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CORRELATION OF BANANA CV GRAND NAINE WITH GROWTH AND YIELD ASPECT

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Abstract: The experiment was laid out in a non replicated trial for metric and non metric variables. A wide range of variation was observed for vegetative growth parameters of banana at various growth periods viz., leaf length (39.42 - 157.52 cm), leaf width (19.17 - 41.09 cm), variation in functional leaf area (0.43 - 6.06 m^2), petiole length (10.28 - 34.61 cm), variation in functional leaf (6.99 - 13.27), height of pseudo stem (19.08 - 198.37 cm), girth of pseudo stem (16.77 - 59.01 cm), PCA (23.41 - 277.55 cm^2), peduncle length (43.67 cm), peduncle width (14.49 cm), male bud size (31.18 cm length and 30.70 cm girth) showed continuously increased during crop cycle of banana and bunch position was slightly angled. The number of days taken from planting to inflorescence emergence (272.4), days taken from inflorescence emergence to harvesting (101.65) and total crop duration (374.05 days) was recorded during crop cycle of banana plant. The yield attributing characters viz. weight of bunch (21.88 kg), hands per bunch (11.43), fruits on 2^{nd} hand (17.80), hand weight per bunch (1827.45 g), fruits per bunch (202.88), length and girth of fruit (17.61 cm and 10.81 cm, respectively), fruit pedicel length (2.25 cm), fruit pedicel width (1.62 cm), fruit weight (102.58 g) and non metric characters like fruit shape was observed curved (sharp curved) and fruit apex was observed blunt tipped. Coefficient of correlation was estimated for 23 characters of banana cv. Grand Naine. Among these fruit yield exhibited strong positive correlation with leaf area at harvesting time (0.459) and shooting time (0.418), pseudo stem girth at shooting time (0.523) followed by 8^{th} and half MAP (0.476) and harvesting time (0.401), PCA at shooting time (0.521) followed by 8^{th} and half MAP (0.469) and harvesting time (0.398), number of functional leaves at harvesting time (0.402) and shooting time (0.382) and yield attributing characters such as fruits per 2^{nd} hand (0.362), hands per bunch (0.611), fruits per bunch (0.693), fruit weight (0.792), hand weight (0.691), plant crop cycle (0.340) and days taken from flowering to harvesting (0.381).

Keywords: Banana, Phenological characters, Correlation, Yield

INTRODUCTION

Banana (*Musa paradisiaca* L.) is a herbaceous, perennial, monocotyledonous and monocarpic crop belonging to the family Musaceae. It is known as “Apple of Paradise”. Its origin is tropical region of South – East Asia. Banana has nutritional, medicinal and industrial value. Owing to its multifaceted uses, it is referred as Kalpatharu (a plant of virtues). Banana is one of the most important tropical fruit crops of the world and many consider banana as one of man’s first food (Manoj *et al.,* 2014).

India is the largest banana growing country in the world. Among the fruits, banana holds first position in production and productivity in India. Banana is grown all over India and is available round the year. However, Tamil-Nadu, Maharashtra, Gujarat, Andhra Pradesh and Karnataka have ideal conditions for its growth and production. In India, it is cultivated on an estimated area of 770 thousand ha, with an annual production of 26,470 thousand MT and productivity of 34.4 MT/ha (Anonymous, 2010a). In Gujarat, it is cultivated on an estimated area of 61.9 thousand ha, with production of about 3779.6 thousand MT and productivity of 61 MT/ha (Anonymous, 2010b). It is one of the most important fruit crops of middle and south Gujarat regions. The farmers prefer its cultivation because of its high demand as a fresh fruit in the market.

Banana plant produces the parthenocarpic fruit of commercial importance is propagated vegetatively from underground storage organ rhizome and surface level is the meristematic region which gives rise to the leaves, and finally to the inflorescence which produces the fruit. The leaves emerge in sequence with each rolled leaf pushing throughout the centre of an increasingly greater number of over lapping leaf sheath base which constitute a pseudo stem. There is a marked polymorphism of the leaves exhibited by the rapid change in dimension of succeeding leaves; they are one of the largest photosynthetic units in the plant kingdom. The pseudo stem produces flowers only once and is cut off after fruiting .The fruits are called fingers, which are borne in hands. The Grand Naine Bananas (also spelled Grande Naine) literally translates from French meaning "Large Dwarf." It is a cultivar of the well known Cavendish bananas. This group of bananas is distinguished from other groups by it AAA genotype. The AAA genotype refers to the fact that this group is a triploid variant of the species *M. acuminata*. There are 33 chromosomes present in the AAA cultivar and all produce seedless fruits through parthenocarpy (Ploetz, 2007).

The Grand Naine has become one of the most popular varieties for commercial plantations. Its characteristic medium height and large fruit yields make it ideal for commercial agriculture. The moderate height allows easy harvesting and some resistance to wind throw (plants breaking due to strong winds). Plantations growing Grand Naine range from the tropical regions of Central America,

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Africa, India, and Southeast Asia. In many tropical communities, entire local economies are based upon banana production and export. Because of its importance as a staple crop as well as a cash crop, much botanical research has focused around the Grand Naine (Anonymous, 2007). There is no authentic information available on morphological, phenological and yield attributing variations required for an ideal production by a banana plant under South Gujarat Agro Climatic conditions, so the investigation was undertaken on banana cv. Grand Naine to describe various phenological characters and to work out correlation of different characters with yield. Therefore, the present study was undertaken to evaluate effect of various growing medias on mango cultivars in regard with their growth parameters.

MATERIAL AND METHOD

An experiment was conducted at Block "C" of N. M. College of Agriculture, Navsari Agricultural University, Navsari entitled "Correlation of banana cv. Grand Naine with growth and yield aspect" during the year 2011-12. The studies consisted of 150 plants of banana cv. Grand Naine for various parameters and their correlation with yield. The experiment was laid out in a non replicated trial for metric and non metric variables. Observation period was as mentioned below. P_1- 2nd MAP of banana, P_2-2nd and half MAP of banana, P_3-3rd MAP of banana, P_4-3rd and half MAP of banana, P_5-4th MAP of banana, P_6-4th and half MAP of banana, P_7-5th MAP of banana, P_8-5th and half MAP of banana, P_9-6th MAP of banana, P_{10}-6th and half MAP of banana, P_{11}-7th MAP of banana, P_{12}-7th and half MAP of banana, P_{13}-8th MAP of banana, P_{14}-8th and half MAP of banana, P_{15}- At the shooting time of banana, and P_{16}- At the harvesting time of banana.

A wide range of variation was observed for vegetative growth parameters of banana at various growth periods viz., leaf length leaf width, variation in functional leaf area, petiole length, variation in functional leaf, height of pseudo stem, girth of pseudo stem, PCA, peduncle length, peduncle width, male bud size showed continuously increased during crop cycle of banana and bunch position was slightly angled. The number of days taken from planting to inflorescence emergence, days taken from inflorescence emergence to harvesting and total crop duration was recorded during crop cycle of banana plant. The yield attributing characters viz. weight of bunch, hands per bunch, fruits on 2nd hand, hand weight per bunch, fruits per bunch, length and girth of fruit, fruit pedicel length, fruit pedicel width, fruit weight and non metric characters like fruit shape was observed curved (sharp curved) and fruit apex was observed blunt tipped.

RESULT AND DISCUSSION

Growth characters and their correlation with yield:

The variation in vegetative characters among plants of banana cv. Grand Naine differed considerably with respect to growth characters like leaf characters, pseudo stem characters, inflorescence or male bud *etc.*

The among different plants of banana cv. Grand Naine, leaf length (39.42-157.52 cm), leaf width (19.17-41.09 cm), variation in functional leaf area (0.43-6.06 m^2), petiole length (10.28-34.61 cm), variation in functional leaf (6.99-13.27), height of pseudo stem (19.08-198.37 cm), girth of pseudo stem (16.77-59.01 cm), PCA (23.41-277.55 cm^2), peduncle length (43.67 cm), peduncle width (14.49 cm), male bud size (31.18 cm length and 30.70 cm girth) was continuously increased during crop cycle of banana plant (Table 4.1).

Table 1. Leaf characters and Pseudo stem characters during crop cycle of banana cv. Grand Naine.

	Leaf characters					Pseudo stem characters		
Time	**Leaf length(cm)**	**Leaf width(cm)**	**Leaf area/ plant(m^2)**	**Petiole length(cm)**	**No. of functional leaves**	**Pseudo stem height (cm)**	**Pseudo stem girth (cm)**	**PCA (cm^2)**
P1	39.42	19.17	0.43	10.28	6.99	19.08	16.77	23.41
P2	53.64	21.74	0.82	12.34	8.61	29.22	18.50	27.78
P3	62.18	24.31	1.26	14.56	10.23	38.57	19.13	29.97
P4	76.40	25.96	1.71	16.60	10.74	53.94	22.33	40.87
P5	84.93	27.59	2.27	18.43	11.95	62.74	25.85	54.09
P6	96.31	29.46	2.86	19.90	12.42	83.31	34.52	96.75
P7	105.04	31.10	3.29	20.90	12.47	91.45	35.09	99.02
P8	113.42	32.07	3.67	22.77	12.53	98.91	35.66	102.70
P9	122.50	33.72	4.41	24.60	13.27	109.06	41.21	137.02
P10	127.61	34.71	4.53	26.36	12.64	121.44	42.96	149.75
P11	131.25	35.96	5.03	28.14	13.24	130.08	46.32	173.36
P12	138.06	37.26	5.23	29.77	12.66	141.37	50.90	208.87
P13	142.00	38.07	5.46	31.38	12.59	169.78	51.50	211.90

P14	152.52	39.99	6.06	33.56	12.42	187.83	54.28	234.99
P15	155.79	40.65	5.93	34.06	11.70	191.83	55.40	244.89
P16	157.52	41.09	4.81	34.61	9.27	198.37	59.01	277.55

Such differential response may probably be due to continuous increasing age of the banana plant however less functional leaf area were observed at shooting and harvesting time this might be due to less number of functional leaf during growth period. Similar finding has also been reported by Uma *et al.* (2000); Mandal and Sharma (2001); Rajamanickam and Rajmohan (2005); Panday *et al.* (2005); Rajamanickam *et al.* (2007); Kumar *et al.* (2008) and Rajmanickam and Rajmohan (2010).

Table 2. Correlation coefficient (r) of Leaf characters and Pseudo stem characters during crop cycle of banana cv. Grand Naine.

	Leaf characters					**Pseudo stem characters**		
Time	**Leaf length (cm)**	**Leaf width (cm)**	**Leaf area per plant (m^2)**	**Petiole length (cm)**	**No. of functional leaves**	**Pseudo stem height (cm)**	**Pseudo stem girth (cm)**	**PCA (cm^2)**
P1	0.040	0.122	0.084	-0.053	0.037	0.058	0.057	0.062
P2	0.019	0.134	0.112	-0.054	0.111	0.095	0.151	0.152
P3	0.020	0.067	0.140	-0.057	0.182	0.084	0.139	0.151
P4	0.045	0.150	0.069	-0.054	-0.034	0.031	0.027	0.035
P5	0.038	0.006	0.044	-0.054	0.035	0.086	0.131	0.123
P6	0.051	0.034	0.151	-0.055	0.208	0.104	0.033	0.032
P7	0.004	0.066	0.084	-0.054	0.105	0.147	0.069	0.061
P8	0.048	0.148	0.051	-0.052	-0.058	0.140	0.151	0.144
P9	0.104	0.129	0.156	-0.048	0.072	0.155	0.008	0.027
P10	0.169	0.152	0.154	-0.043	0.065	0.174	0.174	0.175
P11	0.136	0.168	0.144	-0.032	0.028	0.155	0.175	0.178
P12	0.137	0.166	0.184	-0.008	0.085	0.193	0.216	0.220
P13	0.132	0.165	0.142	0.044	0.044	0.165	0.055	0.061
P14	0.073	0.084	0.144	0.076	0.108	0.190	0.476	0.469
P15	0.173	0.202	0.418	0.066	0.382	0.219	0.523	0.522
P16	0.192	0.249	0.459	0.061	0.402	0.209	0.401	0.398

Note: Correlation coefficient (r) At 2 Tail, (0.05%) r = +/- 0.160

It is also evident that among different plants of banana cv. Grand Naine, banana fruit yield showed significantly positive correlation with growth characters (Tables 4.2) viz., leaf length at harvesting time (0.192) and shooting time (0.173), leaf width at harvesting time (0.248) and shooting time (0.202), leaf area at harvesting time (0.459) and shooting time (0.418), pseudo stem height at shooting time (0.219) and harvesting time (0.208), pseudo stem girth at shooting time (0.523) followed by 8th and half MAP (0.476) and harvesting time (0.401), PCA at shooting time (0.521) followed by 8th and half MAP (0.469) and harvesting time (0.398), number of functional leaves at harvesting time (0.402) and shooting time (0.382), peduncle length (0.221) whereas it was non significant with petiole length (0.076) and male bud girth (0.029) but negatively correlated with peduncle width (-0.143) and male bud length (-0.058) as presented (Table 4.3). The increase in yield might be due to more area of functional leaf, which synthesized and accumulate more photosynthetic matters. Several variations have been observed in the plant when a single cultivar is planted on a commercial scale which is mainly due to differences in root characters leading to nutrient uptake. The results are in accordance with the finding of Patil *et al.* (2010), Patil *et al.* (2010) and Kumar and Panday (2010).

Table 3. Inflorescence or male bud of banana cv. Grand Naine.

Inflorescence or male bud	**Unit (cm)**	**Correlation coefficient (r) At 2 Tail, (0.05%) r = +/- 0.160**
Peduncle length (cm)	43.68	0.221
Peduncle width (cm)	14.50	-0.143
Male bud length (cm)	31.18	-0.058
Male bud girth (cm)	30.70	0.029

Crop duration and their correlation with yield

The number of days from planting to inflorescence emergence (272.4), days taken from inflorescence emergence to harvesting (101.65) and total crop duration (374.05 days) were recorded during crop cycle of banana plant (Table 4.4). The present results confirmed the report of Sirisena and Senanayake (2002); Badgujar *et al.* (2004); Rajamanickam and Rajmohan (2005); Panday *et al.* (2005); Rajamanickam *et al.* (2007); Uazire *et al.* (2008); Kavitha *et al.* (2009); Hazarika and Ansari (2010); Rajmanickam and Rajmohan (2010) and Patel *et al.* (2011). It is evident from the data presented in tables, banana fruit yield showed significantly positive correlation with days taken from inflorescence emergence to harvesting (0.381) and plant crop cycle (0.340) while it was non significant with days taken to shooting (0.120). This might be due to more time available for accumulation of reserved in the bunch. Similar findings are reported earlier by Rajamanickam and Rajmohan (2008).

Table 4. Crop duration (days) and Correlation coefficient (r) of plant crop cycle with yield of banana cv. Grand Naine.

Parameters	Crop duration (days)	Correlation coefficient (r) At 2 Tail, (0.05%) r = +/- 0.160
Days to shooting (days)	272.40	0.120
Flower emergence to harvesting (days)	101.66	0.382
Plant crop cycle (days)	374.06	0.341

Yield and yield attributing characters and their correlation with yield

The yield attributing characters viz., weight of bunch (21.88 kg), number of hands per bunch (11.43), number of fruit on 2nd hand (17.80), hand weight per bunch (1827.45 g), number of fruits per bunch (202.88), length and girth of fruit (17.61 cm and 10.81 cm, respectively), fruit pedicel length (2.25 cm), fruit pedicel width (1.62 cm) and fruit weight (102.58 g) of banana cv. Grand Naine (Tables 4.5). The results are coincided with the finding of Sirisena and Senanayake (2002); Dens *et al.* (2002); Weerasinghe and Ruwanpathirana (2004); Nainwad *et al.* (2005); Rajamanickam *et al.* (2007); Ebeed *et al.* (2008); Rajamanickam and Rajmohan (2008); Kavitha *et al.* (2009); Khalequzzaman *et al.* (2009); Baiyeri *et al.* (2010); Rajmanickam and Rajmohan (2010) and Patel *et al.* (2011).

Table 5. Yield attributing characters and Correlation coefficient (r) with yield of banana cv. Grand Naine.

Parameters	Yield	Correlation coefficient (r) At 2 Tail, (0.05%) r = +/- 0.160
Bunch weight (kg)	21.88	0.362
Fruits on 2nd hand	17.81	0.612
Hands/bunch	11.43	0.694
Fruits/bunch	202.89	0.068
Fruit length (cm)	17.62	0.232
Fruit diameter (cm)	10.81	-0.007
Fruit pedicel length (cm)	2.25	0.029
Fruit pedicel width (cm)	1.62	0.792
Fruit weight (g)	102.59	0.691
Hand weight (g)	1827.46	0.362

The banana fruit yield showed significantly positive correlation with number of hands per bunch (0.6112), number of fruits on 2nd hand (0.362), hand weight per bunch (0.691), number of fruits per bunch (0.693), fruit diameter (0.232), fruit weight (0.792) while it was non significant with fruit length (0.06821) and fruit pedicel width (0.0292) (Table 4.5). However fruit yield showed negatively correlated with fruit pedicel length (-0.0070) of banana cv. Grand Naine therefore, for high fruit yield in banana improvement, selection can be based on number of hands per bunch, number of fruits on 2nd hand, hand weight per bunch, number of fruits per bunch, fruit diameter and fruit weight. The results are coincided with that of George (2005); Rajamanickam and Rajmohan (2008) and Patil *et al.* (2010).

