
1.	Age	1.146	0.082 NS
2.	Education	1.031	0.375 NS
3.	Family size	-0.190	-0.125 NS

4.	Social participation	0.087	0.118 NS
5.	Extension participation	-1.165	-0.532 NS
6.	Farming experience	-0.858	-0.066 NS
7.	Occupation	1.464	1.246 NS
8.	Land holding	-0.282	-0.098 NS
9.	Annual income	-1.388	-0.763 NS
10.	Credit acquisition	-0.564	-0.618 NS
11.	Irrigation facility	1.271	0.753 NS
12.	Source of information	1.743	0.404 NS
13.	Contact with extension personnel	-4.690	-2.709**
14.	Scientific orientation	-1.535	-0.103 NS
15.	Risk orientation	-0.002	0.006 NS
16.	Knowledge level	-5.986	-0.337**

** Significant at 0.01 level of probability $R^2 = 0.657$

* Significant at 0.05 level of probability F value of R = 12.37 NS = Non significant

CONCLUSION

The technological gap among tribal farmers was found to be negatively and significantly related with the extension participation, land holding, annual income, credit acquisition, source of information, contact with extension personnel and knowledge level of recommended production technology of black gram. Occupation was positively and significantly related with the technological gap in adoption of recommended production technology of black gram.

Whereas age, education, family size, social, participation, farming experience, irrigation facility, scientific orientation and risk orientation non-significantly correlated with technological gap in adoption of recommended production technology of black gram.

Regarding multiple regression analysis, only two variables were negative significantly contribution towards technological gap at 0.01 level of probability.

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SHORT COMMUNICATION

MAJOR WEED SPECIES IN FINGER MILLET

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Abstract : The experiment comprising 13 weed management practices which comprised single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on Clayey *Vertisols* soil of College of Agriculture, Raipur during *kharif* season of 20012. *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Over all the most dominant species was *Echinochloa colona* which ranged between 24-46 per cent at all the growth stages.

Keywords: Major weed species, finger millet

INTRODUCTION

Finger millet (*Eleusine indica*) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. It is used both as medicinal and traditional purposes. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield (Kushwaha *et al*., 2002). The production and productivity of the country is lower because of weeds pose one of the major constraints in the production of finger millet. Owing to initial slow growth of the finger millet favours weed growth, which cause more competition for sunlight, nutrient and water in early stages of growth lead in lowering productivity (Kumara *et al*., 2007). The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav, 1982). Weeds compete with crop plants for water, nutrients, space and solar radiations by reduction of yield upto 20 to 50 per cent. (Kushwaha *et al*., 2002). According to various research work major weed flower was observed in finger millet crop was *Cyperus rotundus* among sedges, *Echinochloa colona*, *Digitaria marginata*, *Cynodon dactyton*, *Chloris barbata*, *Erograstis uniloides*, *Panicum spp*., *Eleusine indica* and *Setaria glauca*, among monocot and *Commelina benghalensis*, *Acanthospermum hispidum*, *Portulaca oleracea*, *Borreria hispida*, *Amaranthus viridis*, *Phyllantlus niruri*, *Argemone mexicana*, *Cleome monophylla*, *Crotons sparsiflorus*, *Emilia sanchifol1a*, *Euphorbia hirta*, *Euphorbia geniculata*, *Legasca mollis*, *Parthenium hysterophorus*, *Tridax procumbens*, *Ipomoea eriopcarp*, *Hibiscus asper* and *Spilanthus ecmela* among broad leaf weeds.

MATERIAL AND METHOD

The present investigation entitled "Evaluation of post-emergence herbicides for weed management in direct sown Finger millet." was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season (July-November) 2012. The soil of experimental field was Clayey *(Vertisols)*. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, using seed rate of 10 kg ha^{-1} at 25 cm distance. Weed counts (number m^{-2}) was recorded by putting a quadrate (0.25 m^{-2}) at random spots in each plot and relative weed density (%) was calculated by using the formula

$$\text{Relative weed density} \quad \% \quad = \frac{D}{Td} \times 100$$

D = Weed density of weedy check plot of different weed species at different interval
Td = total weed density of weedy check plot

RESULT AND DISCUSSION

Weeds

The major weed flora of experimental field consisted of *Echinochloa colona, Phyllanthus urinaria, Eclipta alba, Alternanthera triandra and Cyperus iria*. The major weeds species were observed in weedy check which has been presented in Table 1.

Table 1 : Major weeds species observed in the experiment field

S. No.	Scientific name	Family	Common name	Group
1	*Echinochloa colona*	Poaceae	Sawan/Jungle rice	Grasses
2	*Cyperus iria*	Cyperaceae	Motha/Yellow	Sedges
3	*Alternanthera triandra*	Compositae	Resham kanta	Broad leaf
4	*Eclipta alba*	compositeae	Bhringraj/False daisy	Broad leaf
5	*Phyllanthus urinaria*	Euphorbiaceae	Dodania	Broad leaf

Table 2: Weed density and relative weed density at different interval in weedy check in direct seeded finger millet

S. No.	Major weed species	Weed density (m^{-2})						Relative weed density %					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
1.	*Echinochloa colona*	30.00	85.00	100.67	72.00	64.00	52.67	40.36	45.78	36.26	24.30	29.22	35.51
2.	*Cyperus iria*	2.34	18.00	35.00	67.00	20.33	8.33	3.15	9.69	12.60	22.61	9.28	5.62
3.	*Alternanthera triandra*	9.00	9.33	25.00	26.67	20.00	18.33	12.11	5.03	9.00	9.00	9.13	12.36
4.	*Eclipta alba*	3.33	18.33	51.33	59.67	57.33	28.67	4.48	9.87	18.49	20.14	26.18	19.33
5.	*Phyllanthus urinaria*	13.67	30.33	35.33	38.33	30.67	26.33	18.39	16.34	12.72	12.93	14.00	17.75
6.	Other weed species	16.00	24.67	30.33	32.67	26.67	15.33	21.52	13.29	10.92	11.02	12.18	10.34
	Total weed species	74.34	185.66	277.66	296.34	219	149.66	100.00	100.00	100.00	100.00	100.00	100.00

The weed flora composition (%) at different stages of direct seeded finger millet is given in Table 1. At 15 DAS, the percentage composition of *Echinochloa colona* (28%) was recorded highest followed by other weed species (20%) and *Phyllanthus urinaria* (29%). At 30 DAS the percentage composition of *Echinochloa colona* (29%) followed by *Phyllanthus urinaria* (17%) and 45 DAS the percentage composition of *Echinochloa colona* (25%) was recorded highest followed by *Eclipta alba* (18%) while, at 60 DAS, the composition of *Echinochloa colona* (20%) was recorded highest. At 75 and 90 DAS, the percentage composition of *Echinochloa colona* (22% and 25%, respectively) was recorded highest followed by *Eclipta alba* (21% and 19%, respectively). At harvest the percentage composition of *Alternanthera triandra* (39%) was recorded highest followed by other weed species (33%).