CONCLUSION

The present investigation concluded that all the vegetative parameters were significantly increased with crop cycle of banana plant except functional leaf area and number of functional leaf and also studies on correlation coefficient analysis were conducted on the "Grand Naine" variety of banana to identify the major factors contributing to yield. Fruit yield exhibited strong positive correlation with leaf area, pseudo stem girth, PCA, number of functional leaves and yield attributing characters such as fruits per 2nd hand, hands per bunch, fruits per bunch, fruit weight, hand weight, plant crop cycle and days taken from flowering to harvesting apart from this yield attributes recorded at harvest can also be used for predicting fruit yield though it is late. However, the yield attributes recorded at harvesting are going to remain to same even 3 to 4 month prior to harvesting (complete emergence of bunch). Banana fruit can be predicted precisely well in advance using leaf area, pseudo stem girth, PCA, number of functional leaves and yield attributing characters such as fruits per 2nd hand, hands per bunch, fruits per bunch, fruit weight, hand weight, plant crop cycle and days taken from flowering to harvesting. This will help the farmers in planning the sound marketing strategy.

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POOR MAN'S FRUIT: A COMPREHENSIVE REVIEW ON JACK

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Abstract: Jack is a fruit yielding tree species found in tropical, sub-tropical and humid areas of India. However, as an underutilized crop, jackfruit has escaped attention from intensive production and proper marketing. The efforts were taken to synthesize the detailed information on distribution and diversity, management practices, intercropping, jack production, medicinal and culinary uses, marketing and value addition techniques. This paper also stresses on intensive jack production and promote for wide uses. However, species should be treated as candidate fruit crop.

Keywords: Jack, Intercropping, Production, Phyto-chemistry; Marketing channel

INTRODUCTION

The genus Artocarpus belongs to the family Moraceae and is distributed across India. There are 18 artocarpus species found in India (Ahmedullah and Nayar, 1986). However, the name *Artocarpus* is derived from the Greek words *artos* (bread) and *carpos* (fruit) (Bailey, 1942). The jackfruit is also called jack, an English adaptations of the Portuguese jaca (Popenoe, 1974). The common name of "jackfruit" used by the physician and naturalist Garcia de Orta in his 1563 book Colóquios dos simples e drogas da India (Anon, 2000). In Hindi called Kathal, Malayalam Chakke, Kannada Halasu, Malayalam Chakke, Marati Phanas. It is native to South and Southeast Asia. Originated in the southwestern rain forests of India (Yule, 1863). Artocarpus is one of the major keystone species in Western Ghats (Nayar, 1996; Isaac and Nair, 2005). Due to increasing importance of domestic use the genus has been introduced to other parts of the tropics in Caribbean, Central and South America, Africa (Ragone, 1997). The genus is receiving increasing importance for agroforestry, plantation forestry and afforestration programmes due to wide range of utilities like fruits and timbers, ayurvedic, culinary uses, etc. However, very limited studies are available in jackfruit, production, marketing and value addition (Chowdhury *et al.*, 2012; Sharma *et al.*, 2013). Still, Due to great diversity of clones in Western Ghats of India may call the home of jack; this offers large scope for studying the variability and improvement of this crop by clonal selection (Guruprasad, 1981; Samaddar, 1985). Langford (2014) also reported that jackfruit could be a replacement of wheat, corn and other staple crops which are threatened by global warming and unpredictable rainfall.

Habitat

The trees can be grown under varying habitat condition. Young trees require some shade, but mature tree grow in full sunlight. The mean annual temperature for its growth varies between 19 to 29^{O}C and rainfall between 1000 to 2400 mm. p^{H} of the soil should be 4.3 to 8. However, jack is intolerant to frost and susceptible to prolonged drought (Duke, 1989). It is commonly grown in polycultures systems in homesteads, road side plantations and hilly tracts (Elevitch and Manner, 2006). Stem is straight rough while bark is green or black, about 1.25 cm thick, exuding milky latex. The leaves broad obovate, elliptic, decurrent, glabrous, entire inflorescence solitary axillaries, cauliflorous and ramflours on short leafy shoots (Prakash *et al.*, 2009). Male head is sessile or on short peduncles receptacles. Female head is oblong ovoid receptacle, syncarpus, cylindrics (Rowe-Dutton, 1985). The trees are monoecious producing enormous multiple fruits (Jagadeesh *et al.*, 2006; Jarrett, 1959). Pollinated by wind, insect and is generally require cross-pollination for satisfactory fruit production. It grows best in deep alluvial soil (Haq, 2006). Fruit bearing season varies between April to August. Establishment of jack requires good planting stock and proper management.

Distribution and diversity

The tree attains height of about 45 m and girth up to 4.5 m. Distributed at an altitude of 1600 m above Mean Sea Level. Though, wide range of genetic and morphological variation has been reported in jack (Azad *et al.*, 2007; IPGRI, 2000; Jagadeesh *et al.*, 2006) nonetheless attention must for proper documentation of genetic diversity of indigenous jack (Shyamalamma *et al.*, 2008; Ullah and Haque, 2008). Several varieties are already been propagated across the country viz., Gulabi, Champa, Hazaric, Rudrakshi, Ceylon jack, etc. Jagadeesh *et al.*, (2013) studied the jackfruit diversity in Western Ghats of India and they reported jack as treasure house of wide diversity. Coastal belts of Karnataka found to have two famous varieties called bakke and imba. APAARI (2012) report stressed that a few selections, namely, NJT1, NJT2, NJT3 and NJT4 produce large fruits and excellent quality of pulp for table purpose,

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while types like NJC1, NHC2, NJC3 and NJC4 were found better for culinary purpose. Varietal improvement in jackfruit is so far limited to selection of high yielding, better quality genotypes. Srinivasan, (1970) described a variety called Muttam Varikka which produced fruit of 7 kg each. Varikka, Koozha, Navarikka types jackfruit strains are available in Kerala, Tamil Nadu, Karnataka with maximum diversity in Wayanad Plateau (NBPGR, 1978). In south India called Rudrakshi it comes fairly true to type when grown from seed, but its fruit is smaller and of poor quality (Ray, 2002). Aligiapillai *et al.*, (1996) selected a clone "PPI-1". It is "Kazhukupala" type, high yielding and comes to first fruiting in 5 years. Ray (2002) described 12 genotypes and reported KJF 3 as the highest yielding (60 fruits/tree) and sweetest fruit. Biotechnological approaches like hybridization, organelle transfer, genetic transformation, protoplast fusion, anther culture and embryo culture should employ to produce both intra and inter specific hybrids. However, some tissue culture techniques have been developed for faster multiplication of improved genotypes using nodal segments (Roy *et al.*, 1990).

Management practice

Jack a multipurpose fruit tree found in all locations might provide the basis for nutritional strength and food security in India. However, after care and management are ut-most important. Jackfruit may be propagated by seed, grafting and cuttings (Jonathan *et al.*, 2013).The vegetative propagation is most successful. Soft wood grafting on 2 months old seedlings with scion of 3-4 months old provide good results (70 -80%) (Abd El-Zaher, 2008). The viability of seeds are very low and should be sown immediately after extraction to raise root stocks (Priya Devi, 2014). Haripriya, (2014) recommended 8 m x 8 m spacings for grafted trees and 10 m x 10 m to 12 m x 12 m for those raised from seeds. Application of farmyard manure at 10 kg per plant in first year, 0.15:0.08:0.1 kg of N:P:K per plant per year in the first year and in the sixth year an increased dose of 0.75:0.4:0.5 kg of N:P:K per plant per year found to increase growth, flowering and fruiting in jack (Hasan, 2008; Haripriya, 2014). The commonly found pests are shoot and fruit borer (*Deaphania caesalis*) and brown bud weevil (*Ochyromera artocarpi*). The soft rot or fruit rot (*Rhizopus artocarpi*) is an important disease. However, integrated pest and disease management with proper mechanical, chemical and biological practices are necessary (Chandurkar, 2003). Haq (1995) reported that important features of jack is "ideotype" that are easy to manage and require less pruning for fruit production. The advantage of long straight trunks help for crop diversification and agroforestry practices.

Jack based agri-horti-silvi systems

Jack has been managed under different agroforestry practices across the India. It is intercropped with mango and citrus in Uttar Pradesh (Singh *et al.*, 2011). In young orchards of jack has been intercropped with annual cash crops such as banana, sweet corn, groundnut, peas, etc. in Chhattisgarh (Magcale-Macandog, 2010). Other studies also reported that bamboo+jackfruit+maize+pineapple is best intercropping practice in Tripura (Kanfade, 2014) and jackfrut+rubber+cashew nut+mangosteen system in Kerala (Joshi *et al.*, 2006; John, 2014). Nair and Sreedharan (1986) reported that four-tier structure is common in southern states. However, intensive land-use practices of jack in homestead farming were increasingly popular among majority of the marginal farmers (John, 2014). The agricultural universities and other research institutes already undertaken proper investigations on agroforestry based value chain systems of jackfruit in rural areas for upliftment of poor farmers. However, intensive studies further required for better tree-crop combination for jack based system.

Medicinal importance

The Artocarpus species have been used by traditional folk medicine in India. It is having immense medicinal value and is considered a rich source of carbohydrates, minerals, carboxylic acids, dietary fiber and vitamins such as ascorbic acid and thiamine (Lin *et al.*, 2000). Manganese and magnesium (Barua and Boruah, 2004), potassium, calcium and iron (Goldenberg, 2014) elements are found in seed. Seeds contain two lectins namely jacalin and artocarpin (Theivasanthi and Alagar, 2011). Jacalin has been proved to be useful for the evaluation of the immune status of patients infected with human immunodeficiency virus (Haq, 2006). Seed nanoparticles were effective against *Escherichia coli* and *Bacillus megaterium* bacteria (Theivasanthi *et al.*, 2011). It also have antioxidant activity (Biworo, 2015). Act against inflammation, malarial fever and skin disease (Khan *et al.*, 2003), anti-bacterial and anti-helmintics (Soeksmanto *et al.*, 2007). Jack leaves commonly used as healing for ulcer. Its leaves have the potential of curing diabetecs due to the presence of hypoglycemic and hypolipidemic substances (Prakash *et al.*, 2009). The leaves and stem also have sapogenins, cycloartenone, cycloartenol, β-sitosterol and tannins (Sathyavathi *et al.*, 1987). The latex yield artosteron mixed with vinegar promotes healing of glandular swelling and snake bites (Devaraj *et al.*, 1985 and Mukhergee, 1993). Root extract is remedy for skin disorder and asthma (Ferrao, 1999). The wood has sedative property and believed that it may cause promotion of abortion (Morton, 1965), cure diarrhea and fever (Samaddar, 1985). Fruits and roots used for tapeworm infection (Patil *et al.*, 2002; Su *et al.*, 2002; Khan *et al.*, 2003).

Jack Production

The NTFPs of jack mainly come from wild-harvest as well as from cultivated sources. In Asia-pacific, India is the largest producer followed by Bangladesh and Thailand. Technological development and intensification of jack based production is most important due to ever increasing demand-supply gap. Jack provide wide array of fruit sources. However, as an underutilized crop, jackfruit has escaped attention from intensive production. Jack distribution in India is estimated to be 102,000 ha. with annual production of 1436000 tonnes and productivity of 11.42 t/ha (Haq, (2006); Ghosh, (1996) and AEC, (2003)). Jackfruit (*Artocarpus heterophyllus* Lam.) about 50-80 tons can be harvested from a hectare of land. However, because of large production and widely used by economically weaker sections. It is popularly known as poor man's fruit of India (APAARI, 2012).

Culinary uses and value addition

The jack is a multi-purpose species provide food, timber, fuel, fodder, medicinal and industrial products. Both immature and mature fruits are used (APAARI, 2012). The fruit contains free sugar (sucrose), fatty acids, ellagic acid and amino acids like arginine, cystine, histidine, leucine, lysine, metheonine, theonine, tryptophan etc. (Pavanasasivam and Sultanbawa, 1973; Swami *et al.*, 2012). Seeds are rich with starch (Singh *et al.*, 1991). Amit and Ambarish (2010) reported that the maximum alcohol content in jack wine was 10% (v/v), with 14% of total sugar solids. However, due to large scale availability, number of recipes has been prepared in India. Swami *et al.*, (2012) reported that the various products developed from jackfruit in Karnataka are candy, finger chips, fruit bars, fruit leather, halvah, papad, ready-to- serve beverages, toffee and milk-based srikhand, ice cream and Kulfi. Haridoss (2009) also prepared recipes like chips, sambar, and kadabu that are useful Malenadu recipes during the jackfruit season. College of Forestry, Sirsi was conducted training under RKVY project and was prepared value added products like jack juice and syrup. Jack also used as cooking delicacies like idlis and vada (Holst, 2011). A Jackfruit seminar organized by BSKKV, Dapoli Maharashtra and demonstrated a production of value added jackfruit drink, named as 'Mondys'. UAS Bangalore was organized an International Jackfruit Conference and provided wide array of information on jack cultivation, management and post-harvest management techniques.

Phyto-chemical constituents

The heartwood of jack contain varying constituents of moisture (6.7%), glucosides (38.0%), lipids (0.7%), protein (1.7%) and cellulose (59.0 %) (Perkin and Cope 1895). Flakes of ripe fruits are rich with nutritive value; every 100 g of ripe flakes contains 287-323 mg potassium, 30.0-73.2 mg calcium and 11-19 g carbohydrates (Elevitch and Manner, 2006). Bark from main trunk contains betullic acid and a flavone pigment, cycloheterophyllin ($C_{30}H_{30}O_7$) (Chawdhary and Raman, 1997). Lycopene also found in jackfruit pulp (Setiawan *et al.*, 2001). There are 18 carotenoids were successfully separated, identified and quantified and 14 were detected in jackfruit (De Faria *et al.*, 2009). The leaves and stem show the presence of sapogenins, cycloartenone, cycloartenol, β-sitosterol and tannins show estrogenic activity. A root contains β-sitosterol, ursolic acid, Betulinic acid and cycloartenone (Dayal and Seshadri, 1974). Jack seed flour contains a thin brown spermoderm, the crude fiber (2.36 %) (Singh *et al.* (1991; Swami *et al.*, 2012). However, the composition of flour depends on nature of seed.

Marketing

India is producing large varieties of fruits accounting 10 per cent of world total fruit production with an annual production of 50 million tonnes (Singh *et al.*, 2006). However, data on production and export of jack not yet been documented properly. Although its wide range of uses and high nutritive value (MART, 2007), very little is known about marketing of jackfruit. For proper marketing of jack there should be an urgent policy regulations to de-regulate (UNESCAP, 2007) the wholesale principles of third party interference. However, in access to this the government has to provide channels for direct farmer-consumer contact system. For proper marking of jack requires thorough understanding of jack marketing and value addition. However, the role of women's in production and marketing of jack is crucial. The overlooked (women's) peoples of the society should be merged. It is essential for technological transfer of knowledge and skills on jack fruit value addition and bringing jack enterprise to the farm women's and Self Help Groups. In addition there should also be a jackfruit policy proposal for production, value addition and market channel so that poor farmers can avail the production benefits.

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ESTIMATION OF HETEROSIS FOR QUANTITATIVE AND QUALITY TRAITS IN QUALITY HYBRIDS RICE (*ORYZA SATIVA* L.)

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Abstract: The heterosis study on quantitative and quality traits in quality hybrids rice from line x tester analysis from 24 F_1 hybrids derived from 3 female and 8 male lines. The observations were recorded on 28 quantitative and quality traits. Analysis of variance revealed that all the treatments exhibited highly significant variation for almost all the traits under study. The highest heterotic effects observed for mid parents, better parent and standard heterosis were 233.33%, 97.50% and 60.14% for grain yield per plant noted for the crosses IR 58025A/R1679-1674-1-234-1. Maximum heterosis over mid parents of 313.25%, 33.67%, 26.98% and 100.15% for productive tillers per plant, panicle length, spikelet fertility percentage and harvest index and maximum heterobeltiosis of 163.64%, 29.18%, 24.54% and 43.35% for productive tillers per plant, panicle length, spikelet fertility percentage and harvest index and maximum standard heterosis of 218.68%, 21.10%, 5.89% and 49.09% for productive tillers per plant, panicle length, spikelet fertility percentage and harvest index was found in IR 58025A/R1679-1674-1-234-1.

Keywords: Heterosis, Traint, Hybrids, Rice

INTRODUCTION

Rice is life and princes among cereals. More than half of the world's population depends on rice for calories and proteins, especially in developing countries. Exploitation of hybrids vigour is one of the possible ways for increasing production and productivity to meet the demand of population for food and raw materials. Hybrids rice breeding holds promise to make a backthrough in rice production. Hybrid rice technology exploits the phenomenon of heterosis and involves raising a commercial crop from F_1 seeds. This technology enabled chine to increase rice production from 140 million tones in 1978 to 188 million tones in 1990 (Virmani, 1990). The exploitation of heterosis is considered an outstanding application of the principles of the science of genetics in agriculture. Heterosis breeding had led to a breakthrough in yield in several crop plants. For the exploitation of heterosis, it is imperative to study the magnitude of heterosis. The expression of heterosis is greatly influenced by the magnitude of genetic differences among parents involved in the crosses. The parents with optimal to intermediate genetic diversity will show maximum heterosis (Moll and Stuber, 1974). Varying levels of heterosis in grain yield and yield components have been reported by several workers in rice.

MATERIAL AND METHOD

The material for the present study comprised 24 F_1 of rice generated involving 3 lines (*viz.*, PUSA 6A, CRMS 32A, IR 58025A) and 8 diverse rice varieties (*viz.*, R1607-673-2-322-1, R1679-1674-1-234-1, R1519-815-1-646-1, R1551-1066-1-449-1, R1630-342-1-47-1, R1665-1620-1-985-1, RNR2354 and Improved pusa basmati) as testers through Line x Tester design during *Kharif* 2011-2012. The resultant 24 F_1 were grown in completely randomized block design at the Research Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG). Each genotype was grown in two replication with spacing 20 x 15 cm, respectively. Recommended agronomic package and practices were followed to raise a good crop. In each entry, five plants were selected randomly from each replication and biometrical observations were recorded for days to 50% flowering, plant height, productive tillers per plant, panicle length, number of filled grains per panicle, number of unfilled grains per panicle, spikelet fertility (%), spikelet sterility (%), grain yield per plant (g), seed index/hundred seed weight (g), biological yield per plant (g), harvest index (%), hulling (%), milling (%), head rice recovery (%), paddy length (mm), paddy breadth (mm), paddy L/B ratio, brown rice length (mm), brown rice breadth (mm), brown rice L/B ratio, kernel length (mm), kernel breadth (mm), kernel L/B ratio, kernel length after cooking (mm), kernel breadth after cooking (mm), cooked rice L/B ratio and elongation ratio.

RESULT AND DISCUSSION

Analysis of variance presented in Table 1 revealed that the differences among genotypes for almost all the traits under study were highly significant. It was suggested that the material has adequate variability and validated further statistical and genetically analysis.

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Evaluation of heterosis

Percent heterosis for quantitative and quality traits was computed over mid parents, better parent and standard heterosis. The magnitude of heterosis varied from trait to trait and crosses to cross. For days to 50 % flowering, plant height, number of unfilled grains per panicle, spikelet sterility percentage, paddy breadth, brown rice breadth, kernel breadth and kernel breadth after cooking negative heterosis was desirable but for rest of the traits positive heterosis was desirable.

Days to 50% flowering

The mid parent heterosis ranged from -9.14 (IR 58025A/R1679-1674-1-234-1) to 20.25% (PUSA 6A/R1630-342-1-47-1). Among 24 hybrids, 5 hybrids showed significant negative heterosis and 17 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -8.65 (IR 58025A/R1679-1674-1-234-1) to 23.60% (CRMS 32A/R1665-1620-1-985-1 and IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 1 hybrid showed significant negative heterosis and 22 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from 1.21 (PUSA 6A/R1679-1674-1-234-1) to 20.61% (CRMS 32A/R1665-1620-1-985-1, IR 58025A/R1630-342-1-47-1, IR 58025A/R1665-1620-1-985-1 and IR 58025A/Improved pusa basmati). Among 24 hybrids, none hybrids showed significant negative heterosis and 23 hybrids showed significant positive heterosis for this trait. Similar finding have also been reported by Chaudhry *et al*. (2007), Gawas *et al.* (2007), Wang *et al*. (2010) and Kumar *et al.* (2012).

Plant height (cm)

The mid parent heterosis ranged from -29.96 (PUSA 6A/R1607-673-2-322-1) to 23.38% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 13 hybrids showed significant negative heterosis and 6 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -23.83 (PUSA 6A/R1607-673-2-322-1) to 24.17% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 7 hybrids showed significant negative heterosis and 12 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -36.32 (PUSA 6A/R1607-673-2-322-1) to 3.81% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 23 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait. Similar results have also been reported by Gawas *et al*. (2007), Saidaiah *et al*. (2010) and Kumar *et al*. (2012).

Productive tillers per plant

The mid parent heterosis ranged from -66.35 (PUSA 6A/R1607-673-2-322-1) to 313.25% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 5 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -72.66 (PUSA 6A/R1607-673-2-322-1) to 163.64% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -61.54 (PUSA 6A/R1607-673-2-322-1) to 218.68% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 9 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Soni *et al*. (2005) and Kumar *et al*. (2012).

Panicle length (cm)

The mid parent heterosis ranged from -24.93 (PUSA 6A/R1607-673-2-322-1) to 33.67% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 7 hybrids showed significant negative heterosis and 9 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -25.05 (PUSA 6A/R1607-673-2-322-1) to 29.18% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -26.16 (PUSA 6A/R1607-673-2-322-1) to 21.10% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 10 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait. Similar findings reported by Soni *et al*. (2005), Pandya and Tripathi (2006), and Singh *et al*. (2007).

Number of filled grains per panicle

The mid parent heterosis ranged from -97.85 (PUSA 6A/R1607-673-2-322-1) to 64.38% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 17 hybrids showed significant negative heterosis and 5 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -97.94 (PUSA 6A/R1607-673-2-322-1) to 52.56% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 18 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -95.67 (PUSA 6A/R1607-673-2-322-1) to 201.58% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 10 hybrids showed significant negative heterosis and 12 hybrids showed significant positive heterosis for this trait. Similar findings reported by Singh *et al*. (2007).

Number of unfilled grains per panicle

The mid parent heterosis ranged from -63.81 (IR 58025A/R1679-1674-1-234-1) to 296.97% (IR 58025A/R1519-815-1-646-1). Among 24 hybrids, 3 hybrids showed significant negative heterosis and 16 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -57.55 (IR 58025A/R1679-1674-1-234-1) to 446.44% (CRMS

32A/RNR2354). Among 24 hybrids, 1 hybrid showed significant negative heterosis and 17 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from 52.01 (R1551-1066-1-449-1) to 1645.42% (CRMS 32A/RNR2354). Among 24 hybrids, none hybrids showed significant negative heterosis and 21 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Soni *et al.* (2005).

Spikelet fertility (%)
The mid parent heterosis ranged from -96.18 (PUSA 6A/R1607-673-2-322-1) to 26.98% (IR 58025A/ R1679-1674-1-234-1). Among 24 hybrids, 16 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -96.34 (PUSA 6A/R1607-673-2-322-1) to 24.54% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 17 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -96.83 (PUSA 6A/R1607-673-2-322-1) to 5.89% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 19 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait. Similar results have been reported by Singh (2005), Soni *et al.* (2005), Shanthi *et al.* (2006) and Kumar *et al*. (2012).

Spikelet sterility (%)
The mid parent heterosis ranged from -71.72 (IR 58025A/R1679-1674-1-234-1) to 394.13% (CRMS 32A/RNR2354). Among 24 hybrids, 4 hybrids showed significant negative heterosis and 16 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -70.17 (IR 58025A/R1679-1674-1-234-1) to 561.07% (CRMS 32A/RNR2354). Among 24 hybrids, 4 hybrids showed significant negative heterosis and 17 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -39.89 (IR 58025A/R1679-1674-1-234-1) to 656.14% (PUSA 6A/R1607-673-2-322-1). Among 24 hybrids, none hybrids showed significant negative heterosis and 19 hybrids showed significant positive heterosis for this trait.Similar results have been reported by Veni *et al.* (2005) and Pandya and Tripathi (2006).

Grain yield per plant (g)
The mid parent heterosis ranged from -98.59 (PUSA 6A/R1607-673-2-322-1) to 233.33% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -98.74 (PUSA 6A/R1607-673-2-322-1) to 97.50% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 16 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -99.01 (PUSA 6A/R1607-673-2-322-1) to 60.14% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 19 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Issac (2007), Li *et al.* (2008), Vaithiyaligan and Nandarajan (2010), Mirarab *et al*. (2011), Tiwari *et al.* (2011) and Kumar *et al*. (2012).

Seed index/hundred seed weight (g)
The mid parent heterosis ranged from -6.76 (PUSA 6A/R1607-673-2-322-1) to 36.07% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 1 hybrid showed significant negative heterosis and 19 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -16.14 (PUSA 6A/R1607-673-2-322-1) to 28.61% (PUSA 6A/R1665-1620-1-985-1). Among 24 hybrids, 5 hybrids showed significant negative heterosis and 13 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -27.73 (IR 58025A/R1679-1674-1-234-1) to 23.64% (PUSA 6A/R1665-1620-1-985-1). Among 24 hybrids, 8 hybrids showed significant negative heterosis and 6 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Wang *et al.* (2010).

Biological yield per plant (g)
The mid parent heterosis ranged from -84.02 (PUSA 6A/R1607-673-2-322-1) to 126.62% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 8 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -85.88 (PUSA 6A/R1607-673-2-322-1) to 64.21% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 6 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -86.32 (PUSA 6A/R1607-673-2-322-1) to 31.34% (IR 58025A/R1519-815-1-646-1). Among 24 hybrids, 14 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Hossain *et al*. (2004), Verma *et al.* (2004), Singh *et al.* (2006) and Kumar *et al.* (2012).

Harvest index (%)
The mid parent heterosis ranged from -91.22 (PUSA 6A/R1607-673-2-322-1) to 100.15% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 17 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -91.40 (PUSA 6A/R1607-673-2-322-1) to 43.35% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 17 hybrids showed significant negative heterosis and

2 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -92.56 (PUSA 6A/R1607-673-2-322-1) to 49.09% (IR 58025A/R1679-1674-1-234-1). Among 24 hybrids, 18 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Tiwari *et al*. (2011) and Kumar *et al*. (2012).

Hulling (%)

The mid parent heterosis ranged from -12.60 (CRMS 32A/R1665-1620-1-985-1) to 4.67% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 11 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -13.84 (CRMS 32A/R1665-1620-1-985-1) to 1.80% (PUSA 6A/R1551-1066-1-449-1). Among 24 hybrids, 15 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -11.78 (CRMS 32A/R1665-1620-1-985-1) to 3.86% (PUSA 6A/R1551-1066-1-449-1). Among 24 hybrids, 7 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Pandya and Tripathi (2006).

Milling (%)

The mid parent heterosis ranged from -14.97 (IR 58025A/R1551-1066-1-449-1) to 9.23% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 7 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -15.65 (PUSA 6A/Improved pusa basmati) to 1.37% (CRMS 32A/Improved pusa basmati). Among 24 hybrids, 9 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -14.77 (PUSA 6A/Improved pusa basmati) to 5.41% (CRMS 32A/Improved pusa basmati). Among 24 hybrids, 4 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Pandya and Tripathi (2006).

Head rice recovery (%)

The mid parent heterosis ranged from -50.01 (PUSA 6A/Improved pusa basmati) to 16.53% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 10 hybrids showed significant negative heterosis and 5 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -51.55 (PUSA 6A/Improved pusa basmati) to 10.45% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -52.21 (PUSA 6A/Improved pusa basmati) to 7.56% (PUSA 6A/R1607-673-2-322-1 and IR 58025A/R1607-673-2-322-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Singh and Lal, (2005), and Singh (2005).

Paddy length (mm)

The mid parent heterosis ranged from -6.48 (IR 58025A/RNR2354) to 25.63% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 3 hybrids showed significant negative heterosis and 12 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -23.35 (PUSA 6A/R1679-1674-1-234-1) to 11.05% (CRMS 32A/RNR2354). Among 24 hybrids, 11 hybrids showed significant negative heterosis and 5 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -20.63 (CRMS 32A/R1679-1674-1-234-1) to 15.87% (PUSA 6A/R1519-815-1-646-1). Among 24 hybrids, 6 hybrids showed significant negative heterosis and 13 hybrids showed significant positive heterosis for this trait. Similar results have been reported by Bisne and Motiramani (2005).

Paddy breadth (mm)

The mid parent heterosis ranged from -19.61 (PUSA 6A/R1607-673-2-322-1) to 14.94% (PUSA 6A/RNR2354). Among 24 hybrids, 4 hybrids showed significant negative heterosis and 10 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -6.82 (PUSA 6A/R1607-673-2-322-1) to 22.73% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 1 hybrids showed significant negative heterosis and 12 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -10.87 (PUSA 6A/R1607-673-2-322-1) to 17.39% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 3 hybrids showed significant negative heterosis and 5 hybrids showed significant positive heterosis for this trait.

Paddy L/B ratio

The mid parent heterosis ranged from -17.57 (IR 58025A/RNR2354) to 36.01% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 8 hybrids showed significant negative heterosis and 8 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -29.61 (PUSA 6A/R1679-1674-1-234-1) to 8.29% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 15 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -23.36 (PUSA 6A/R1679-1674-1-234-1) to 15.82% (PUSA 6A/R1519-815-1-646-1). Among 24 hybrids, 8 hybrids showed significant negative heterosis and 6 hybrids showed significant positive heterosis for this trait.

Brown rice length (mm)
The mid parent heterosis ranged from -8.30 (PUSA 6A/R1679-1674-1-234-1) to 19.49% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 9 hybrids showed significant negative heterosis and 10 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -26.57 (PUSA 6A/R1679-1674-1-234-1) to 5.22% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 13 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -30.92 (PUSA 6A/R1679-1674-1-234-1) to -1.97% (PUSA 6A/R1519-815-1-646-1 and CRMS 32A/R1665-1620-1-985-1). Among 24 hybrids, none hybrids showed significant negative heterosis and 24 hybrids showed significant positive heterosis for this trait.

Brown rice breadth (mm)
The mid parent heterosis ranged from -9.52 (PUSA 6A/R1551-1066-1-449-1) to 16.22% (PUSA 6A/RNR2354). Among 24 hybrids, 6 hybrids showed significant negative heterosis and 12 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from 0.00 (CRMS 32A/R1665-1620-1-985-1 and IR 58025A/R1630-342-1-47-1) to 23.68% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, none hybrids showed significant negative heterosis and 20 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -5.13 (IR 58025A/R1519-815-1-646-1) to 20.51% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 1 hybrid showed significant negative heterosis and 10 hybrids showed significant positive heterosis for this trait.

Brown rice L/B ratio
The mid parent heterosis ranged from -19.73 (IR 58025A/RNR2354) to 28.03% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 13 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -33.88 (PUSA 6A/R1679-1674-1-234-1) to 2.55% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 20 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -35.38 (CRMS 32A/R1679-1674-1-234-1) to 0.51% (PUSA 6A/R1519-815-1-646-1 and CRMS 32A/R1665-1620-1-985-1). Among 24 hybrids, 18 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.

Kernel length (mm)
The mid parent heterosis ranged from -11.97 (CRMS 32A/RNR2354) to 22.33% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 9 hybrids showed significant negative heterosis and 13 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -23.26 (PUSA 6A/R1679-1674-1-234-1) to 10.94% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 14 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -28.68 (CRMS 32A/R1679-1674-1-234-1) to 4.41% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 19 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait.Similar results have been reported by Veni *et al*. (2005) and Singh (2005).

Kernel breadth (mm)
The mid parent heterosis ranged from -13.25 (IR 58025A/R1551-1066-1-449-1) to 17.95% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 4 hybrids showed significant negative heterosis and 9 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -5.26 (IR 58025A/R1551-1066-1-449-1) to 17.95% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 1 hybrid showed significant negative heterosis and 14 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -7.69 (IR 58025A/R1551-1066-1-449-1) to 17.95% (CRMS 32A/R1607-673-2-322-1). Among 24 hybrids, 3 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait.

Kernel L/B ratio
The mid parent heterosis ranged from -20.29 (CRMS 32A/RNR2354) to 38.34% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 11 hybrids showed significant negative heterosis and 7 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -29.08 (PUSA 6A/R1679-1674-1-234-1) to 14.57% (IR 58025A/R1551-1066-1-449-1). Among 24 hybrids, 16 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -29.80 (CRMS 32A/RNR2354 and IR 58025A/RNR2354) to 10.03% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 15 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait.

Kernel length after cooking (mm)
The mid parent heterosis ranged from -22.44 (IR 58025A/R1519-815-1-646-1) to 28.43% (PUSA 6A/R1551-1066-1-449-1). Among 24 hybrids, 11 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait. The heterobeltiosis ranged from -32.08 (PUSA 6A/Improved pusa basmati) to 20.00% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids,

16 hybrids showed significant negative heterosis and 2 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -40.85 (CRMS 32A/R1679-1674-1-234-1) to 2.13% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 23 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.Similar results have been reported by Veni *et al*. (2005).