Over all the most dominant species was *Echinochloa colona* which ranged between 24-46 per cent at all the growth stages. It was followed by *Phyllanthus urinaria* (13-18 %), *Eclipta alba (5-26 %), Cyperus iria* (3-23 %) and *Alternanthera triandra* (5-12 %).

Other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Cyperus rotundus, Euphorbia hirta, Euphorbia geniculata, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum. These results were in conformity with Pradhan *et al*. (2010) and Gowda *et al*. (2012).

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SHORT COMMUNICATION

IMPACT OF WEED MANAGEMENT PRACTICES ON WEED CONTROL, NODULATION, RHIZOBIUM POPULATION AND YIELD IN SOYBEAN

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Absract: The experiment using JS 97-52 variety of soybean was laid out during *kharif* season of 2013 at the Research Cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) using Randomized Block Design, comprising four replications and eight treatments. The result revealed that highest number of root nodules plant^{-1} was recorded under hand weeding twice at 20 and 40 DAS, however it was found comparable with Sulfentrazone @ 300 g *a.i.* ha^{-1}as PE + Imazethapyr @ 100 g *a.i.* ha^{-1} as PoE. The lowest root nodules plant^{-1} was registered under untreated control. Maximum dry weight of nodules plant^{-1} was recorded under hand weeding twice at 20 and 40 DAS as compared to other treatments, however it was on par with Sulfentrazone @ 360 g *a.i.* ha^{-1} as PE and Sulfentrazone @ 300 g *a.i.* ha^{-1}as PE + Imazethapyr @ 100g *a.i.* ha^{-1} as PoE . The lowest weight of root nodules plant^{-1} was registered under untreated control. Maximum rhizobial population was observed under treatment untreated control, which was at par with treatment hand weeding twice at 20 and 40 DAS, and minimum rhizobial population was observed under treatment Pendimethalin @ 1 kg *a.i.* ha^{-1} as pre-emergence.Minimum density and dry weight of weeds were also registered under Hand weeding twice at 20 and 40 DAS.

Keywords: Nodule number, rhizobium population, weed control, soybean

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is an important oil-yielding leguminous crop having multiple uses. Due to its various uses soybean is rightly called **"Golden Gift"** of nature to mankind. Soybean known as a **'Miracle Crop'** because it contains about 40-42 per cent high quality protein, 20-22 per cent edible oil, 20-30 per cent carbohydrates, large amount of phosphorus, high level of amino acids such as Lysine, Lucien, Lecithin and vitamins. Soybean builds up the soil fertility by fixing atmospheric nitrogen (45 to 60 kg ha^{-1}) through the root nodules, and adds about 0.5 to 1.5 tonnes ha^{-1} organic matter in soil through leaf fall (Kanase *et al*., 2006). It is able to leave residual nitrogen effect for succeeding crop equivalent to 35-40 kg N ha.$^{-1}$ Soybean can tolerate mild drought as well as floods. This characteristic has made soybean to fit well in sustainable agriculture.At Raipur (C.G) most prominent weeds observed in soybean *Echinochloa colona, Cyperus rotundus, Euphorbia spp., Commelina benghalensis, Phyllanthus niruri,* (Kolhe *et al et al.,* 1998).The critical period of crop-weed competition in soybean is reported to be first DAS (Swarnakar, 2010).In soybean, the weed flora as observed from the unweeded control plots consist of 58% sedges, 32% broad-leaved weeds and 10% grasses.Hand weeding is a traditional and effective method of weed control, but untimely and continuous rains as well as unavailability of labour at peak time are main limitations of manual weeding. The only alternative that needs to be explored is the use of pre as well as post-emergence herbicides. The screening of such herbicides in soybean reveals their efficiency against either monocotyledonous or dicotyledonous weeds. Many herbicides like sulfentrazone, and imazethapyr are available at present day giving effective and broad spectrum weed control in soybean. In the present study, an attempt was made to evaluate cultural practices and selective herbicides for the control of weeds and to find out the effect of weed-control methods on yield of soybean.

MATERIAL AND METHOD

A field experiment was conducted at Research Cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *kharif* seasons of 2013. The soil of experimental field was *clayey* in texture, low in nitrogen, medium in phosphorus and high in potassium contents with neutral pH. The experiment was laid out in Randomized Block Design, comprising four replication and eight treatments which included Sulfentrazone 48 % F 300 g *a.i* ha^{-1} as pre-emergance, Sulfentrazone 48 % F 360 g *a.i* ha^{-1}as pre- emergence, Pendimethalin 30 EC 1 kg *a.i* ha^{-1} as pre-emergence, Sulfentrazone 48 % F 300 g *a.i* ha^{-1} as pre -emergance + Imazethapyr 10 SL as Post-emergance, Sulfentrazone 48 % F 300 g *a.i* ha^{-1} as pre -emergance + one hand weeding , Sulfentrazone 48 % F 300 g *a.i* ha^{-1} as pre -emergance + hoeing , hand weeding twice at 20 and 40 DAS and untreated control . Soybean variety JS 97-52 was sown with spacing of 30 cm x 7cm during the last week of June and the seed rate of 83.33 kg ha^{-1} and fertilizer dose was 25, 60 and 40 kg/ ha of N, P_2O_5 and K_2O respectively was used, at the time of sowing. Yield attributes were recorded at harvest. Observations of weeds, number and dry weight of nodules were recorded at 60 DAS. Analysis of rhizobium population in soil was done by serial dilution plating method (Subba Rao 1988).

1.M.Sc. (Ag.) Scholar, 2 & 3. Principal Scientist, 4. Ph.D Scholar

RESULT AND DISCUSSION

Higher number of root nodules plant^{-1} was recorded under treatment twice hand weeding at 20 and 40 DAS (T_7) as compared to other treatments, however it was found comparable with Sulfentrazone @ 300 g *a.i.* ha^{-1}as PE + Imazethapyr @ 100g *a.i.* ha^{-1} as PoE (T_4). The lowest root nodules plant^{-1} was registered under untreated control (T_8).

Increased number of root nodules plant^{-1} in above treatments might be due to the favourable microclimate after suppression of weeds near the root zone of soybean crop. Higher nodulation fixed the atmospheric nitrogen which ultimately supported in higher crop growth of soybean. Increased number of nodules up to 60 DAS might be due to less weed and favourable micro climate. Furthermore, nodules count in the above treatments might be due to greater infection *Rhizobium* in the growing roots. Increased number of nodules up to 60 DAS might be due to less weed and favourable micro climate. Furthermore, nodules count in the above treatments might be due to greater infection *Rhizobium* in the growing roots. The increased in nodule number probably due to increased aeration of *Rhizosphere*. On the contrary, in rest of the treatments, limitation of soil moisture and nutrients for plant uptake, adversely affected the nodulation and decline nitrogenase activity.