Kernel breadth after cooking (mm)

The mid parent heterosis ranged from -6.87 (CRMS 32A/R1519-815-1-646-1) to 11.11% (CRMS 32A/R1665-1620-1-985-1). Among 24 hybrids, none hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -6.15 (CRMS 32A/R1519-815-1-646-1) to 17.24% (PUSA 6A/RNR2354). Among 24 hybrids, none hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait.The standard heterosis ranged from -10.45 (IR 58025A/R1519-815-1-646-1) to 4.48% (PUSA 6A/R1630-342-1-47-1, PUSA 6A/R1665-1620-1-985-1, CRMS 32A/R1607-673-2-322-1 and CRMS 32A/R1665-1620-1-985-1). Among 24 hybrids, none hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.

Cooked rice L/B ratio

The mid parent heterosis ranged from -19.74 (PUSA 6A/Improved pusa basmati) to 29.48% (PUSA 6A/R1551-1066-1-449-1). Among 24 hybrids, 12 hybrids showed significant negative heterosis and 3 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -35.29 (IR 58025A/R1679-1674-1-234-1) to 19.51% (PUSA 6A/R1551-1066-1-449-1). Among 24 hybrids, 16 hybrids showed significant negative heterosis and 2 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -38.75 (IR 58025A/R1679-1674-1-234-1) to 8.83% (IR 58025A/R1665-1620-1-985-1). Among 24 hybrids, 23 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.

Elongation ratio

The mid parent heterosis ranged from -27.45 (IR 58025A/R1630-342-1-47-1) to 16.82% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 13 hybrids showed significant negative heterosis and 4 hybrids showed significant positive heterosis for this trait.The heterobeltiosis ranged from -31.40 (IR 58025A/R1519-815-1-646-1) to 8.75% (PUSA 6A/R1679-1674-1-234-1). Among 24 hybrids, 16 hybrids showed significant negative heterosis and 1 hybrids showed significant positive heterosis for this trait. The standard heterosis ranged from -35.26 (CRMS 32A/R1519-815-1-646-1) to 4.05% (CRMS 32A/RNR2354 and IR 58025A/RNR2354). Among 24 hybrids, 19 hybrids showed significant negative heterosis and none hybrids showed significant positive heterosis for this trait.

Table 1. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	Kernel breadth after cooking (mm)			Cooked rice L/B ratio			Elongation ratio		
	MP	BP	SH	MP	BP	SH	MP	BP	SH
PUSA 6A/									
R1607-673-2-322-1	-0.74	0.00	0.00	8.89	0.00	-17.09**	14.38**	0.00	-1.16
R1679-1674-1-234-1	-0.76	3.17	-2.99	15.09*	1.03	-29.91**	16.82**	8.75**	-6.36*
R1519-815-1-646-1	0.00	1.52	0.00	-10.99	-21.68**	-28.49**	-6.45*	-13.58**	-24.28**
R1551-1066-1-449-1	-0.75	1.54	-1.49	29.48**	19.51*	-17.09**	4.33	-3.02	-16.76**
R1630-342-1-47-1	5.26	7.69	4.48	-13.29*	-19.86**	-34.47**	-12.85**	-25.35**	-22.54**
R1665-1620-1-985-1	8.53	14.75*	4.48	-13.75*	-24.06**	-30.77**	-9.64**	-16.78**	-27.17**
RNR2354	7.94	17.24**	1.49	-11.19	-21.75**	-28.77**	2.56	-9.06**	-13.29**
Improved pusa basmati	-0.76	3.17	-2.99	-19.74**	-34.29**	-28.49**	-14.81**	-25.15**	-27.17**
CRMS 32A/									
R1607-673-2-322-1	6.06	7.69	4.48	-3.83*	-7.22	-23.08**	-4.61	-12.28**	-13.29**
R1679-1674-1-234-1	0.00	1.59	-4.48	-4.29*	-19.59**	-38.18**	-1.71	-3.37	-17.34**
R1519-815-1-646-1	-6.87	-6.15	-8.96	-	-	-	-	-	-

				16.07**	22.62**	29.34**	24.28**	26.16**	35.26**
R1551-1066-1-449-1	0.00	0.00	-2.99	-1.36	-13.12	-33.05**	-12.14**	-13.76**	-25.43**
R1630-342-1-47-1	-3.08	-3.08	-5.97	3.68	0.70	-17.66**	-13.31**	-22.01**	-19.08**
R1665-1620-1-985-1	11.11*	14.75*	4.48	-10.92	-17.81**	-25.07**	-4.23	-6.91*	-18.50**
RNR2354	5.69	12.07	-2.99	-2.71	-10.17	-18.23**	16.18**	8.46**	4.05
Improved pusa basmati	-4.69	-3.17	-8.96	-8.97	-22.25**	-15.38**	-11.04**	-17.75**	-19.65**
IR 58025A/									
R1607-673-2-322-1	5.51	11.67	0.00	-6.73	-12.61*	-17.09**	-0.29	-0.58	-1.16
R1679-1674-1-234-1	7.32	10.00	-1.49	-16.63*	-35.29**	-38.75**	-11.39**	-17.44**	-17.92**
R1519-815-1-646-1	-4.76	0.00	-10.45	-18.90**	-20.42**	-24.50**	-26.93**	-31.40**	-31.79**
R1551-1066-1-449-1	5.60	10.00	-1.49	-13.73*	-30.18**	-33.62**	-24.30**	-29.36**	-29.48**
R1630-342-1-47-1	7.20	11.67	0.00	-21.77**	-27.18**	-31.05**	-27.45**	-28.97**	-26.59**
R1665-1620-1-985-1	4.13	5.00	-5.97	17.00**	14.71*	8.83	4.32	-1.74	-2.31
RNR2354	10.17	12.07	-2.99	-12.03*	-13.81*	-18.23**	6.37**	4.36	4.05
Improved pusa basmati	2.44	5.00	-5.97	-16.92**	-22.25**	-15.38**	-7.04**	-7.85**	-8.09**

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

Table 2. ANOVA for different quantitative and quality characters

		Mean sum of square														
Source of Variation	df	16	17	18	19	20	21	22	23	24	25	26	27	28		
Replication	1	0.027	0.011	0.090	0.0031	0.0051	0.022	0.0012	0.00054	0.00030	0.36*	0.0012	0.044	0.015**		
Treatment	34	2.97**	0.064**	0.94**	1.37**	0.044**	0.63**	1.18**	0.028**	0.51**	3.43**	0.045	0.39**	0.073**		
Error	34	0.030	0.0053	0.029	0.0047	0.0013	0.0044	0.0068	0.0023	0.0068	0.060	0.031	0.034	0.0018		
Error	34	0.68	3.67	1.73	0.93	70.52	152.08	7.77	7.77	3.50	0.0051	39.41	3.16	0.80	1.22	3.50

*= Significant P > 0.05, **= Significant P > 0.01

1. Days to 50% flowering
2. Plant height (cm)
3. Productive tillers per plant
4. Panicle length (cm)
5. Number of filled grains per panicle
6. Number of unfilled grains per panicle
7. Spikelet fertility (%)
8. Spikelet sterility (%)
9. Grain yield per plant (g)
10. Seed index/hundred seed weight (g)
11. Biological yield per plant (g)
12. Harvest index (%)
13. Hulling (%)
14. Milling (%)
15. Head rice recovery (%)
16. Paddy length (mm)
17. Paddy breadth (mm)
18. Paddy L/B ratio
19. Brown rice length (mm)
20. Brown rice breadth (mm)
21. Brown rice L/B ratio
22. Kernel length (mm)
23. Kernel breadth (mm)
24. Kernel L/B ratio
25. Kernel length after cooking (mm)
26. Kernel breadth after cooking (mm)
27. Cooked rice L/B ratio
28. Elongation ratio

Table 3. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	Days to 50% flowering			Plant height (cm)			Productive tillers per plant			Panicle length (cm)			Number of filled grains per panicle		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
PUSA 6A/															
R1607-673-2-322-1	-3.43**	6.29**	2.42*	-29.96**	-23.83**	-36.32**	-66.35**	-72.66**	-61.54**	-24.93**	-25.05**	-26.16**	-97.85**	-97.94**	-95.67**
R1679-1674-1-234-1	-3.47**	5.03**	1.21	23.38**	24.17**	3.81*	86.68**	28.75	13.19	26.26**	19.16**	17.40**	50.65**	43.46**	201.58**
R1519-815-1-646-1	5.14**	15.72**	11.52**	5.35**	14.71**	-4.10*	-29.26**	-45.64**	-10.99	7.75*	0.99	13.78**	-58.07**	-58.21**	-12.13
R1551-1066-1-449-1	4.24**	8.18**	4.24**	7.23**	13.91**	-4.77*	43.23**	38.75*	21.98	12.02**	6.05	4.48	3.81	2.99	119.96**
R1630-342-1-47-1	20.25**	21.38**	16.97**	-14.02**	-13.35**	-28.67**	-5.62	-14.29	-7.69	-9.34*	-16.70**	-17.94**	-48.14**	-49.67**	5.81
R1665-1620-1-985-1	13.75**	14.47**	10.30**	-7.98**	-7.19**	-23.72**	-50.25**	-58.12**	-46.15**	-9.73*	-12.69**	-13.99**	-95.29**	-96.45**	-92.53**
RNR2354	5.54**	13.84**	9.70**	-4.76*	1.02	-15.55**	-26.04*	-36.61**	-21.98	-4.76	-7.48	-3.33	-16.88**	-26.98**	102.75**
Improved pusa basmati	-2.03*	6.29**	2.42*	-4.88**	3.10	-13.80**	48.51**	22.95*	64.84**	-0.17	-7.45*	6.75	3.22	-15.81**	76.99**
CRMS 32A/															
R1607-673-2-322-1	0.00	2.19*	13.33**	-3.80*	7.84**	-14.69**	-39.91**	-50.00**	-29.67*	-5.87	-8.34*	-10.00*	-17.41**	-23.01**	48.35**
R1679-1674-1-234-1	1.08	2.19*	13.33**	2.87	6.48**	-15.77**	129.30**	55.59**	45.39**	10.73**	7.40	-0.04	12.88**	5.88	101.34**
R1519-815-1-646-1	2.14**	4.37**	15.76**	1.13	13.50**	-10.21**	-34.19**	-48.32**	-15.39	-0.20	-8.89*	2.63	-86.45**	-87.82**	-74.56**
R1551-1066-1-449-1	11.86**	15.79**	20.00**	-13.76**	-5.63*	-25.35**	-41.69**	-45.12**	-48.79**	-1.70	-4.35	-11.02**	-36.16**	-43.18**	21.36*
R1630-342-1-47-1	7.25**	14.20**	12.12**	2.87	4.96*	-16.97**	-7.10	-13.27	-6.59	16.96**	10.34*	2.67	-10.66*	-17.72**	62.81**
R1665-1620-1-985-1	15.70**	23.60**	20.61**	7.18**	9.27**	-13.56**	-6.93	-19.66	3.30	12.27**	11.67**	3.91	-90.73**	-92.40**	-87.33**
RNR2354	1.91*	2.19*	13.33**	-8.03**	0.47	-20.51**	-2.28	-14.06	5.71	-11.29**	-16.14**	-12.38**	-94.64**	-95.71**	-88.09**
Improved pusa basmati	-1.90*	-1.09	9.70**	-9.35**	1.27	-19.88**	-54.59**	-61.48**	-48.35**	-5.53	-14.66**	-1.56*	-14.38**	-23.08**	28.14**
IR 58025A/															
R1607-673-2-322-1	4.79**	6.49**	19.39**	-17.72**	-6.79**	-27.65**	-57.98**	-60.94**	-45.06**	-18.77**	-20.61**	-22.05**	-68.09**	-70.56**	-43.28**
R1679-1674-1-234-1	-9.14**	-8.65**	2.42*	9.52**	14.49**	-	313.25*	163.64*	218.68*	33.67**	29.18**	21.10**	64.38**	52.56**	190.11*

						11.14**	*	*	*						*
R1519-815-1-646-1	2.66**	4.32**	16.97**	3.09	16.93**	-9.24**	9.65	-4.70	56.04**	-0.72	-9.05*	2.47	-82.76**	-84.66**	-67.96**
R1551-1066-1-449-1	1.69*	5.85**	9.70**	-1.48	8.93**	-15.45**	13.51	-4.55	15.39	9.53*	6.19	-0.45	26.26**	11.25*	137.61**
R1630-342-1-47-1	14.70**	22.84**	20.61**	16.02**	19.54**	-7.22**	-14.42	-19.09	-2.20	8.24*	1.76	-4.61	26.89**	15.65**	128.84**
R1665-1620-1-985-1	15.03**	23.60**	20.61**	-22.06**	-19.77**	-37.72**	-48.90**	-50.43**	-36.26*	-0.77	-1.67	-7.82	-96.47**	-97.07**	-95.24**
RNR2354	6.78**	7.07**	19.39**	-25.77**	-18.06**	-36.40**	-56.08**	-56.47**	-46.37**	-19.32**	-23.46**	-20.03**	-95.33**	-96.30**	-89.72**
Improved pusa basmati	7.28**	7.57**	20.61**	-18.83**	-8.35**	-28.87**	-47.54**	-50.12**	-33.08*	-13.57**	-21.67**	-9.63*	-66.67**	-69.75**	-50.75**

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

Table 4. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	Number of unfilled grains per panicle			Spikelet fertility (%)			Spikelet sterility (%)			Grain yield per plant (g)			Seed index/hundred seed weight (g)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
PUSA 6A/															
R1607-673-2-322-1	86.54**	111.78**	874.36**	-96.18**	-96.34**	-96.83**	251.09**	297.93**	656.14**	-98.59**	-98.74**	-99.01**	-6.76*	-16.14**	-9.09**
R1679-1674-1-234-1	-23.81	-18.63	274.36**	15.29**	11.99**	-2.89	-42.19**	-37.08**	19.60	213.75**	93.66**	23.87**	11.30**	-13.39**	-25.00**
R1519-815-1-646-1	137.06**	160.31**	901.25**	-51.67**	-52.61**	-57.24**	173.98**	193.70**	387.87**	-57.52**	-67.42**	-60.99**	19.45**	13.65**	-1.82
R1551-1066-1-449-1	-15.30	4.06	228.57*	4.03	-0.12	-5.89	-15.00	0.56	39.89	-0.66	-6.25	-32.43**	24.19**	15.22**	0.00
R1630-342-1-47-1	113.86**	189.40**	680.22**	-39.72**	-42.49**	-45.08**	153.08**	210.98**	305.44**	-31.68**	-38.89**	-50.45**	32.42**	26.51**	9.55**
R1665-1620-1-985-1	167.03**	210.78**	976.92**	-93.91**	-94.23**	-95.00**	236.88**	291.41**	643.70**	-82.55**	-83.33**	-88.29**	35.32**	28.61**	23.64**
RNR2354	129.14**	179.59**	793.04**	-24.76**	-29.14**	-30.45**	102.55**	172.41**	206.30**	-20.54**	-41.53**	-20.72*	18.95**	12.86**	-2.27
Improved pusa basmati	-15.63	6.02	222.34*	4.92	5.54	-9.54**	-14.88	-13.36	64.62**	71.62**	61.49**	17.12*	15.73**	6.64*	9.55**
CRMS 32A/															
R1607-673-2-322-1	-21.53	2.74	271.06**	0.82	-3.66	-16.23**	-2.15	11.43	109.95**	-7.64	-18.54	-34.68**	9.49**	-0.84	7.73**
R1679-1674-1-234-1	-49.43**	-38.13	123.44	17.18**	13.68**	-1.16	-47.67**	-42.78**	7.78	151.03**	56.25**	-4.28	15.53**	-10.59**	-21.36**
R1519-815-1-646-1	232.61*	243.41*	1140.29*	-	-	-	285.00*	310.86*	582.43*	-	-	-	14.91**	8.53**	-4.55

	*	*	*	84.15**	84.44**	85.95**	*	*	*	84.08**	87.97**	85.59**			
R1551-1066-1-449-1	108.87**	123.90**	606.96**	-31.92**	-34.55**	-38.33**	119.66**	158.62**	259.72**	-45.95**	-50.00**	-63.96**	19.78**	10.34**	-3.18
R1630-342-1-47-1	53.66*	79.76*	384.62**	-12.23**	-16.17**	-19.92**	47.43**	80.26**	134.99**	-20.25	-30.00**	-43.24**	0.27	-4.91	-16.36**
R1665-1620-1-985-1	270.19**	278.01**	1209.89**	-91.42**	-91.88**	-92.94**	231.77**	287.33**	629.78**	-86.30**	-87.18**	-90.99**	5.43	0.95	-2.73
RNR2354	412.92**	446.44**	1645.42**	-94.53**	-94.84**	-94.94**	394.13**	561.07**	643.31**	-88.56**	-91.69**	-88.74**	21.26**	14.21**	0.45
Improved pusa basmati	149.17**	172.59**	728.72**	-32.00**	-32.49**	-41.30**	97.21**	101.59**	279.86**	-74.75**	-76.71**	-83.11**	12.04**	3.98	6.82*
IR 58025A/															
R1607-673-2-322-1	109.34**	162.26**	918.32**	-61.75**	-63.05**	-68.58**	155.43**	180.30**	464.70**	-88.83**	-88.89**	-90.99**	8.76**	-5.03	2.73
R1679-1674-1-234-1	-63.81**	-57.55*	64.84	26.98**	24.54**	5.89	-71.72**	-70.17**	-39.89	233.33**	97.50**	60.14**	11.62**	-10.96*	-27.73**
R1519-815-1-646-1	296.97**	298.86**	1434.07**	-83.98**	-84.44**	-85.97**	271.33**	310.88**	582.43**	-79.37**	-82.71**	-79.28**	16.86**	14.89**	-6.82*
R1551-1066-1-449-1	-56.82*	-51.86	52.01	16.98**	11.26**	4.85	-60.57**	-51.72**	-32.81	2.94	-2.78	-21.17*	24.93**	19.66**	-3.18
R1630-342-1-47-1	40.31	71.20*	361.54**	-2.06	-7.44*	-11.59**	7.60	36.95*	78.54**	11.11	11.11	-9.91	-0.71	-1.97	-20.45**
R1665-1620-1-985-1	192.32**	209.94**	973.99**	-95.88**	-96.06**	-96.65**	233.29**	274.68**	654.90**	88.10**	-88.89**	-90.99**	36.07**	25.30**	20.45**
RNR2354	92.03**	112.73**	579.49**	-88.37**	-89.15**	-89.35**	349.42**	527.35**	605.37**	91.68**	-93.36**	-90.99**	16.91**	14.61**	-7.27*
Improved pusa basmati	68.25**	91.57**	482.42**	-51.07**	-51.27**	-58.23**	148.36**	151.33**	394.56**	88.27**	-88.89**	-90.99**	4.46	-6.64*	-4.09

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

Table 5. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	**Biological yield per plant (g)**			**Harvest index (%)**			**Hulling percentage (%)**			**Milling percentage (%)**			**Head rice recovery (%)**		
	MP	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
PUSA 6A/															
R1607-673-2-322-1	-84.02**	-85.88**	-86.32**	-91.22**	-91.40**	-92.56**	-0.02	-0.04	1.98	1.97	0.00	5.11**	7.50**	0.00	7.56**
R1679-1674-1-234-1	126.62**	64.21**	22.14**	54.51**	17.44*	1.56	4.67**	-3.75**	-1.81	9.23**	-0.28	0.75	16.53**	10.45**	2.24
R1519-815-1-646-1	-4.63	-21.12**	-10.32	-54.27**	-58.43**	-56.06**	-0.88	-1.04	0.96	-0.69	-0.85	0.50	-3.14	-6.52**	-6.98**
R1551-1066-1-449-1	-16.57*	-24.66**	-30.47**	17.81*	12.48	-2.72	2.68*	1.80	3.86**	1.50	1.12	2.95	-4.53*	-8.86**	-7.21**

R1630-342-1-47-1	-12.48	-15.09	-32.84**	-21.59**	-27.70**	-25.94**	-2.86**	-3.55**	-1.60	-4.75**	-5.67**	-2.82	-9.61**	-15.16**	-10.47**
R1665-1620-1-985-1	-0.87	-5.02	-29.35**	-81.85**	-83.32**	-82.80**	-4.79**	-5.97**	-4.07**	-1.07	-2.05	-1.04	-3.94	-4.10	-10.94**
RNR2354	14.45	2.37	-3.48	-28.93**	-43.13**	-18.07**	-0.32	-1.70	0.29	1.20	0.79	1.84	4.80*	-0.31	2.24
Improved pusa basmati	64.27**	57.01**	28.11**	4.84	3.69	-8.35	-3.12**	-4.56**	-2.63*	-14.84**	-15.65**	-14.77**	-50.01**	-51.55**	-52.21**
CRMS 32A/															
R1607-673-2-322-1	-8.61	-21.69*	-24.13**	0.18	-3.22	-13.93*	1.51	1.30	3.73**	0.37	-0.16	4.92**	-2.65	-4.56*	2.66
R1679-1674-1-234-1	102.75**	50.36**	3.98	37.01**	3.14	-8.27	3.34**	-5.13**	-2.85*	5.65**	-4.79**	-0.99	8.71**	-2.04	1.22
R1519-815-1-646-1	-42.86**	-54.05**	-47.76**	-71.84**	-74.07**	-72.61**	-3.31**	-3.64**	-1.33	-3.39*	-4.61**	-0.81	-13.93**	-15.52**	-12.71**
R1551-1066-1-449-1	-4.47	-16.44*	-22.89**	-43.91**	-47.15**	-53.01**	-4.96**	-5.95**	-3.69**	-8.84**	-9.80**	-6.21**	-21.65**	-22.23**	-19.65**
R1630-342-1-47-1	23.49*	15.72	-8.46	-35.77**	-39.99**	-38.53**	1.02	0.11	2.52*	0.05	-0.42	3.56*	-9.01**	-9.95**	-4.97*
R1665-1620-1-985-1	-22.10*	-22.66	-46.52**	-82.41**	-83.61**	-83.09**	-12.60**	-13.84**	-11.78**	-11.67**	-13.78**	-10.34**	-14.41**	-18.74**	-16.03**
RNR2354	-11.72	-23.48**	-27.86**	-85.94**	-88.63**	-83.64**	-0.23	-1.79	0.57	0.90	-0.93	3.02	2.50	2.12	5.52*
Improved pusa basmati	-24.09*	-29.88**	-42.79**	-66.63**	-66.73**	-70.43**	-0.52	-2.17	0.18	3.80**	1.37	5.41**	-6.35**	-8.48**	-5.43*
IR 58025A/															
R1607-673-2-322-1	-32.06**	-38.38**	-40.30**	-83.79**	-85.44**	-84.83**	-0.88	-1.74	1.98	0.85	0.00	5.11**	3.14	0.00	7.56**
R1679-1674-1-234-1	91.66**	36.44**	7.59	100.15**	43.35**	49.09**	2.68*	-6.31**	-2.76*	9.00**	-1.50	1.79	12.32**	2.26	3.28
R1519-815-1-646-1	36.43**	15.54*	31.34**	-84.93**	-85.05**	-84.18**	-2.39*	-3.37**	0.29	1.16	0.20	3.54*	-2.12	-2.84	-1.87
R1551-1066-1-449-1	30.81**	21.29*	11.94	-22.75**	-32.16**	-29.46**	-5.38**	-6.98**	-3.46**	-14.97**	-15.60**	-12.78**	-43.49**	-43.71**	-42.69**
R1630-342-1-47-1	11.50	11.32	-11.94	-0.69	-1.45	2.50	-2.86**	-4.36**	-0.74	-0.13	-0.29	3.04**	-1.71	-3.82	1.50
R1665-1620-1-985-1	-18.61	-24.13*	-40.17**	-85.41**	-85.47**	-84.91**	-2.60*	-4.62**	-1.01	-2.04	-4.08*	-0.88	1.75	-2.34	-1.38
RNR2354	-28.88**	-34.70**	-38.43**	-88.18**	-89.82**	-85.34**	-0.91	-3.10**	0.57	1.22	-0.31	3.02	3.68	2.89	5.52*
Improved pusa basmati	-20.93*	-22.26*	-36.57**	-85.12**	-86.24**	-85.70**	-3.39**	-5.62**	-2.05	-3.55*	-5.52**	-2.36	-19.00**	-19.95**	-19.15**

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

Table 6. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	Paddy length (mm)			Paddy breadth (mm)			Paddy L/B ratio			Brown rice length (mm)			Brown rice breadth (mm)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
PUSA 6A/															
R1607-673-2-322-1	5.26**	-3.55*	0.53	-19.61**	-6.82*	-10.87**	26.90**	3.58	12.90**	-4.83**	-10.49**	-15.79**	1.20	16.67**	7.69**
R1679-1674-1-234-1	-5.33**	-23.35**	-20.11**	6.67*	9.09**	4.35	-11.64**	-29.61**	-23.36**	-8.30**	-26.57**	-30.92**	8.11**	11.11**	2.56
R1519-815-1-646-1	4.53**	-1.35	15.87**	4.55	4.55	0.00	-0.16	-5.93	15.82**	0.68	-2.61**	-1.97*	5.56**	5.56**	-2.56
R1551-1066-1-449-1	24.77**	3.55*	7.94**	-8.33**	0.00	-4.35	32.90**	3.58	12.90**	17.55**	0.70	-5.26**	-9.52**	5.56**	-2.56
R1630-342-1-47-1	15.94**	1.52	5.82**	-5.26	2.27	-2.17	20.60**	-0.56	8.27	12.06**	0.70	-5.26**	-3.80*	5.56**	-2.56
R1665-1620-1-985-1	0.25	-0.50	5.29**	9.30**	11.90**	2.17	-8.18*	-10.92**	3.16	0.35	-0.68	-4.61**	10.81**	13.89**	5.13**
RNR2354	-2.76	-10.66**	-6.88**	14.94**	16.28**	8.70**	-15.28**	-21.34**	-14.36**	-4.91**	-11.89**	-17.11**	16.22**	19.44**	10.26**
Improved pusa basmati	0.00	-4.19*	8.99**	8.05**	9.30**	2.17	-7.55*	-12.40**	6.57	-3.95**	-9.32**	-3.95**	2.70	5.56**	-2.56
CRMS 32A/															
R1607-673-2-322-1	4.35*	-0.55	-4.76*	5.88*	22.73**	17.39**	-4.10	-19.08**	-18.98**	2.29*	-1.47	-11.84**	10.59**	23.68**	20.51**
R1679-1674-1-234-1	-0.99	-17.13**	-20.63**	-2.22	0.00	-4.35	1.62	-16.40**	-16.30**	-4.50**	-22.06**	-30.26**	10.53**	10.53**	7.69**
R1519-815-1-646-1	-0.74	-9.91**	5.82**	-2.27	-2.27	-6.52*	1.47	-8.00*	13.38**	-2.42**	-7.84**	-7.24**	2.70	5.56**	-2.56
R1551-1066-1-449-1	22.83**	5.52**	1.06	-4.17	4.55	0.00	25.62**	0.97	0.97	13.45**	-0.74	-11.18**	-6.98**	5.26**	2.56
R1630-342-1-47-1	21.58**	10.50**	5.82**	-5.26	2.27	-2.17	26.78**	8.14	8.27	13.60**	4.41**	-6.58**	-1.23	5.26**	2.56
R1665-1620-1-985-1	4.46**	-0.50	5.29**	13.95**	16.67**	6.52*	-8.39*	-14.60**	-0.97	5.67**	2.05*	-1.97*	0.00	0.00	-2.56
RNR2354	16.18**	11.05**	6.35**	5.75	6.98*	0.00	9.94*	6.20	6.33	7.75**	2.21*	-8.55**	7.89**	7.89**	5.13**
Improved pusa basmati	1.52	-6.51**	6.35**	10.34**	11.63**	4.35	-8.06*	-16.20**	1.95	-3.03**	-10.56**	-5.26**	5.26**	5.26**	2.56
IR 58025A/															
R1607-673-2-322-1	4.52*	-2.63	-2.12	-2.91	11.11**	8.70**	4.96	-12.32**	-9.98*	-1.54	-4.48**	-15.79**	-3.53*	7.89**	5.13**

R1679-1674-1-234-1	1.28	-16.84**	-16.40**	3.30	4.44	2.17	-2.11	-20.26**	-18.00**	-0.91	-18.66**	-28.29**	7.89**	7.89**	5.13**
R1519-815-1-646-1	2.43	-4.95**	11.64**	1.12	2.27	-2.17	1.08	-7.31*	14.11**	0.35	-5.88**	-5.26**	0.00	2.78	-5.13**
R1551-1066-1-449-1	25.63**	5.79**	6.35**	-9.28**	-2.22	-4.35	36.01**	8.29*	11.19*	19.49**	5.22**	-7.24**	-9.30**	2.63	0.00
R1630-342-1-47-1	13.02**	0.53	1.06	-10.42**	-4.44	-6.52*	24.77**	5.33	8.03	9.68**	1.49	-10.53**	-6.17**	0.00	-2.56
R1665-1620-1-985-1	1.03	-1.50	4.23*	8.05**	11.90**	2.17	-6.57	-11.87**	1.95	4.29**	0.00	-3.95**	5.26**	5.26**	2.56
RNR2354	-6.48**	-12.63**	-12.17**	13.64**	16.28**	8.70**	-17.57**	-21.33**	-19.22**	-7.03**	-11.19**	-21.71**	15.79**	15.79**	12.82**
Improved pusa basmati	-6.17**	-11.63**	0.53	9.09**	11.63**	4.35	-13.99**	-20.70**	-3.41	-13.22**	-20.50**	-15.79**	10.53**	10.53**	7.69**

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

Table 7. Mid parent heterosis, Heterobeltiosis and Standard heterosis for different characters

Parents	**Brown rice L/B ratio**			**Kernel length (mm)**			**Kernel breadth (mm)**			**Kernel L/B ratio**			**Kernel length after cooking (mm)**		
	MP	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**	**MP**	**BP**	**SH**
PUSA 6A/															
R1607-673-2-322-1	-8.34**	-23.17**	-21.79**	-6.17**	-11.63**	-16.18**	2.63	5.41*	0.00	-8.81**	-16.19**	-16.33**	8.33**	0.00	-17.02**
R1679-1674-1-234-1	-15.73**	-33.88**	-32.82**	-4.35**	-23.26**	-27.21**	3.90	8.11**	2.56	-9.01**	-29.08**	-29.23**	13.88**	-3.03	-31.91**
R1519-815-1-646-1	-4.62**	-7.76**	0.51	-3.73**	-7.19**	-5.15**	6.85**	8.33**	0.00	-9.93**	-5.16**	-5.16*	-10.40**	-20.00**	-28.51**
R1551-1066-1-449-1	24.36**	-4.53**	-2.82	21.46**	3.10*	-2.21	-4.88**	5.41*	0.00	24.29**	-2.15	-2.29	28.43**	16.36**	-18.30**
R1630-342-1-47-1	14.42**	-4.53**	-2.82	3.45**	-6.98**	-11.76**	-1.27	5.41*	0.00	3.62	-11.75**	-11.75**	-8.00**	-12.97**	-31.49**
R1665-1620-1-985-1	-9.35**	-10.83**	-9.23**	4.28**	3.88**	-1.47	1.33	2.70	-2.56	2.92	1.15	1.15	-5.56*	-12.82**	-27.66**
RNR2354	-18.38**	-26.20**	-24.87**	-6.22**	-12.40**	-16.91**	13.51**	13.51**	7.69**	-17.48**	-22.92**	-22.92**	-2.86	-8.11**	-27.66**
Improved pusa basmati	-6.46**	-9.43**	-1.54	-4.80**	-9.15**	-5.15**	2.70	2.70	-2.56	-7.37**	-11.59**	-2.87	-19.51**	-32.08**	-30.64**
CRMS 32A/															
R1607-673-2-322-1	-9.02**	-20.39**	-26.92**	6.78**	3.28*	-7.35**	17.95**	17.95**	17.95**	-9.50**	-12.46**	-21.49**	2.16	-3.08	-19.57**