Higher dry weight of nodules plant^{-1} was recorded under hand weeding twice at 20 and 40 DAS (T_7) as compared to other treatments, however it was on par with Sulfentrazone @ 360 g *a.i.* ha^{-1} as PE (T_2) and Sulfentrazone @ 300 g *a.i.* ha^{-1}as PE + Imazethapyr @ 100g *a.i.* ha^{-1} as PoE (T_4). The lowest weight of root nodules plant^{-1} was registered under untreated control (T_8). Increased dry weight of nodules in the above treatments might be due to more nodule count and greater infection of *Rhizobium* in the growing roots. Lowest dry weight of nodule might be due to more crop-weed competition and effect of herbicides.

Rhizobial population (x 10^6 g^{-1} soil) of soybean field was counted at 60 DAS and data are presented in Table 1. maximum rhizobial population was observed under treatment untreated control (T_8), which was at par with treatment hand weeding twice at 20 and 40 DAS (T_7), whereas significantly minimum rhizobial population was observed under treatment Pendimethalin @ 1 kg *a.i.* ha^{-1} as pre-emergence (T_3). The highest rhizobial population observed under untreated control (T_8) followed by hand weeding twice at 20 and 40 DAS (T_7), and incomparable treatments might be due to the favourable microclimate and absence of herbicidal effect. Lowest Rhizobial population was observed under Pendimethalin @ 1 kg *a.i.* ha^{-1} as pre-emergence (T_3) might be due to more crop-weed competition and herbicidal effects. Similar findings were reported by Jeenie and Sharma (2011).

The experimental site was dominated by *Parthenium hysterophorus, Euphorbia geniculata, Digera arvensis, Commelina benghalensis, Convolvulus arvensis, Echinocloa colona*, *Cynodon dactylon* and *Cyperus rotundus*. Density of weeds were observed significantly maximum under Untreated control and significantly minimum density was recorded under Hand Weeding twice at 20 and 40 DAS. This was because no any weed management practices was applied to control weeds under untreated control plot, which freely proliferated and compete with the crop for available nutrient, moisture and sunlight resulting in reduction of crop yield. Similar results were observed by Idapuganti *et al.* (2005) and Pal *et al* (2013). Dry matter production by weeds were observed significantly maximum under Untreated control and significantly minimum production of dry matter under treatment Hand weeding twice at 20 and 40 DAS. Idapuganti *et al.* (2005) and Karande *et al.* (2008) also reported similar results from their study. The total production of dry matter by weeds was significantly highest under Untreated control throughout the crop growth period, which was due to absence of suitable weed management practices, which leads to accumulation of more dry matter in weeds upto harvest.

Table 1: Effect of weed management practices on number and dry weight of nodules, rhizobium population, weed density and dry weight of weeds in soybean

Treatments	**Number of nodules plant^{-1}**	**Dry weight of nodules (g plant^{-1})**	**Rhizobium population (x 10^6 g^{-1} soil)**	**Weed density (No m^{-2})**	**Dry weight of weeds (g m^{-2})**
T_1-Sulfentrazone 48 % F @ 300 g a.i ha $^{-1}$ as PE	78.3	0.98	42	**6.1** (37.2)	**3.8** (14.2)
T_2-Sulfentrazone 48 % F@ 360 g a.i ha $^{-1}$ as PE	87.8	1.25	37	**5.9** (23.5)	**3.1** (9.6)
T_3- Pendimethalin 30 EC @ 1 kg a.i ha $^{-1}$ as PE	73.8	0.86	32	**8.2** (66.4)	**5.2** (28.9)
T_4- Sulfentrazone 48 % F @ 300 g a.i ha $^{-1}$ as PE fb	97.3	1.19	26	**2.8** (7.2)	**2.0** (3.9)

Imazethapyr 10 SL @ 100 g a.i ha $^{-1}$ as PoE					
T_5-Sulfentrazone 48 % F@ 300g a.i ha $^{-1}$ as PE fb One Hand Weeding at 25 DAS	80.3	1.03	47	**5.4** (28.6)	**3.7** (13.2)
T_6-Sulfentrazone 48 % F@ 300 g a.i ha $^{-1}$ as PE fb Hoeing at 25 DAS	76.1	0.92	49	**6.6** (42.9)	**4.2** (17.4)
T_7-Hand weeding twice at 20 and 40 DAS	99.2	1.49	54	**2.5** (6)	**1.3** (1.2)
T_8-Untreated control	63.2	0.61	62	**12.3** (152.3)	**12.1** (147.7)
SEm ±	**0.8**	**0.12**	**1.7**	**1.9**	**2.3**
CD (P=0.05)	**2.8**	**0.43**	**5.1**	**5.6**	**6.7**

Figures in the parentheses are original values; data were transformed through $\sqrt{x+0.5}$ which are given in bold

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SHORT COMMUNICATION

PROBING BEHAVIOUR OF *NILAPARVATA LUGENS* (STAL.) ON RICE PLANT AS INFLUENCED BY POTASH APPLICATION

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Abstract: Rice is an important cereal crop of the world which is known to be attacked by several insect pest during its different development stages out of these brown plant hopper *(Nilaparvata.lugens*) is an important insect pest of rice. The main approach for the management of this pest has been through the chemical methods which has resulted several problems; therefore the fertilizer components affecting the biophysical parameters of the host ultimately influencing the probing behaviour of BPH (*N.lugens*) was thrust point of investigation. In present study the major components of fertilizer viz., nitrogen was tested at 0, 40, 60, 100, 160, 220, 280, 340, 400 and 460 kg/ha and its impact on the probing behaviour of *N.lugens* was recorded. There was significant negative correlationship (r =0.99) between probe marks and nitrogen doses. The regression equations for probe marks in relation to different nitrogen levels applied was = 0.0324x + 4.9589.

Keywords: *Nilaparvata lugens*, paddy, probing behaviour, brown plant hopper

INTRODUCTION

Rice (*Oryza sativa*) is a main cereal crop cultivated on an area of 44 million ha in India having production of about 93 million tones. In Chhattisgarh state, rice is grown in 34.69 lakh hectares with the production of 28.862 lakh tones during 2002-03, which is 8.15% of total area and 3.70% of total production in country (ANONYMOUS, 2003). Among the various insect pests, brown plant hopper of rice is major one with greater economic significance causing extensive losses to paddy crop up to 34.40% in Chhattisgarh (GANGRADE *et al*., 1978). Several attempts had been done in past and present scenario by using several chemicals but due to ignorance and lack of techniques know how, the result did not come up to expectation more over, several after use of these chemical problems had been noted. It has been reported that close planting production of more tillers per unit area, increased use of fertilizers indiscriminate plant protection measures were reported to have increased behavior and its abundance (KALODE, 1974, 1976 AND OKA, 1977). Non judicious uses of fertilizers suppose to cause many problems of the insect pest as well as more use of organic matter may give rise the problem of brown plant hopper (*N.lugens*). Therefore, to work out the impact of macronutrient on the probing capacity of brown plant hopper *(N.lugens*), which could give a clue for its better management, is the aim of framing this piece of investigation at the lab level.