R1679-1674-1-234-1	-13.70**	-29.61**	-35.38**	-3.00*	-20.49**	-28.68**	6.33**	7.69**	7.69**	-9.06**	-26.20**	-33.81**	-4.47	-20.57**	-40.85**
R1519-815-1-646-1	-5.24**	-12.71**	-4.87**	3.45**	-2.88*	-0.74	-1.33	2.78	-5.13*	4.43*	-5.44*	4.58	-21.56**	-28.10**	-35.74**
R1551-1066-1-449-1	18.32**	-5.73**	-13.33**	12.26**	-2.46	-12.50**	-4.76*	2.56	2.56	15.87**	-4.95	-14.90**	-0.97	-12.57**	-34.89**
R1630-342-1-47-1	13.87**	-0.84	-8.97**	15.56**	6.56**	-4.41**	-1.23	2.56	2.56	16.38**	3.83	-6.88**	1.11	-1.62	-22.55**
R1665-1620-1-985-1	5.66**	2.08	0.51	4.00**	1.56	-4.41**	11.69**	13.16**	10.26**	-6.92**	-10.24**	-13.18**	-0.54	-5.64*	-21.70**
RNR2354	0.00	-5.17**	-13.08**	-11.97**	-15.57**	-24.26**	10.53**	13.51**	7.69**	-20.29**	-21.57**	-29.80**	2.78	0.00	-21.28**
Improved pusa basmati	-7.93**	-15.09**	-7.69**	-1.52	-8.45**	-4.41**	0.00	2.70	-2.56	-1.87	-10.94**	-2.01	-12.77**	-24.58**	-22.98**
IR 58025A/															
R1607-673-2-322-1	0.56	-11.47**	-20.00**	-0.87	-1.72	-16.18**	1.30	2.63	0.00	-2.17	-4.26	-16.33**	-1.27	-2.50	-17.02**
R1679-1674-1-234-1	-8.12**	-24.65**	-31.79**	3.09*	-13.79**	-26.47**	2.56	5.26*	2.56	-0.10	-18.17**	-28.37**	-10.13**	-29.00**	-39.57**
R1519-815-1-646-1	0.13	-8.35**	-0.26	5.88**	-2.88*	-0.74	5.41*	8.33**	0.00	0.22	-10.23**	-0.57	-22.44**	-24.29**	-32.34**
R1551-1066-1-449-1	28.03**	2.55	-7.18**	22.33**	8.62**	-7.35**	-13.25**	-5.26*	-7.69**	38.34**	14.57**	0.29	-8.38**	-23.50**	-34.89**
R1630-342-1-47-1	15.76**	1.42	-8.21**	15.98**	9.48**	-6.62**	-5.00*	0.00	-2.56	21.42**	9.49**	-4.30	-15.84**	-19.00**	-31.06**
R1665-1620-1-985-1	-0.95	-4.95**	-6.41**	16.39**	10.94**	4.41**	-2.63	-2.63	-5.13*	19.53**	13.95**	10.03**	21.52**	20.00**	2.13
RNR2354	-19.73**	-23.37**	-30.77**	-9.65**	-11.21**	-24.26**	12.00**	13.51**	7.69**	-19.31**	-19.64**	-29.80**	-3.90	-7.50**	-21.28**
Improved pusa basmati	-21.49**	-28.07**	-21.79**	-8.53**	-16.90**	-13.24**	9.33**	10.81**	5.13*	-16.46**	-25.00**	-17.48**	-15.00**	-22.08**	-20.43**

*= Significant P > 0.05, **= Significant P > 0.01, MP= Mid Parent Heterosis, BP= Better Parent Heterosis, SH= Standard Heterosis

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COMPETITIVE BEHAVIOR OF WEED FLORA IN WETLAND RICE ECOSYSTEM AS INFLUENCED BY NUTRIENT MANAGEMENT AND SPACING

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Abstract: A field experiment was conducted at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala to study the extent of crop-weed competition for nutrients and space as influenced by nutrient management and plant population in a wetland rice ecosystem. The treatments included four levels of nutrient management and three levels of crop spacing. The results indicated that by altering nutrient management and adjusting the plant population, the competitive ability of rice crop could be improved and weed management made more efficient and economic. During both the seasons, at 20 and 40 DAT, the weed density and dry weight were the lowest when NPK @ 90:45: 45 kg ha^{-1} was applied with 25 per cent N as organic while at 60 DAT the enhanced nutrient level of NPK @112.5:56:25:56.25 kg ha^{-1} applied with 25 per cent N as organic recorded the lowest weed density values. The general trend was that, though weed growth increased with increasing nutrient levels, partial organic substitution had a positive effect in suppressing weed growth. At all growth stages the weed growth parameters were minimum in closer spacing of 15 X 15 cm. An overall analysis of the weed growth and crop performance indicated that the enhanced nitrogen especially when it is applied in an integrated manner with organic substitution benefited the rice crop more than the weeds through altering the micro environment in favour of rice.

Keywords: Crop, Nutrients, Spacing, Rice

INTRODUCTION

Weeds compete with crops for one or more plant growth factors such as water, mineral nutrients, solar energy and space and the factors excluding water are found to be limiting in wetland situations. Crop plants vary greatly in their ability to compete with the associated weeds and the total effect of interference as reflected in the crop growth and yield, results mainly from competition for nutrients, moisture and sunlight (Rao, 2000). Changes in cultivation methods results in wide variation in species composition and diversity (Tomita *et al.*, 2003). Making rice more competitive by adjusting the plant population and altering nutrient management techniques is an effective eco-friendly technique for weed management (Pamplona *et al.*, 1990). A study of these factors, which aid in manipulating crop environment to the disadvantage of weeds so that they can be outgrown by crop plants should be highly appreciated (Gupta, 2009). The present study was undertaken to study the extent of crop-weed competition for nutrients and space as influenced by nutrient management and plant population

MATERIAL AND METHOD

The field experiments were conducted during the first and second crop seasons of 2010 in the wetlands of the Instructional farm attached to College of Agriculture, Vellayani located at 8.5°N latitude and 76.9°E longitude and at an altitude of 29 m above mean sea level (MSL). The rice variety used for the experiment was PTB 52 (Aiswarya) released from Rice Research Station, Pattambi. The experimental area was puddled twice and leveled. Weeds and stubbles were removed by hand picking. Five blocks with 12 treatment combinations each were laid out in strip plot design. The plots were separated with channels of 60 cm width and each block were separated with channels of 1 m width. The treatments included N_1 – NPK @ 90:45:45 kg ha^{-1} with 100 % N as chemical fertilizer (POP), N_2 – NPK @ 90:45:45 kg ha^{-1} with 75 % N as chemical fertilizer and 25 % N as organic, N_3 – NPK @ 112.5:56.25:56.25 kg ha^{-1} with 100 % N as chemical fertilizer, N_4 – NPK @ 112.5:56.25:56.25 kg ha^{-1} with 75 % N as chemical fertilizer and 25 % N as organic under three spacings (p_1- 15 X 15, p_2- 20 X 15, p_3- 20 X 20cm). All the treatments uniformly received FYM @ 5 t ha^{-1} as per package of practices recommendations for rice, Kerala Agricultural University.

RESULT AND DISCUSSION

Weed spectrum in the rice ecosystem

In the present investigation, the weed spectra observed in the experimental field was quite diverse with three specii of grasses, four specii of sedges, five specii of broad leaved weeds and two ferns. Among them the grass *Isachne miliacea* Roth ex Roem et Schult., the sedge *Cyperus iria* L., the broad leaved weed Lindernia grandiflora and the ferns *Marsilea quadrifoliata* Linn., and *Salvinia molesta* D.S. Mitch. were present throughout the crop growth period in both the years emphasizing its ubiquitous nature in the ecosystem under study.

Effect of nutrient management on weed density and weed dry weight

The weed density was found to be influenced significantly by the sources and levels of nutrients. The general trend was that during both seasons at 20 and 40 DAT, the density was the lowest when NPK

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@ 90:45: 45 kg ha^{-1} was applied with 25 per cent N as organic (n_2) (Table 1 & 2.) while at 60 DAT the enhanced nutrient level of NPK @112.5:56:25:56.25 kg ha^{-1} applied with 25 per cent N as organic (n_4) recorded the lowest value (Table 3.). The effect of nutrient management on weed dry weight was also statistically significant and followed the same trend as in weed density. The pooled data also confirmed this trend in weed infestation (Table 4)

Experiments conducted by Gallandt *et al.* (1999) revealed that soil fertility management could be used to manipulate weed dynamics, so that weed control could be improved, to favor the crop. The results of the present study showed that though the weed density in the wetland rice crop increased with increased levels of nutrients, the plots which received enhanced nutrient level with organic substitution was superior in suppressing the weed growth.

Effect of crop spacing on weed density and weed dry weight

The results revealed that crop spacing also had pronounced influence on weed growth in the rice field. During both years, the weed density was the lowest at all growth stages under the closer spacing of 15 X 15 cm (p_1) and the difference was statistically significant in most of the observations. The weed dry weight also followed a similar trend. Several scientists have also opined that when rice was grown at closer spacing the crop became more competitive and weed population was reduced (Ghosh and Singh, 1996, Gogoi, 1998., Bisht *et al.,*1999). Higher plant density of 44 plants m^{-2} resulted in significant reduction of dry matter accumulation by weeds over plant densities of 33 plants m^{-2} (Brar and Walia, 2001). However there are also contradictory reports that increased weed densities were observed when spacing was increased from 10 X 10 cm to 40 X 40 cm (Sankar, 1979) emphasizing the theory that the extent of weed – crop interference, which varies widely in both space and time depends on numerous factors such as crop and weed species, duration and intensity of weed growth, time of occurrence of weeds, nutrient and water status of soils and cropping practices.

Even though the dry weight of weeds was reduced by closer spacing, the variation between treatments tended to be less pronounced than in the case of weed density. A probable explanation is that under closer spacing, the sprouted weed seedlings could not harness enough resources for vigorous growth and dry matter accumulation. Jacob (2002) has also reported similar observations from his study on impact of plant population on the performance of Basmati rice.

Effect of interaction between nutrient management and crop spacing on weed density and weed dry weight

Though not always consistent, from the pooled analysis data it was evident that the combined effect of nutrient management and crop spacing on both weed density and weed dry weight was significant in the present experiment. The general trend was that the plots which received lower nutrient levels with organic substitution and when planted closely (n_2p_1) was superior in terms of weed suppression. This of course was a reflection of the individual effect of these factors on the weed growth parameters.

CONCLUSION

Thus the results of the present study showed that though the weed density in the wetland rice crop increased with increased levels of nutrients, the plots which received enhanced nutrient level with organic substitution was superior in suppressing the weed growth emphasizing that proper nutrient management was an indirect tool for better weed management. An overall analysis of the weed growth and crop performance indicated that the enhanced nitrogen especially when it is applied in an integrated manner with organic substitution was found to have benefited the crop more than the weeds. After critically analyzing the overall effect of nutrient management and crop spacing on weed growth and crop productivity, it can be concluded that by altering nutrient management and adjusting the plant population, the competitive ability of rice crop could be improved and weed management made more efficient and economic.

Table 1. Weed density (no. m^{-2}) in wetland rice ecosystem at 20 DAT as influenced by nutrient management and plant density

Treatments	First crop season			Second crop season		
	Grasses	Sedges	BLW	Grasses	Sedges	BLW
n_1	12.9	38.0	19.1	20.5	18.3	11.8
n_2	11.5	24.3	17.8	22.3	11.7	11.7
n_3	14.3	24.6	14.7	24.8	13.3	10.8
n_4	17.5	39.7	15.9	24.7	14.5	11.9
SEM(3,12)	0.0746	0.0993	0.0594	0.0954	0.0808	0.0396
C.D (0.05)	0.230	0.306	0.183	0.294	0.249	0.122
p_1	14.6	25.6	14.8	24.8	13.9	11.1
p_2	14.3	32.5	17.2	25.7	15.9	11.8

p_3	13.4	36.9	18.7	18.8	13.5	11.9
SEM (2,8) C.D (0.05)	0.0540 0.176	0.0914 0.298	0.0770 0.251	0.0785 0.256	0.0288 0.094	0.0310 0.101
$n_1 p_1$	13.2	28.4	17.4	23.4	16.8	11.0
$n_1 p_2$	14.4	49.8	19.4	22.6	23.2	12.0
$n_1 p_3$	11.2	35.8	20.4	15.4	14.8	12.4
$n_2 p_1$	12.4	15.2	14.6	24.8	10.8	10.8
$n_2 p_2$	11.4	27.0	21.6	25.8	12.6	12.2
$n_2 p_3$	10.8	30.8	17.2	16.4	11.8	12.0
$n_3 p_1$	16.4	23.6	13.4	27.2	17.2	11.4
$n_3 p_2$	13.0	19.8	14.6	26.2	10.8	10.4
$n_3 p_3$	13.4	30.4	16.2	21.0	12.0	10.6
$n_4 p_1$	16.2	35.2	13.8	23.6	10.8	11.0
$n_4 p_2$	18.2	33.2	13.2	28.0	17.2	12.4
$n_4 p_3$	18.2	50.8	20.8	22.4	15.4	12.4
SEM (6.24) C.D (0.05)	0.1172 0.342	0.1617 0.472	0.1096 0.320	0.1504 0.439	0.1220 0.356	0.0846 0.247

Table 2. Weed density (no. m^{-2}) in wetland rice ecosystem at 40 DAT as influenced by nutrient management and plant density

Treatments	First crop season			Second crop season		
	Grasses	Sedges	BLW	Grasses	Sedges	BLW
n_1	14.9	49.5	37.5	25.0	11.8	20.6
n_2	9.3	46.5	37.3	15.5	10.7	28.0
n_3	16.3	48.5	35.0	22.3	10.1	30.6
n_4	34.3	46.4	31.7	22.6	11.1	29.3
SEM(3,12) C.D (0.05)	6.6751 20.57	0.1502 0.463	0.0840 0.259	0.1289 0.389	0.1139 0.351	0.0643 0.198
p_1	16.2	37.4	31.1	20.0	11.2	25.4
p_2	26.9	50.1	39.4	25.7	9.9	31.1
p_3	13.0	55.8	35.8	18.4	11.7	24.9
SEM (2,8) C.D (0.05)	5.7617 NS	0.1300 0.424	0.126 0.416	0.1392 0.454	0.0282 0.092	0.0555 0.181
$n_1 p_1$	14.6	31.8	26.0	18.8	12.0	17.4
$n_1 p_2$	21.6	59.8	46.8	36.6	10.6	26.6
$n_1 p_3$	8.6	56.8	39.6	19.6	12.8	17.8
$n_2 p_1$	7.4	41.4	34.8	13.0	12.8	30.2
$n_2 p_2$	8.4	50.8	47.0	18.0	8.4	28.8
$n_2 p_3$	12.2	47.4	30.2	15.6	10.8	25.0
$n_3 p_1$	18.0	34.1	31.2	22.2	10.2	19.6
$n_3 p_2$	15.0	48.0	33.8	23.0	10.0	36.8
$n_3 p_3$	15.8	63.4	40.0	21.6	10.2	35.4
$n_4 p_1$	25.0	42.1	32.2	26.0	9.6	34.4
$n_4 p_2$	62.6	41.6	29.8	25.0	10.8	32.0
$n_4 p_3$	15.4	55.4	33.2	16.8	13.0	21.6
SEM (6.24) C.D (0.05)	11.2748 32.911	0.2138 0.624	0.2062 0.602	0.2097 0.612	0.1871 0.546	0.1929 0.563

Table 3. Weed density (no. m^{-2}) in wetland rice ecosystem at 60 DAT as influenced by nutrient management and plant density

Treatments	First crop			Second crop		
	Grasses	Sedges	BLW	Grasses	Sedges	BLW
n_1	23.7	21.5	47.6	31.5	12.1	53.6
n_2	16.4	33.1	37.1	28.8	11.6	34.7
n_3	23.9	28.3	40.5	32.0	10.3	52.3
n_4	24.7	24.7	25.3	23.6	10.2	26.9

SEM(3,12) C.D (0.05)	0.0915 0.282	0.282 0.879	0.1165 0.359	0.0701 0.216	0.0750 0.231	0.0866 0.267
p_1	21.8	22.7	28.2	27.2	10.8	33.3
p_2	24.3	31.2	46.1	29.5	10.6	47.0
p_3	20.5	26.8	38.6	30.3	11.8	45.3
SEM (2,8) C.D (0.05)	0.0806 0.263	0.3155 1.029	0.1223 0.399	0.0951 0.310	0.1487 0.485	0.1699 0.554
$n_1 p_1$	27.4	18.6	39.0	25.6	12.2	45.6
$n_1 p_2$	29.0	24.0	54.8	32.0	11.0	70.0
$n_1 p_3$	14.6	22.0	49.0	36.8	13.0	45.2
$n_2 p_1$	17.6	24.8	23.6	26.8	10.4	27.6
$n_2 p_2$	15.6	38.2	47.0	28.6	11.0	40.0
$n_2 p_3$	16.0	36.4	40.6	31.0	13.4	36.4
$n_3 p_1$	21.6	28.2	27.2	31.4	10.3	36.8
$n_3 p_2$	25.6	32.2	56.6	29.6	10.0	50.8
$n_3 p_3$	24.4	24.4	37.6	35.0	10.6	69.2
$n_4 p_1$	20.6	19.1	22.8	24.8	10.2	23.2
$n_4 p_2$	26.8	30.4	26.0	27.6	10.4	27.2
$n_4 p_3$	26.8	24.5	27.0	18.4	10.0	30.4
SEM (6.24) C.D (0.05)	0.1706 0.498	0.5293 1.545	0.2336 0.682	0.2025 0.591	0.1781 0.520	0.2241 0.654

Table 4. Total dry weight (g m^{-2}) of weeds in wetland rice ecosystem as influenced by nutrient management and plant density

Treatments	20 DAT			40 DAT			60 DAT		
	First crop	Second crop	Pooled	First crop	Second crop	Pooled	First crop	Second crop	Pooled
n_1	80.83	76.43	78.63	108.00	87.13	97.57	115.20	126.30	120.75
n_2	64.80	72.97	68.88	94.37	68.17	81.27	96.87	108.03	102.45
n_3	67.90	78.03	72.97	112.07	86.43	99.25	115.87	121.67	118.77
n_4	89.97	80.27	85.12	119.03	84.77	101.90	100.37	87.43	93.90
SEM(3,12) C.D (0.05)	0.001 0.001	0.0047 0.0103	0.002 0.005	0.0471 0.1027	0.001 0.001	0.024 0.051	0.001 0.001	0.001 0.001	0.001 0.001
p_1	70.65	79.76	75.20	98.65	79.03	88.84	94.90	101.12	98.01
p_2	76.45	84.23	80.34	115.08	93.45	104.26	119.92	114.87	117.40
p_3	80.53	66.80	73.66	111.38	72.40	91.89	106.40	116.57	111.49
SEM(2,8) C.D (0.05)	0.001 0.001	0.0041 0.0094	0.002 0.005	0.0408 0.0941	0.001 0.001	0.020 0.047	0.001 0.001	0.001 0.001	0.001 0.001
$n_1 p_1$	71.30	81.30	76.30	85.60	70.90	78.25	113.50	106.90	110.20
$n_1 p_2$	95.90	84.90	90.40	132.10	116.70	124.40	138.70	137.90	138.30
$n_1 p_3$	75.30	63.10	60.00	106.30	73.80	95.00	93.40	134.10	113.75
$n_2 p_1$	56.70	78.80	67.75	82.80	66.00	74.40	84.30	96.90	90.60
$n_2 p_2$	68.30	78.60	73.45	103.00	71.20	87.10	103.30	111.20	107.25
$n_2 p_3$	69.40	61.50	65.45	97.30	67.30	82.30	103.00	116.00	109.50
$n_3 p_1$	72.00	81.30	76.65	100.20	81.00	90.60	100.60	114.10	107.35
$n_3 p_2$	59.20	79.10	69.15	107.60	92.10	99.85	127.20	111.20	119.20
$n_3 p_3$	72.50	73.70	73.10	128.40	86.20	107.30	119.80	139.70	129.75
$n_4 p_1$	82.60	77.62	80.11	126.00	98.20	112.10	81.20	86.60	83.90
$n_4 p_2$	82.40	94.30	88.35	117.60	93.80	105.70	100.50	99.20	104.85
$n_4 p_3$	104.90	68.90	86.90	113.50	62.30	87.90	109.40	76.50	92.95
SEM(6,24) C.D (0.05)	0.001 0.001	0.0082 0.0165	0.0040 0.0080	0.0816 0.1649	0.001 0.001	0.041 0.082	0.001 0.001	0.001 0.001	0.001 0.001

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EFFECT OF DROUGHT AT FLOWERING STAGE ON YIELD AND YIELD COMPONENTS OF RAINFED LOWLAND RICE

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Abstract: Drought is a major factor limiting rice production in India. Its occurrence at flowering stage is very common in rainfed lowland rice which leads to a considerable yield reduction or even crop failure some times. The study was therefore, contemplated to determine the effect of drought stress at flowering stage on yield and some yield attributing parameters of four rice varieties viz., IR-42, NDR 8002, BPT 5204 and TCA-48. The experiment was carried out in plastic tubs in a completely randomized design with three replications. Varieties were subjected to three water stress treatments (saturated or 100% available soil moisture regime (ASMR), 50% ASMR, 25% ASMR) at flowering stage by withholding water application. The study revealed that drought reduced significantly the grain yield and yield attributing characters, EBT plant^{-1}, test weight, panicle length, total grains panicle^{-1} and fertile grains panicle^{-1} of all the varieties; but to a greater extent at 25% ASMR. Sterility of varieties under saturated condition varied from 11 to 16%, which increased to the tune of 17 to 32% and 26 to 40% under 50% and 25% ASMR, respectively. Significant drought and varieties interaction effects were exhibited for EBT plant^{-1}, sterile grains panicle^{-1} and fertile grains panicle^{-1}, indicating significant differences of drought levels and genetic differences for these traits. Amongst the varieties, NDR-8002 and TCA-48 were noted to be relatively more drought tolerant than others on the basis of assessment of their yield performance.

Keywords: Rice, Flowering stage, Drought, Yield

INTRODUCTION

Drought is the most important abiotic constraint that reduces yield of rice in rainfed areas (Bernier *et al.*, 2009). It is estimated that 50% of the world's rice production is affected more or less by drought (Bouman *et al.*, 2005). It frequently occurs in those areas, which solely depend on rainfall for irrigation. In eastern India, around 10 million ha area under rice is rainfed lowland. Stable and high yields of rainfed lowland rice are important for food security in many of the subsistence farming system in Asia (Cooper, 1999). In rice, the effect of drought varies with the variety, degree and duration of stress and its coincidence with different growth stages (Kato, 2004). In contrast with other crops, rice is particularly more sensitive to water stress especially at critical growth stages such as panicle initiation, flowering and grain filling (Tao *et al.*, 2006, Yang *et al.*, 2008). Drought at flowering stage is highly detrimental to rice plants. It hampers anthesis and seed setting leading to higher spikelet sterility and lower yield in rice (Ram *et al.*, 1988). It also reduces effective leaf area and photosynthesis, thus plants have to depend on pre-anthesis reserves which may impart tolerance against internal water deficits (Austin *et al.*, 1980). Though plants have naturally evolved several stress adaptive strategies, most of them pertain to survival of plants under stress. However, from the agricultural point of view, any stress adaptive strategy, drought stress in particular, would be useful only if it is associated with superior crop yield under a given stressful environment (Kar *et al.* 2005). Response of different plants to water stress is much complex and various mechanisms are adopted by plants when they encounter drought stress at various growth stages (Levitt, 1980; Jones, 2004). Even behaviour of genotypes within a species is also different. So, one of the strategies to abate drought stress is selection of a genotype expressing comparatively better drought tolerance (Suriyan *et al.*, 2010). It is, therefore necessary to study the performance of genotypes under water stress with the objective of improving crop performance in the drought prone areas of India. Hence, the present endeavour was an attempt to assess the impacts of drought stress at flowering stage on the performance of the rice varieties in terms of the yield and yield components.

MATERIAL AND METHOD

The present study was carried out in plastic tubs at the experimental site of the Department of Crop Physiology, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during *Kharif* season of 2011. The experiment consisted four rice varieties (viz. IR-42, NDR 8002, BPT 5204, TCA-48) and three drought treatments (saturated or 100% available soil moisture regime (ASMR), 50%

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ASMR, 25% ASMR) which was imposed at flowering stage. The experiment was planned in completely randomized design (Factorial) with three replications. The soil was silt loam type having a pH of 7.8. The native N, P and K contents were 124 kg/ha, 18 kg/ha and 220 kg/ ha respectively. Seeds were directly sown in tubs. Thinning was done in each tub after seedling emergence and only ten healthy and uniform plants were maintained. Plants under saturated condition were irrigated normally. 50% and 25% ASMR was maintained by withholding irrigation in tubs. After 4 days of water withholding in tubs, soil sampling was done periodically and moisture content was computed. When moisture content in soil reached to 14.5% in 50% ASMR and 10.75% in 25% ASMR, drought treatment was terminated by irrigating the tubs. Yield and yield components were recorded at harvest of the crop as follows:

No. of EBT (ear bearing tiller) /plant

EBT were counted on tagged plants and average was taken to express number of EBT/plant.

Panicle length (cm)

Panicle lengths at maturity in each treatment were measured from the base to the apex of panicle with the help of a meter scale.

Total grains/panicle

Grains were carefully separated from panicles of tagged plants and total number of grains per panicle was counted for each treatment.

Fertile and Sterile grains/ panicle

After carefully separating the grains from panicles of tagged plants, total number of fertile and sterile grains per panicle was counted for each treatment.

Sterility percentage

The sterility percentage was calculated as: (total number of sterile grains/ total number of grains) x 100.

Test weight

1000 seeds from each treatment were counted and weighted for assessing test weight in each treatment.

Grain yield (g/plant)

Panicles of tagged plants were separated from plant. Then grains were collected and weighed with the help of electronic balance.

Statistical Analysis

The statistical analysis of experimental data was done by the method described by Panse and Sukhatme (1978) using completely randomized design (CRD) factorial experiment. The comparison of the treatment means made with the help of least significant differences ($P<0.05$).

RESULT

EBT /plant

A close perusal of the data evidently revealed a drastic reduction in EBT/plant of all varieties under both moisture stresses and maximum reduction was observed at 25% ASMR (Table 1). At 50% ASMR, only IR-42 showed significant reduction in EBT/plant over saturated condition, while at 25% ASMR, all varieties exhibited significant reduction. Under both 50% and 25% ASMR, highest EBT were found in NDR-8002. Per cent decrease in EBT at both 50% and 25% ASMR with respect to saturated condition were less in TCA-48 and NDR-8002, while IR-42 had highest reduction. Mean effect of variety showed highest number of EBT in NDR-8002 followed by BPT-5204, IR-42 and TCA-48. Mean effect of stress indicated that reduction in EBT was about double at 25% ASMR as compared to 50% ASMR.

Panicle length

The panicle length reduced significantly due to moisture stress (Table1). Extent of reduction was relatively higher at 25% ASMR as compared to 50% ASMR. Reduction in panicle length at 50% and 25% ASMR over saturated condition varied from 12 (NDR-8002) to 22% (IR-42) and 16 (NDR-8002) to 32% (IR-42), respectively. Thus, it is clear that under both moisture stresses, lowest and highest reduction in panicle length were found in NDR-8002 and IR-42 respectively. Mean effect of variety showed highest panicle length in NDR-8002 followed by TCA-48, while BPT-5204 had lowest. Mean effect of stress indicated 17.1% and 23.1% reduction in panicle length at 50% and 25% ASMR, respectively over saturated condition.

Table 1. Effect of drought at flowering stage on EBT/plant and panicle length of rainfed lowland rice

Varieties	Number of EBT/plant				Panicle length (cm)			
	Saturated condition	50% ASMR	25% ASMR	Mean	Saturated condition	50% ASMR	25% ASMR	Mean
IR-42	6.67	5.34 (19.9)	4.37 (34.5)	5.46	22.3	17.39 (22.0)	15.16 (32.0)	18.28

NDR-8002	7.43	7.00 (5.7)	6.27 (15.6)	6.90	32.1	28.24 (12.0)	26.96 (16.0)	29.10
BPT-5204	5.57	5.03 (9.6)	4.48 (19.6)	5.02	20.4	16.12 (20.9)	14.80 (27.4)	17.10
TCA-48	5.00	4.71 (5.8)	4.43 (11.4)	4.71	26.7	22.4 (16.10)	21.09 (21.0)	23.40
Mean	6.17	5.52 (10.5)	4.89 (20.7)		25.37	21.03 (17.1)	19.50 (23.1)	
SEm	V = 0.13	D = 0.11	V x D = 0.23		V = 0.54	D = 0.47	V x D = 0.94	
CD at 5%	V = 0.38	D = 0.33	V x D = 0.66		V = 1.56D = 1.35		V x D = NS	

(Note: Values in parenthesis indicate per cent decrease due to 50% and 25% ASMR calculated over saturated condition; ASMR- Available Soil Moisture Regime)

Total grains/panicle

Number of total grains per panicle as influenced by drought at flowering stage has been given in Table 2. All the varieties showed marked reduction in total grain number at both 50% and 25% ASMR, however magnitude of reduction was more at 25% ASMR. Per cent reduction in total grains per panicle at 50% ASMR over saturated condition ranged from 8.5 to 17.9% which increased to the tune of 12.7 to 25.5% at 25% ASMR. At both 50% and 25% ASMR, minimum per cent reduction in total grains was observed in NDR-8002 followed by TCA-48, BPT-5204 and IR-42. Mean effect of variety indicated highest grain number in BPT-5204 which was significantly higher than other varieties.

Fertile grains/ Panicle

Like total grains, numbers of fertile grain per panicle were also decreased at 50% and 25% ASMR and maximum decrease was found at 25% ASMR (table 2). All the varieties showed significant reduction in fertile grains at 50% and 25% ASMR over saturated condition. At both 50% and 25% ASMR, maximum fertile grains were found in NDR-8002 which was at par to BPT-5204 and significantly higher than other varieties. Per cent reduction in fertile grains at 50% and 25% ASMR over saturated condition varied from 15.3 (NDR-8002) to 35.9% (IR-42) and 27.9 (NDR-8002) to 42.51% (IR-42), respectively. Mean effect of variety showed highest fertile grain in BPT-5204 which was at par to NDR-8002 and significantly higher than other varieties. Mean effect of stress indicated 25.5% and 36.6% reduction in fertile grains at 50% and 25% ASMR, respectively over control.

Table 2. Effect of drought at flowering stage on total grains and fertile grains/panicle of rainfed lowland rice

Varieties	Number of total grains/panicle				Number of fertile grains/panicle			
	Saturated condition	50% ASMR	25% ASMR	Mean	Saturated condition	50% ASMR	25% ASMR	Mean
IR-42	94.75	77.72 (17.9)	70.61 (25.5)	81.03	82.43	52.78 (35.9)	42.51 (48.4)	59.24
NDR-8002	139.00	127.23 (8.5)	121.36 (12.7)	129.20	124.26	105.22 (15.3)	89.56 (27.9)	106.35
BPT-5204	160.00	133.51 (16.6)	126.12 (21.2)	139.88	141.76	96.93 (31.6)	83.62 (41.0)	107.44
TCA-48	120.5	105.00 (12.9)	99.13 (17.7)	108.21	100.35	79.28 (21.0)	69.09 (31.1)	82.91
Mean	128.56	110.86 (13.8)	104.30 (18.9)		112.20	83.55 (25.5)	71.19 (36.6)	
SEm	V = 2.85	D = 2.47	V x D = 4.95		V = 2.14	D = 1.85	V x D = 3.71	
CD at 5%	V = 8.26	D = 7.15	V x D = NS		V = 6.19	D = 5.36	V x D = 10.72	

(Note: Values in parenthesis indicate per cent decrease due to 50% and 25% ASMR calculated over saturated condition; ASMR- Available Soil Moisture Regime)

Sterile grains/ Panicle

All varieties recorded significant increase in sterile grains per panicle at 50% and 25% ASMR over saturated condition (Table 3). At both 50% and 25% ASMR, BPT-5204 recorded significantly higher number of sterile grains than rest of the varieties. Lowest numbers of sterile grains were observed in NDR-8002 and IR-42 at 50% and 25% ASMR, respectively. Mean effect of varieties indicated highest number of sterile grains in BT-5204 followed by TCA-48, NDR-8002 and IR-42. Mean effect of stress showed 40.6% and 51% increase in sterile grains per panicle at 50% and 25% ASMR, respectively over saturated condition.

Sterility percentage

A tremendous increase in sterility percentage of all varieties was found due to moisture stresses at flowering stage (Table 3). Sterility of varieties under saturated condition varied from 10.6 to 16.3%, while at 50% and 25% ASMR, it varied from 17.3 to 32.1% and 26.2 to 39.8%, respectively. Under both 50% and 25% ASMR, lowest sterility % was observed in NDR-8002 and highest in IR-42. Mean effect of variety showed highest sterility % in IR-42 followed by BPT-5204, TCA-48 and NDR-8002.

Table 3. Effect of drought at flowering stage on sterile grains /panicle and sterility % of rainfed lowland rice

Varieties	Number of sterile grains/ panicle				Sterility (%)			
	Saturated condition	50% ASMR	25% ASMR	Mean	Saturated condition	50% ASMR	25% ASMR	Mean
IR-42	12.31	24.94 (50.6)	28.10 (56.2)	21.78	13.00	32.1	39.8	28.3
NDR-8002	14.73	22.01 (33.1)	31.80 (53.7)	22.84	10.6	17.3	26.2	18.0
BPT-5204	18.24	36.58 (50.1)	42.50 (57.1)	32.44	11.4	27.4	33.7	24.2
TCA-48	19.64	25.73 (23.7)	30.04 (34.6)	25.14	16.29	24.5	30.3	23.7
Mean	16.23	27.31 (40.6)	33.11 (51.0)		12.82	25.3	32.5	
SEm	V = 0.63	D = 0. 54	V x D = 1.09		-	-	-	
CD at 5%	V = 1.82	D = 1.58	V x D = 3.16		-	-	-	

(Note: Values in parenthesis indicate per cent decrease due to 50% and 25% ASMR calculated over saturated condition; ASMR- Available Soil Moisture Regime)

Table 4. Effect of drought at flowering stage on test weight (1000 grains) and grain yield of rainfed lowland rice

Varieties	Test weight (g)				Grain yield (g plant^{-1})			
	Saturated condition	50% ASMR	25% ASMR	Mean	Saturated condition	50% ASMR	25% ASMR	Mean
IR-42	27.76	24.61 (11.3)	23.84 (14.11)	25.40	16.41	11.32 (31.0)	8.50 (48.2)	12.07
NDR-8002	33.31	31.98 (4.0)	31.31 (6.5)	32.20	23.01	19.09 (17.0)	15.60 (32.2)	19.23
BPT-5204	23.21	21.95 (5.4)	20.26 (12.7)	21.80	20.01	14.80 (26.0)	11.40 (43.0)	15.40
TCA-48	30.82	28.81 (6.5)	28.13 (8.7)	29.25	19.36	15.10 (22.0)	12.00 (38.8)	15.48
Mean	28.77	26.83 (6.7)	25.88 (10.0)		19.70	15.08 (23.4)	11.87 (39.7)	
SEm	V = 0.65	D = 0. 56	V x D = 1.12		V = 0.38	D = 0. 32	V x D = 0.65	
CD at 5%	V = 1.88	D = 1.63	V x D = NS		V = 1.09	D = 0. 94	V x D = NS	

(Note: Values in parenthesis indicate per cent decrease due to 50% and 25% ASMR calculated over saturated condition; ASMR- Available Soil Moisture Regime)

Test weight

Test weight as influenced by moisture stress at flowering stage has been given in Table 4. All varieties showed a marked decrease in test weight at 50% and 25% ASMR with respect to saturated condition. Per cent reduction in test weight at 50% ASMR over saturated condition varied from lowest 4 (NDR-8002) to highest 11.3% (IR-42), while at 25% ASMR, it varied from lowest 6.5 (NDR-8002) to highest 14.1% (IR-42). Mean effect of variety showed highest test weight in NDR-8002 followed by TCA-48, IR-42 and BPT-5204.