MATERIAL AND METHOD

The experiments were carried out at glass house department of Entomology, college of Agriculture IGKV, Raipur during the period of March-2007 to june-2007. The brown plant hopper, *Nilaparvata lugens* (Stal.) initially collected from entomological field and its culture being maintained throughout the year in the air-cooled glass house, Department of Entomology at $30^{o}c\pm5^{0}c$ on potted TN1 variety. BPH (*N.lugens*) were reared on 40 to 45 days old potted TN1 plant inside the rearing cage of 75x75x75 cm size consisting of wooden frame. Potted TN1 plants were placed inside the rearing cage for egg laying along with at least 60 pairs of BPH per pot. After 23 days the female starts egg laying inside the leaf sheath of paddy plants. For determination of soil fertility status initially soil samples were collected from Entomological field at the two depth (0 to 15 cm and subsurface 15-30 cm). Available nitrogen was determined by alkaline permagnet methods, phosphorus was determined by Olsen extract method and potash was determined by Flame photometric method for preparation of pots the pots were filled with the soil which was already assessed for fertility gradient, then light sprinkle of water given to pots containing soils. First of all potash was conducted for which fixed amount of phosphorus (P) was thoroughly mixed into the soil and nitrogen (N) was mixed into two split doses into the soil and different amount of potash viz; 0, 40, 100, 160, 220, 280, 340, 400 and 460 kg/ha was provided thoroughly into the soil.

For testing of probing behaviour of BPH different fertilizer application seeds of identified susceptible variety TN1 germinated separately in petridishes. Germinated seeds were sown into wooden trays containing well-puddled soil. After seven days it was transferred into individual pots two days old female was introduced into each test tube and allowed to make punctures on the seedling for 24 hours. Test tubes were plugged with sterilized cotton swab. There after the seedlings were taken for staining in another tube 1.0% erythrosine dye aqueous solution. Insects probing marks were counted visually after 30 minutes of staining (NAITO, 1964).

RESULT AND DISCUSSION

Three replicates were used for each treatment and each treatment were repeated three times. The result obtained due to experiment are as it can be seen from table-1 (D1) that an average probing mark by *N.lugens* was significantly the lowest (4) in the least potash (0 kg/ha) applied pot; while the maximum number of average probe marks i.e., 19 was recorded on the highest potash (460 kg/ha) levels. There was a increasing trend of average probing mark behaviour with the increase in potash level. And it is crystal clear from table-2 that there is straight line positive correlationship could be established between different levels of potash and average probing mark and correlation coefficient worked out was 0.99, the regression equation is like that y = 0.324x+4.9589 and the coefficient of determination was found 0.99.

Influence of different potash levels for the probing behaviour of *N.lugens* on paddy was studied as it is clear from the tables (1-2) that the probes were reducing down in number with decrease in different potash levels. In general there was positive correlationship between these two variables studied. Probably, the reason behind this may be due to variation in different biochemical factors. Which may be ultimately influenced and governed by macro and micronutrient of fertilizer uptake. The application of potash imparts disease resistance; produces strong stiff straw especially in paddy and wheat. Potash also regulates osmoregulation and stomatal movement and actsas food farmer sugar and starch transporter, protein builder and a disease retarder (KATYAYAN, 2004).Therefore, the more number of probes made by *N.lugens* on the plant having higher potash application and vice versa was there with lower potash application inferring that the excess potash level had provided stiff morphological attributes of the host plant.

Table 1: Influence of different potash level on the probing behaviour of *Nilaparvata lugens* on paddy during march-2007 to june-2007.

S.NO.	Treatments Potash (Kg/ha)	Mean probing mark in 24 hours by *N.lugens*				Overall average Probing mark
		D1	D2	D3	D4	
1.	T1-O	3.00	3.00	6.00	7.00	4.75
2.	T2-40	5.00	4.00	7.00	9.00	6.25
3.	T3-100	6.00	7.00	9.00	10.00	8.00
4.	T4-160	10.67	8.00	11.00	13.00	10.67
5.	T5-220	11.00	12.00	12.00	14.00	12.25
6.	T6-280	12.00	13.00	15.00	16.00	14.00
7.	T7-340	13.33	17.00	16.00	17.00	15.83
8.	T8-400	16.00	18.00	19.00	19.00	18.00
9.	T9-460	19.00	19.00	21.00	20.00	19.75
	SEm±	1.17	1.48	1.56	1.80	2.67
	CD (p=0.05)	3.46	4.49	4.65	5.33	7.94

D1 = Planted between 07.03.07 to 18.03.07
D2 = Planted between 21.03.07 to 01.04.07
D3 = Planted between 23.05.07 to 02.06.07
D4 = Planted between 03.06.07 to 14.06.07

Table 2: Association between probing behaviour of *Nilaparvata lugens* and different dose of potash.

S.No.	Different planting dates	Correlation coefficient (r)	Regression equation (Y)	Coefficient of determination (R^2)
1	D1	0.98	-0.0408x+23.071	-0.96
2	D2	0.99	0.0327x+3.0748	0.99
3	D3	0.99	0.372x+2.951	0.98
4	D4	0.99	0.324x+5.6853	0.99
	Overall average	0.99	0.0324x+4.9589	0.99

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SHORT COMMUNICATION

EVALUATION OF NEWER INSECTICIDES AGAINST WHITE BACKED PLANT HOPPER (*SOGATELLA FURCIFERA* HORVATH) OF RICE CROP.

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Abstract: Rice is an important cereals crop of the world which is known to be attacked by large numbers of insect pest during its different development stages, out of this white backed plant hopper *(Sogatella furcifera)* is an important insect pest of rice. Evaluation of newer insecticides combine them with present one and new formulations of older molecules was thrust point of investigation viz. incidence of white backed plant hopper *(Sogatella furcifera)* was found in best reducing form by the application of ethiprole + imidacloprid @ 100g.a.i./ha and alika 247 ZC @ 44 g.a.i./ha were observed as effective insecticide for minimizing the WBPH incidence.

Keywords: *Sogatella furcifera*, cereal crop, insecticide

INTRODUCTION

Rice is the staple food of more than half of humanity in the world and for more than 65 to 70 % of Indian population. It is grown over 44 million hectare in India under diverse ecologies, like upland, lowland, Irrigated, deep water etc. Indian population is increasing @1.5% and it needs to produce over 100 million tons of rice by 2015 and 120 million tons by 2020. This additional production has to come from declining and degrading resources like land and water.

Presently the area under rice cultivation in Chhattisgarh is about 3465820 hectare, which is 26 per cent of the total cultivable land (Total area in Chhattisgarh is 13603361 ha). The total production of rice in the state is 8309916 metric tons with an average productivity of 1323 Kg/ha, which is very low as compared to the national average of 2263 Kg/ha. About 96 percent of total area under rice in the state is concentrated in low and very low productivity groups of the state (Sastri et al., 2006).

Rice crop is infested with a large number of insect pest from sowing to harvesting stage of the crop (Gupta and Verma 2001). About 300 insect species have been reported to attack Rice crop in India. About twenty species of insects have been found to be serious and causing more than 50 percent yield loss (Arora and Dhaliwal, 1996). Among them, sucking pests white backed plant hopper (*S.furcifera*) play's important role in reducing the yield levels in paddy. White backed plant hopper (*sogatella furcifera* Horvath) suck plant sap and weaken the plants.

Development of integrated pest management (IPM) strategies is the most appropriate solution to tackle the pest problems. Target specific and eco-friendly insecticide application is one of the important components of IPM.

Insecticide plays a major role in the production system of rice, in spite of their much highlighted hazardous effect on the environment. They are still relied upon by the rice farmers for better management of different pests. Continuous and consistent use of pesticides leads to the development of resistance among pests and adverse effects on non-target organisms.

To cope with ever challenging insects pest problems in Rice, the farmers needs to have the latest technological knowledge in pest management. Evaluation of newer insecticides, combine them with present one and new formulations of older molecules is an important exercise of Rice entomologist. Therefore, Present study has been conducted.

MATERIAL AND METHOD

The present investigation entitled "Evaluation of newer insecticides against white backed plant hopper (*sogatella furcifera*) of rice crop" was carried out at IGKV Research Farm, Raipur under field condition during Kharif 2006-07. The materials used and techniques adopted for this study is illustrated in this chapter.

Treatment details

Treatment	Common name	Trade name	% a.i. in the Formulation	g a.i/ha Dose	g Or ml of formulation/ha
T1.	Chlorpyriphos	Dursban 10G	10%	1000	10.0 Kg
T2.	Chlorpyriphos	Dursban 10G	10%	1250	12.5 Kg
T3.	Carbofuran (check)	Furadan 3G	3.0%	1000	33.0 Kg
T4.	Ethiprole 40% + Imidacloprid 40%	Bayer	80%	100	125 g
T5.	Neonicotinoid +	ALIKA 247ZC	22%	33	150 ml

	Synthetic pyrethroid				
T6.	Neonicotinoid + Synthetic pyrethroid	ALIKA 247ZC	22%	44	200 ml
T7.	Deltamethrin	Decis 10%EC	10%	15	150 ml
T8.	RIL 043 oxadiazin + synthetic pyrethoid)	-	-	-	400 ml
T9.	Indoxacarb	Kingdoxa 15 SC	14.5%	30	200 ml
T10.	Spinosyn A 50% + Spinosyn D 50%	Spinosad 45%SC	45%	45	100 g
T11.	Spinosyn A 50% + Spinosyn D 50%	Spinosad 45%SC	45%	56	120 g
T12.	Monocrotophos (check)	Monocrown 36 WSC	36%	500	1390 ml
T13.	Phorate 10G	Uthane (UPL)	10%	1000	12.5 Kg
T14.	Untreated control	-	-	-	-

Fertilizer application (N: P: K 80:60:40) Kg/ha

The paddy crop grown for experimental purpose was given nutrition through the chemical fertilizer @ 80:60:40 NPK kg/ha. Full dose of P and K were applied at the time of planting and "N" was applied in three split doses. First dose was given at the time of planting and remaining two doses were applied at the tillering and panicle initiation stage of the crop.

Method of insecticidal treatment application

The required quantity of insecticide for each plot was calculated on the basis of active ingredient and standard doses. Before applications of insecticide per plot insect population were counted for ten random plants in each plot, then the insecticidal treatments were applied to the crop homogeneously.

Time of insecticidal treatment application:

All the insecticidal treatments were applied twice during the crop season. The first application was given as prophylactic treatment at 30 days after transplanting. The second insecticidal treatment application was given at the maximum tillering stage of the crop i.e.50 DAT. The increasing trend of insect infestation was observed at 50 DAT observations.

Sampling technique applied in field experimentation

The observations on occurrence of major insect pests of paddy were recorded in each plots after transplanting. The pre treatment and post treatment observations were recorded at 30 and 50 DAT on ten randomly selected hills from each plot.

White backed plant hoppers

The total count of nymphs and adults of white backed plant hopper (*Sogatella furcifera* Horvath) was recorded separately on ten randomly selected hills from each plot by using kittur's glass book technique. One day before application of insecticides as pre-treatment and after insecticidal application as post treatment observation. The total number of nymphs and adults were recorded per hill basis.

RESULT AND DISCUSSION

This chapter deals with the brief description of results obtained under different objectives of this study. The findings of the present study are compared with the previous findings of the relevant aspects in justified manner to draw a concrete conclusion. The results and discussion are presented here under different sub headings:

Bio-efficacy under field condition

The experiment was laid out in randomized block design with 14 treatments replicated four times to access the bio-efficacy of different insecticide against the major insect pest of paddy. Three granular insecticides viz. Carbofuran and Phorate and seven sprayable insecticides viz. Chlorpyriphos. , Ethiprole + Imidacloprid, Neonicotinoid+Synthetic Pyrethroid, Deltamethrin, Oxadiazin+Synthetic Pyrethroid, Indoxacarb, Spinosyn A 50%+Spinosyn D 50% and Monocrotophos were taken under this study. These treatments were compared with an untreated control. All the treatments were applied twice i.e. at 30 and 50 day after transplanting.

White backed plant hopper (Sogatella furcifera)

Observation on white backed plant hopper (WBPH) incidence were recorded from sampling of ten randomly selected hills of each treatment replications. WBPH incidence were recorded prior and pest application of insecticidal treatment on the basis of per ten hill population. The WBPH population were counted with the help of Kitturs glass book sampling technique. The data of insect count from ten hills are presented form interpretation.

The WBPH incidence was observed at the early stage of crop, it was found escaped at the alter stage. Therefore the data of treatment application impact

were recorded only during the first treatment application. The observations were based on the total WBPH count of ten plant observed with the help of kitturs glass book.

Pre-treatment observations

In pre treatment observation WBPH count varied from 16 to 22 number in different plots which was statistically non-significant. It may be stated that the WBPH incidence were found homogenous during pre-treatment observation.

Post treatment observations

The post treatment observation of WBPH incidence was recorded at ten days after application in the form of per ten plant population. Significant impact of treatment application was observed in this study. The minimum WBPH count was recorded with the treatment ethiprole + imidacloprid @ 100 g a.i/ha followed by alika 247 SC @ 22 g a.i/ ha (1.75). The higher number of WBPH was found under the untreated control treatment (5.75). The application of Phorate 10 G @ 1000 g a.i/ha was found statistically at par with untreated control.

ethiprole + imidacloprid and alika-247 SC were observed as best effective insecticides in minimizing the WBPH incidence. Similar results were also reported by Bhavani and Rao (2005), Seetha Ramu *et al*. (2005) and Shakti (2006). They have also reported ethiprole + imidacloprid as best effective in reducing WBPH population. Panda et.al. (1991) have reported monocrotophos as best effective insecticide for controlling WBPH of rice.

Table 1 : Intensity of Paddy White backed plant hopper population observed Under different insecticidal treatment during Kharif – 2007

Treatment	Formulation g a.i/ha	Mean WBPH population / 10 plants	
		Pre- treatment	Post- treatment
T1: Dursban 10 G	1000	5.00 (2.34)	3.00 (1.86)
T2: Dursban 10 G	1250	5.00 (2.34.)	3.75 (2.06)
T3: Furadan 3 G	1000	4.25 (2.18)	3.00 (1.86)
T4: Ethiprole 40% + Imidacloprid 40%	100	4.75 (2.29.)	1.00 (1.18)
T5: Alika 247 SC	33	4.75 (2.28)	3.00 (1.86)
T6: Alika 247 SC	44	4.50 (2.23)	1.75 (1.49)
T7: Decis 10 EC	15	5.25 (2.39.)	3.00 (1.85)
T8: RIL- 043	400	5.25 (2.39)	2.25 (1.65)
T9: Kingdoxa 14.5 SC	30	4.25 (2.17.)	3.50 (1.99)
T10: Spinosad-45 SC	45	5.00 (2.34.)	3.25 (1.93)
T11: Spinosad-45 SC	56	4.25 (2.29)	2.75 (1.79)
T12: Monocrown 36 WSC	500	5.50 (2.44)	3.50 (1.99)
T13: Phorate 10 G	1000	5.25 (2.37)	3.75 (2.06)
T14: Untreated control	-	4.00 (2.23)	5.75 (2.49)
SE (m) +		0.11	0.10
CD (5%)		NS	0.29

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SHORT COMMUNICATION

EFFECT OF P SOLUBLIZING BACTERIA ON YIELD OF WHEAT AND NUTRIENT AVAILABILITY IN ACID SOIL IN VARANASI REASON

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Abstract : A field experiment was conducted for two rabi crop during season 2009-2010 at Varanasi.To study the effect of application of rack phosphate along with P solublizing microorganism on yield of wheat and nutrient availability in inseptisol. The experiment finding the grain yield was significant increased with rack phosphate application up to 60 kg P_2O_5 ha-^{1} highest yield was recorded with the addition of rack phosphate and P solublizing bacteria in combination of rack phosphate @60 kg P_2O_5 ha-^{1}. A significant increase in organic carban and available NPK was also observed with use of rock phosphate +P solublizing bacteria. The result indicate that yield, maintained the soil health minimizing the cost of P fertilizer.

Keyworld : Rock Phosphate, P use efficiency, wheat, PSM

INTRODUCTION

Wheat is important food crop in India. Wheat grown in rabi season. The fertilizer consumption in this state is very low. NPK ratio is 4.7:2.7:1 low mineralized organic P fixation of P compound with Iron and Aluminum oxide and sorption of P compound with organic compound have resulted in low P use efficiency Singh and Dutta 1987). Acid soils are generally poor in calcium iron and phosphate are precipitated in the form of ferric or aluminum compound. Which are not so easily amendable to solublizing by plant roots by micro organism, introduction of phosphorus solublising bacteria in rhizoshpere of crop by soil increase the availability of P form insoluble source of phosphate, desorption of fixed phosphorus and also increase the efficiency of phosphatic fertilizer (Gour1990).

METHOD AND MATERIAL

Where as the effective CEC (sum of all exchangeable catain) was found to be 10.8 Cmol (P^{+}) kg ha-^{1}with 22.2% Al saturation of EC. The treatments consisted of control 30 kg P_2O_5ha^{-1}, 60 kg P_2O_5ha^{-1} Phosphorus solublizing bacteria (PSB) inoculation 30 kg P_2O_5ha^{-1}+ PSB, 60 kg P_2O_5ha^{-1} +PSB. Lime requirement of soil was observed to be 4.1t ha^{-1} to attain a pH level of 6.4 (Shoemaker *et al* 1981) and it was applied @1.5 t ha^{-1}uniform every year well in advance of sowing of the crop. The peat bound cultures of *pseudomonas striata* (PSB) However seed are treated with PSB by coating of seed before sowing. A uniform dose of N @120kg ha^{-1}in the form of Urea and K @ 40 kg ha^{-1}in the form of K_2O(murate of potash) applied as basal dressing. P used as basal dressing in the form of Rock phosphate (20-40 kg ha^{-1}). All the culture was followed as per schedule.

RESULT AND DISCUSION

Effect of graded dose of Phosphate

The result of table 1 reveals that grain yield was significant increase with the application of graded dose of Rock phosphate up to 60 kgha^{-1} over control the increase was 11.2 and 13.2 over control with the application of 30 and 60 P_2O_5 kg ha^{-1} respectively. Application of Rock phosphate in this acidic soil resulted in effective solublizing of P and influenced higher crop yields of wheat.

Effect of P solublizing Microorganisms.

It evident that inoculation of wheat seed with PSB (*Pseudomonas striata*) showed the significant increase in grain yield over control. it was found that application of rock phosphate @ 60 P_2O_5 kg ha^{-1}and PSB inoculated recorded highest grain yield 55.15q/ha followed 60 P_2O_5 kg ha^{-1}(49.65ha-^{1}) the increase grain yield with the inoculation of P solublizing of microorganism may be due to increase in P availability (Gaur and Sinha 1999) the phosphate micro organism are reported to secrete a number of organic acid which may form chelate with Fe and Al resulting in to effective solublizing of phosphates these result are agree with finding of Subba rao(1999).

Effect of P solublizing micro organism in soil

The result in table 2 that the soil Ph significant in all the treatment over the initial value the increase in Ph might be due to regular liming by CaO for neutralizing the soil acidity. The organic carbon and available N,P and K showed a decreasing trend in control with continues cropping without any added p but the nutrient status improve with the addition of Rock phosphate and inoculation with P solublizing microorganism. It showed that the availability of P status in the soil was increased by 12.3and 14.3 over the initial status due application of rock Phosphate @ 30 P_2O_5 kg ha^{-1} +PSB and 60 P_2O_5 kg ha^{-1} +PSB. This might be due to more solubilizing of Rock Phosphate in acidic range of pH of soil with regular liming trend to a significant in the available nutrient status of soil. Similar finding of Debnath and Mandal (1983) . It is conducted that inoculation of wheat

seed with PSB in combination with optimum dose of Rock phosphate produce higher yield and suitable crop response by increasing the efficient of added P fertilizer and also improve the fertility status of soil.

Table 1: Effect of P solublizing microorganism on grain yield Wheat.

Treatment	Grain yield (q/ha) 2009	2010	Mean	Yield response (%)	Yield response Kg grain kg^{-1} P_2O_5
Control	30.6	39.3	34.95	--	-
30 kg $P_2O_5ha^{-1}$	44.2	45.1	44.65	11.2	15.1
60 kg $P_2O_5ha^{-1}$	49.3	50.0	49.65	13.2	17.2
PSB	39.6	40.2	39.9	10.2	
30 kg $P_2O_5ha^{-1}$+ PSB	48.7	49.2	48.95	14.1	18.3
60 kg $P_2O_5ha^{-1}$+ PSB	55.8	54.3	55.15	15.6	19.1
Mean	44.7	46.38			
S E m ±	0.03	0.04			
CD (P=0.05)	0.11	0.012			

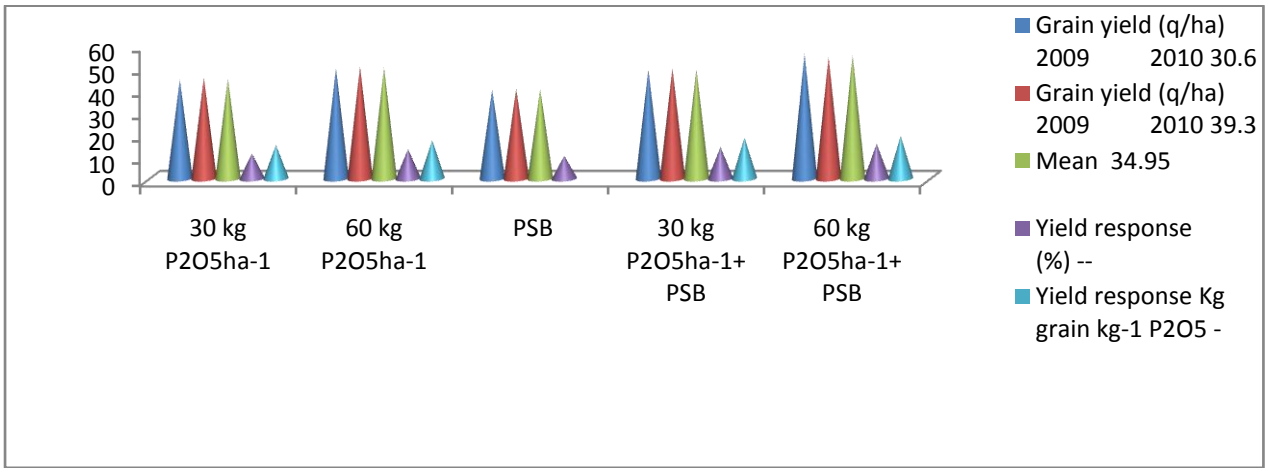

Fig. 1

Table 2: Effect of P solublizing microorganism on soil physical chemical properties after 2010.

Treatment	pH	Organic carbon(g/kg)	Available nutrient kg ha^{-1} N	P	K
Control	5.8	1.05	210	9.4	208
30 kg $P_2O_5ha^{-1}$	6.2	1.11	216	7.6	223
60 kg $P_2O_5ha^{-1}$	6.02	1.16	258	11.0	235
PSB	6.13	1.01	271	10.8	216
30 kg $P_2O_5ha^{-1}$+ PSB	6.15	1.08	270	12.3	234
60 kg $P_2O_5ha^{-1}$+ PSB	6.12	1.07	265	14.3	247
S E m ±	0.02	0.10	2	0.13	2
CD (P=0.05)	0.04	0.21	4	0.41	5

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SHORT COMMUNICATION

EFFECT OF POST EMERGENCE HERBICIDE ON GROWTH AND YIELD OF FINGER MILLET

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Abstract: The experiment comprising 13 weed management practices which comprised single application of different post-emergence herbicides either alone or in combination and hand weeding was conducted on Clayey *Vertisols* soil of College of Agriculture, Raipur during *kharif* season of 20012. *Echinochloa colona* among grasses, *Cyperus iria* among sedges and *Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Hand weeding twice recorded the highest grain yield and net return. This higher yield in Hand weeding twice was reflected in terms of better yield parameter like Number of fingers m^{-2}, finger length, number of fingerlet $finger^{-1}$, grains $finger^{-1}$ and test weight and growth parameter like plant height, dry matter accumulation, Number of tillers. Application of ethoxysulfuron registered the highest B:C ratio which was at par with metsulfuron methyl + chlorimuron ethyl and hand weeding twice.

Keywords: Weed management, Finger millet, herbicide

INTRODUCTION

Finger millet (*Eleusine indica*) is an important small millet crop that is hardy and grows well in dry zones as rain-fed crops. It is used both as medicinal and traditional purposes. Finger millet is a high statue crop with slower initial growth which remains under smothering due to the infestation of weeds at early stages of growth. This situation causes higher competition and may result in drastic reduction in yield (Kushwaha *et al*., 2002). The production and productivity of the country is lower because of weeds pose one of the major constraints in the production of finger millet. Owing to initial slow growth of the finger millet favours weed growth, which cause more competition for sunlight, nutrient and water in early stages of growth lead in lowering productivity (Kumara *et al*., 2007). The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav, 1982). Weeds compete with crop plants for water, nutrients, space and solar radiations by reduction of yield upto 20 to 50 per cent. (Kushwaha *et al*., 2002) and (Singh and Singh, 1984) reported that weeds caused an appreciable reduction in density, dry weight and depletion of nutrients. Manual weed management, which is the most prevalent method for weed management in finger millet, requires a lot of labour. Now a day, due to the scarcity of labours, chemical weed management is considered as better option than the hand weeding. Chemical weed management practices might be an answer to achieve greater weed control efficiency, which in turn, may increase over all benefit of finger millet cultivation. The work on effect of post emergence herbicides in weed management of finger millet is very limited; therefore, keeping these points in view the present investigation was carried out to evaluation of post-emergence herbicides for weed management in direct sown finger millet.

MATERIAL AND METHOD

The present investigation entitled "Evaluation of post-emergence herbicides for weed management in direct sown Finger millet." was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *kharif* season (July-November) 2012. The soil of experimental field was Clayey *(Vertisols)*. The experiment was laid out in randomized block design (RBD) with three replications. There were thirteen treatments of post-emergence herbicides along with two hand weeding and untreated control. The finger millet cultivar "GPU-28" was sown and harvested on 11th July, 2012 and 20th November, 2012 respectively, using seed rate of 10 kg ha^{-1} at 25 cm distance and gaps were maintained by thinning to obtain proper plant population. Sowing was performed by manually and crop was fertilized with 60:40:40 N: P_2O_5:K_2O kg ha^{-1}. Plant protection measures were followed as per recommendation. The treatments were *viz*. T_1- Fenoxaprop-p-ethyl (37.5 g ha^{-1}), T_2- Fenoxaprop-p-ethyl (45.0 g ha^{-1}), T_3- Metsulfuron methyl + Chlorimuron ethyl, T_4- Ethoxysulfuron, T_5 – Cyhalofop-butyl, T_6- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_7- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, T_8- Fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron, T_9- Fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron, T_{10}- Cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl, T_{11}- Cyhalofop-butyl + ethoxysulfuron, T_{12}- Hand weeding twice and T_{13}- Weedy check. The experimental data recorded for growth, yield and economics were statistically analyzed. Plant height and number of tillers $plant^{-1}$ of five tagged plants in each net plot area and Dry matter accumulation (g $plant^{-1}$) was recorded at an interval of 15, 30, 45, 60, 75 and 90 DAS and at harvest. Post harvest observations were recorded from net plot area under each treatment. Five fingers of the tagged plants were harvested separately finger length (cm), total

fingerlets finger^{-1}, grains finger^{-1} was counted. Number of fingers was recorded from one m^{-2} area of each plot. 1000 seeds from the winnowed produce of each plot were counted and same were oven dried till constant weight and then weight was recorded in gram by using an electronic digital balance. Their average was worked out and used for statistical analysis. Grain yield of the net plot was noted after threshing, winnowing and drying, and then calculated in kilogram hectare $^{-1}$ with appropriate multiplication factor. The harvested produce from each net plot was tied in bundles separately. Straw yield of plot was noted down after subtraction of grain yield from bundle weight. Bundle weight was recorded in kilogram hectare^{-1} with the help of spring balance. Harvest index was computed as the ratio of economic yield *i.e.* grain yield ha^{-1} to the total biomass *i.e.* biological yield ha^{-1} (grain and straw) and expressed in per cent, using formula given by Donald (1962),

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological}} \times 100$$

And weed index expressing the reduction in yield due to presence of weeds in comparison with weed free situation. It was expressed in per cent and calculated by using the formula given below as suggested by (Reddy 2007).

$$\text{Weed Index (\%)} = \frac{\text{Seed yield from weed free plot} - \text{Seed yield from treated plot}}{\text{Seed yield from weed free plot}} \times 100$$

RESULT AND DISCUSSION

Weeds

The major weed flora of experimental field consisted of *Echinochloa colona, Phyllanthus urinaria, Eclipta alba, Alternanthera triandra and Cyperus iria* and other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Cyperus rotundus, Euphorbia hirta, Euphorbia geniculata, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum. There was complete control of broad leaf weeds *viz. Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* and sedges *i.e. Cyperus iria* by the application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron, where as grassy weed *i.e. Echinochloa colona* was completely killed by the application of fenoxaprop-p-ethyl. The crop experienced severe weed competition in cyhalofop-butyl followed by fenoxaprop-p-ethyl at both levels which might be due to unfavourable conditions leading to vigorous growth of weeds. Application of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron alone was found most suitable for weed control without any harm to the crop. They completely killed all the broad leaf weeds and sedges. Weedy check recorded the highest density and dry weight by weeds owing to their greater competitive ability than crop plant put under highest biomass of weedy check.

Crops

The maximum plant height of finger millet was recorded under the treatment hand weeding twice which was at par with that of ethoxysulfuron and metsulfuron methyl + chlorimuron ethyl but highest dry matter accumulation was observed in fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron which was at par with that of hand weeding twice, fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron and fenoxaprop-p-ethyl (37.5 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl. Number of tillers of finger millet were maximum with application of fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron which was at par with that of hand weeding twice, fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron, fenoxaprop-p-ethyl (37.5 g ha^{-1}) + metsulfuron methyl + chlorimuron ethyl, cyhalofop-butyl, metsulfuron methyl + chlorimuron ethyl, ethoxysulfuron, weedy check and cyhalofop-butyl + metsulfuron methyl + chlorimuron ethyl. Number of fingers m^{-2}, finger length, number of fingerlet finger^{-1}, grains finger^{-1} and test weight were maximum under the hand weeding. Grain yield of finger millet was significantly influenced by different weed management practices. Hand weeding twice at 20 and 40 DAS proved significantly superior to all other treatments. Prasad *et al.* (1991) recorded that the weeds reduced yield of finger millet by 55-61 per cent and hand weeding twice gave the highest grain yield. Singh and Arya (1999) also noted similar findings. Among different herbicidal weed management practices, ethoxysulfuron recorded the highest grain yield which was at par with metsulfuron methyl + chlorimuron ethyl and significantly better than rest of the treatments including weedy check. Straw yield of finger millet was the highest under hand weeding twice, which was at par with that of metsulfuron methyl + chlorimuron ethyl and ethoxysulfuron and significantly superior over rest of the treatments including weedy check. Harvest index varied significantly due to application of post emergence herbicides either alone or in combination at lower or higher dose. Hand weeding twice gave higher harvest index, which was at par with combined application of fenoxaprop-p-ethyl (37.5 g ha^{-1}) + ethoxysulfuron and fenoxaprop-p-ethyl (45.0 g ha^{-1}) + ethoxysulfuron and significantly superior over rest of the treatments. Weed index (loss of yield due to weeds) was found to be minimum with application of ethoxysulfuron (34.37 %) followed by metsulfuron methyl + chlorimuron ethyl (36.23 %). Weedy check registered 55.40 per cent weed index. The maximum weed index was found with application of fenoxaprop-p-ethyl (93.62 %) at higher level (45.0 g ha^{-1}) followed by cyhalofop-butyl + ethoxysulfuron.

Economics

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

Table 1: Grain yield, Straw yield, Harvest Index and Weed Index of finger millet as influenced by different herbicidal treatments

Treatment	**Dose (g ha^{-1})**	**Grain yield (Kg ha^{-1})**	**Straw yield (Kg ha^{-1})**	**Harvest index (%)**	**Weed index (%)**
T_1 : Fenox		140	1395	9.11	88.47
T_2 : Fenox	45.0	77	637	11.11	93.62
T_3 : MSM+CME	2.0+2.0	771	6155	11.34	36.23
T_4 : Ethox	15.0	794	5479	13.00	34.37
T_5 : Cyhalo	62.5	188	1217	13.39	84.53
T_6 : Fenox+MSM+ CME	37.5+2.0+2.0	191	1427	12.44	84.23
T_7 : Fenox+MSM+ CME	45.0+2.0+2.0	188	1219	13.44	84.52
T_8 : Fenox+Ethox	37.5+15.0	180	966	15.67	85.15
T_9 : Fenox+Ethox	45.0+15.0	165	819	15.56	86.37
T_{10} : Cyhalo+MSM+ CME	62.5+2.0+2.0	163	1328	11.00	86.53
T_{11} : Cyhalo+Ethox	62.5+15.0	119	1276	8.44	90.22
T_{12} : Weed free (HW at 20 and 40		1210	6363	16.00	-
T_{13}: Weedy check		540	3737	12.64	55.40
SEm ±		**21.58**	**310.86**	**0.76**	**-**
CD at 5 %		**63.00**	**907.34**	**2.23**	**-**

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

Table 2: Economics of different post emergence herbicides for weed management in finger millet

Treatments	**Total Cost of Cultivation (Rs ha^{-1})**	**Gross Return**	**Net Return**	**B:C Ratio**
T_1 : Fenox	12028	2863	-9165	0.24
T_2 : Fenox	12162	1551	-10611	0.13
T_3 : MSM+CME	11662	15417	3755	1.32
T_4 : Ethox	11795	15662	3867	1.33
T_5 : Cyhalo	12706	3682	-9023	0.29
T_6 : Fenox+MSM+ CME	12328	3801	-8527	0.31
T_7 : Fenox+MSM+ CME	12462	3689	-8773	0.30
T_8 : Fenox+Ethox	12548	3488	-9060	0.28
T_9 : Fenox+Ethox	12682	3199	-9483	0.25
T_{10} : Cyhalo+MSM+ CME	13006	3260	-9746	0.25
T_{11} : Cyhalo+Ethox	13226	2467	-10759	0.19
T_{12} : Weed free (HW at 20 and 40 DAS)	18370	23377	5007	1.27
T_{13}: Weedy check	11070	10648	-422	0.96
SEm ±		**451.39**	**451.39**	**0.03**
CD at 5 %		**1317.5**	**1317.5**	**0.10**

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

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