Grain yield/plant

Moisture stress at flowering stage caused a severe reduction in grain yield of all varieties (Table 4). Per cent reduction in grain yield at 50% ASMR over saturated condition ranged from 17 to 31% which increased to the tune of 32.2 to 48.2% at 25% ASMR. Under both moisture stresses, minimum per cent reduction in grain yield was found in NDR-8002 followed by TCA-48, while IR-42 had highest reduction. Mean effect of varieties showed highest grain yield in NDR-8002 followed TCA-48, BPT-5204 and IR-42. Mean effect of stress exhibited 23.4% and 39.7% reduction in grain yield at 50% and 25% ASMR, respectively over saturated condition.

DISCUSSION

Yield of any crop is dependent on the combination of genetic makeup, physiological processes and yield attributes and any degree of imbalance in the said parameters may hamper the crop yield. Moreover, availability of sufficient water supply is inevitable to ensure maximum crop harvest in rice being a water loving crop (Basu *et al.* 2010). In the present experiment, the effect of moisture stress at flowering stage was clearly reflected in great reduction in almost all the yield traits measured. EBT/plant, panicle length, total grains per panicle, fertile grains per panicle, test weight and grain yield were markedly reduced under moisture stresses, however reduction in above traits were more at 25% ASMR in comparison to 50% ASMR. Since, grain yield is the product of EBT number, panicle length, fertile grains per plant and individual grain weight, hence reduction in all these components under moisture stresses accounted for decrease in grain yield. Similar to our findings reduction in grains per panicle, per cent filled grain and 1000 grain weight have been observed due to water stress in rice (IRRI, 1984). Yambao and Ingram (1988) also reported that water stress near flowering can reduce the number of fertile spikelet drastically. Our results also support the work of Sarvestani *et al.* (2008) who observed reduction in total biomass, harvest index, filled grain, unfilled grain and 1000 grain weight under water stress in rice cultivars. He also reported that water stress at flowering stage had a greater grain yield reduction than other times.

Flowering stage was more sensitive to water stress for 1000- grain weight, fertile grains per panicle and sterile grains per panicle leading to substantial decrease in these parameters. Water stress at flowering stage caused a significant reduction in grain size and grain weight which may be due to hindered translocation of assimilates towards grain filling resulting in decreased paddy yield due to hampered stomatal and hydraulic conductance. Pantuwan *et al.* (2002) and Cattivelli *et al.* (2008) also have reported hampered paddy yield because of drought stress at critical growth stages.

It was also observed that sterility % of different varieties increased with increase in moisture stress level. Similar to our results, Lafitte (2002) reported that drought stress around flowering time causes dramatic yield reduction due to spikelet sterility. According to O'Toole and Numuco (1983) decreased panicle exertion is a causal factor of spikelet sterility in water stressed rice.

The well watered plants had, more yield (g/plant), a higher fertility percentage and higher yields as compared to those subjected to water deficit. Similar results were reported by Yeo *et al*. (1996) who observed that water deficit reduces yield in *Oryza sativa*. Bouman and Toung (2001) also had similar results and concluded that rice crops are susceptible to drought which causes large yield losses in many countries. Yield depends on accumulation of dry matter and on its partitioning (Baruah *et al*., 2006). Grain yield of rice may be limited by the supply of assimilates to the developing grain (source limitation) or by the capacity of the reproductive organ to accept assimilates (sink capacity) (Sikuku *et al*., 2010). Low yield under drought treatments may be due to less number of ear bearing tillers per plant, reduction in total grain number per panicle, increase in sterile grains and a greatly decreased proportion of fertile grains and reduction in 1000- grain weight.

Our findings are in harmony with those of Yang *et al.*, (2001), Venuprasad *et al.*, (2008) and Wang *et al.*, (2010), who have stressed upon taking into account of different yield parameters during screening of rice varieties or while developing new rice varieties for drought prone areas. Similarly, Suriyan *et al.* (2010) has observed the ill effects of drought stress and reported that water deficit stress at the reproductive stage of four indica rice (*Oryza sativa* L.) genotypes adversely affected grain size, weight and ultimately paddy yield of all the varieties under study.

CONCLUSION

The results of present experiment clearly demonstrate that drought at flowering stage causes a severe reduction in grain yield and yield components of rice. Genetic differences were found among varieties for EBT plant^{-1}, sterile grains panicle^{-1} and fertile grains panicle^{-1}. NDR-8002 and TCA-48 recorded relatively lower reduction in grain yield and almost all yield contributing characters measured. These varieties have adaptive features for flowering stage drought tolerance and may be cultivated in drought prone areas and used as tolerant lines under breeding programs.

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EFFECT OF FYM AND WEED MANAGEMENT AND THEIR INTERACTION EFFECT ON WEED DYNAMICS, GROWTH, YIELD ATTRIBUTES AND YIELD OF DIRECT SEEDED RICE (*ORYZA SATIVA* L.) UNDER MINIMUM TILLAGE

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Abstract: Results revealed that, FYM @ 5 t ha^{-1} (F1) has significant impact on dry matter accumulation of crop, total tillers m^{-2} and effective tillers m^{-2}. Among weed management practices , hand weeding twice at 25 & 45 DAS (W7) produced significantly highest plant height, dry matter accumulation, total No. of tillers $meter^{-2}$, leaf area, leaf area index, number of effective tillers $meter^{-2}$, test weight (g), Crop growth rate, Absolute growth rate. Highest grain yield (4.21 t ha^{-1}) , straw yield (5.52 t ha^{-1}) and harvest index (51.54 %) was recorded under hand weeding twice at 25 & 45 DAS (W7), followed by Chemical weeding with bispyribac Sodium @ 20 g ha^{-1} 25 DAS (W1), gave grain yield (4.03 t ha^{-1}), straw yield (5.25 t ha^{-1}) and harvest index (51.37 %) . The lowest was recorded under unweeded check (W8). In the experimental field, *Commelina benghalensis* L., *Cyanotis axillaris* Schult. F., *Cyperus difformis* L., *Echinochloa colona* (L.) Link, *Monochoria vaginalis (Burm.f.) Kunth* were dominant weeds. The lowest weed density, weed dry matter production and relative weed density were recorded under hand weeding twice at 25 & 45 DAS (W7), followed by Chemical weeding with bispyribac Sodium @ 20 g ha^{-1} 25 DAS (W1). The highest economic return in terms of gross income (Rs. 42949.00) were obtained from hand weeding twice 25 & 45 DAS (W7), highest net income (26063.00) and B:C ratio (1.69) were obtained under chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1).

Keywords: Growth, Yield, Weed dynamics

INTRODUCTION

Rice is the most important cereal food crop of India, which occupies about 24 per cent of gross cropped area of the country. It contributes 42 per cent of total food grain production and 45 per cent of total cereal production of the country. Rice accounts for 35 to 75 per cent of the calories consumed by more than 3 billion Asians (Kumar *et al*., 2006) and is planted to about 154 millions hectare annually or on about 11 per cent of the total world's cultivated land. The FYM is common source of nutrients to the farmers, which can be prepared easily and contains substantial amount of plant nutrients. Incorporation of organic sources viz., FYM along with chemical fertilizers is effective in alleviating the nutrient deficiency in soil and enhance the yield potential as well. Line sowing coupled with application of herbicide may prove to be very promising on farmer's field. Most of the field experiments and on farm researches have established that direct seeded rice, if properly managed, can yield as high as transplanted rice (Singh and Bhatacharya, 1987). Change in the method of crop establishment from traditional *biasi* or manual transplanting of seedlings to direct line seeding has occurred in many Asian countries in the last two decades in response to rising production costs, especially for labour and water. Weeds are foremost barrier in enhancing yield of direct seeded rice. The extent of yield reduction of rice crop due to weeds is estimated from 15 to 95 per cent (Gogoi *et al.*, 1996). Weeds compete for moisture, nutrients, light and space and a consequence, weeds infestation in direct seeded rice (DSR) to the tune of 30 to 90 % yield loss, reduces grain quality and enhance the cost of production (Singh *et al*., 2009). Similarly weeds demand high lobour inputs for control (Labrada, 1998). Stale seed bed, tillage practices for land leveling, choice of competitive rice cultivars, mechanical weeders, herbicides and associated water management are component technologies essential to the control of weeds in DSR. Herbicides, in particular, are an important tool of weed management, but hand weeding is either partially or extensively practiced in India. Mechanical weeder can reduce the time required for weeding and the corresponding cost involved compared to hand weeding.

MATERIAL AND METHOD

The experimental site was located at Instructional cum-Research Farm, College of Agriculture, IGKV, Raipur (C.G.) during *kharif*, 2012 where adequate facilities for irrigation and drainage existed. Raipur is situated in central part of Chhattisgarh and lies at latitude, longitude of 21°16' N, 81°26' E, respectively and 290.20 meters above mean sea level. Climatologically, Raipur is classified as slightly moist hot zone. It receives an average annual rainfall of 1326 mm (based on 80 years mean). The soil of the experimental field was clay loam in texture *(Alfisols)* locally known as *"Dorsa"* soil. The soil was neutral in reaction (pH 7.41). It had low available nitrogen (220.00 kg ha^{-1}), medium available phosphorus (18.10 00 kg ha^{-1}) and potassium contents (313.00 kg ha^{-1}) . The experiment was laid out in Factorial randomized block design (F-RBD) and treatments were replicated thrice. The treatments comprised of two fertility (FYM) level and eight weed management practices. Fertility level consists of FYM, 0 t ha^{-1} and FYM, 5 t

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ha^{-1}. Weed management consist of Chemical weeding with bispyribac sodium @ 20 gm ha^{-1}, 25 DAS (W1), Mechanical weeding 25 DAS (W2), Mechanical weeding 25 DAS + hand weeding 45 DAS (W3), Hand weeding 25 DAS (W4), Hand weeding intra row 25 DAS + hand weeding 45 DAS (W5), Mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6), Hand weeding 25 & 45 DAS (W7) and unweeded check (W8). Rice variety "MTU-1010" was grown as test crop. FYM was applied manually @ 5 ton ha^{-1} after layout of the field then incorporated manually. Hebicide was sprayed with the help of knapsack sprayer and mechanical weeding was done with the help of ambika paddy weeder. Recommended dose of N; P_2O_5 and K_2O i.e. 80:40:30 kg ha^{-1} was applied through urea, Di-ammonium phosphate and Muriate of potash, respectively, The whole amount of P_2O_5 & K_2O was applied as basal, while nitrogen was applied in three splits *viz.* 50% as basal , 25% at 25 and remaining 25% at 45 DAS. Seeds rate was taken @ 80 kg ha^{-1} and treated with Carbendazim @ 2g kg^{-1} seeds and then sown at the depth of 4-5 cm. keeping the row distance of 20 cm on 12 july, 2012. The crop was harvested on 19 November, 2012. The data on pre harvest crop observations *viz.* Plant height (cm), , Number of total tillers (m^{-2}), Dry matter accumulation (g) were recorded at 20, 40, 60, 80 DAS and at harvest. Leaf Area (cm^2) was recorded up to 60 DAS. The data on weed density and weed dry matter production were recorded at 25, 30, 45 and 50 DAS from randomly selected two places from each net plot by using quadrate of 0.25 m^2 size and they were subjected to square root transformation before statistical analysis. The average values of weed control index for different weed management practices falling in particular fertility level were obtained by following standard method.

RESULT AND DISCUSSION

Effect of FYM and weed management on Weeds

Predominant weed species observed in the experimental field were *Commelina benghalensis, Cyanotis axillaris, Cyperus difformis, Echinochloa colonum* and *Monocharia vegenalis.*

FYM @ 5 t ha^{-1} produced higher weed density and dry weight.At 50 DAS, , the lower total weed density and total weed dry matter production was observed under hand weeding 25 & 45 DAS (W7), mechanical weeding 25 DAS + hand weeding 45 DAS (W3) and hand weeding intra row 25 DAS + Hand weeding 45 DAS (W5) than others. The highest total weed density was observed under unweeded check (W8). Among different weed management practices, hand weeding twice was effective in reducing weed dry matter production up to 50 DAS. Mechanical weeding 25 DAS+ hand weeding 45 DAS(W3) and hand weeding intra row 25 DAS+ hand weeding 45 DAS(W3) and hand weeding intra row 25 DAS+ hand weeding 45 DAS(W5) were also effective in reducing weed dry matter production up to 50 DAS because of complete removal of weeds.

Mechanical weeding at 25 DAS was not effective in reducing weed dry matter production because some weeds were left in between rows and weeds were incorporated in inter row spaces, which can grow and multiply again and increase in dry matter production . While hand weeding in 25 DAS (W4) was effective in reducing dry matter production up to 45 DAS because of completes removal and uprooting of weeds at 25 DAS. Mechanical weeding 25 DAS AND HAND WEEDING INTRA ROW 25 DAS were not sufficient in reducing dry matter production at 30 DAS. While mechanical weeding 25 DAS + hand weeding 45 DAS (W3) and hand weeding intra row 25 DAS+ hand weeding 45 DAS (W5) were effective in reducing weed dry matter production up to 50 DAS. When mechanical weeding weeding 25 DAS was supported by hand weeding 25 DAS (W6) it was effective in reducing dry matter production up to 45 DAS.

Table. Total weed density (No. m^{-2}) , Total weed dry weight (g m^{-2}) Weed Control Efficiency (%) as influenced by FYM level and weed management practices of direct seeded rice under minimum tillage

		Total weed density No. m^{-2}	**Total weed dry weight g m^{-2}**	**Weed Control Efficiency (%)**
	Treatments	**50 DAS**	**50 DAS**	**50 DAS**
	Fertility level			
F0	FYM @ 0 t ha^{-1}	4.80 (22.56)	2.60 (6.24)	60.49
F1	FYM @ 5 t ha^{-1}	6.18 (37.72)	3.22 (9.88)	52.77
	SEm±	**0.48**	**0.05**	
	CD 0.05	**0.33**	**0.16**	

	Weed management			
W1	Chemical weeding Bispyribac Sodium @ 20 g ha^{-1} 25 DAS	7.36 (53.60)	3.53 (11.96)	71.38
W2	Mechanical weeding 25 DAS	9.91 (97.80)	6.26 (38.64)	37.56
W3	Mechanical weeding 25 DAS + Hand weeding 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W4	Hand weeding 25 DAS	8.51 (71.84)	5.09 (25.40)	27.90
W5	Hand weeding intra row 25 DAS + Hand weeding 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W6	Mechanical weeding inter row followed by Hand weeding intra row 25 DAS	7.12 (50.24)	4.77 (22.28)	32.04
W7	Hand weeding 25 & 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W8	Unweeded check	14.30 (204.00	7.43 (54.64)	-
	SEm±	**0.23**	**0.11**	
	CD0.05	**0.67**	**0.32**	

*Original data are given in parenthesis

Effect on Crop Growth

FYM @ 5 t ha^{-1} recorded taller plant than the FYM @ 0 t ha^{-1} during 20 to 40 DAS. In general, the plant height increased with the advancement in age of the crop but the maximum increase was recorded during 20 to 40 DAS, while the pace of the growth was slowed down after 60 DAS. FYM @ 5 t ha^{-1} recorded higher plant dry matter accumulation than the FYM @ 0 t ha^{-1}. The tallest plants were recorded under hand weeding twice 25 & 45 DAS (W7) whereas it was at par with chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1). All the treatments of weed management were significantly superior over unweeded check (W8). Highest dry matter accumulation was obtained under hand weeding twice at 25 & 45 DAS (W7) but it was at par with chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1) at 60 and 80 DAS while it was at par with other weed management practices except unweeded check (W8) at harvest. The lowest plant dry matter accumulation was recorded under unweeded check (W8). Dry matter accumulation was highest under FYM @ 5 t ha^{-1}, because organic manure provide plant nutrient for plant growth and development. Sharma *et al* (1999) also found that the growth and vigour of rice plants were better with FYM application. Kundu *et al* (2004) also found that the growth factors like plant height, dry matter accumulation and yield respond positively when the crop was provided with inorganic nitrogen fertilizers along with FYM @ 5 t ha^{-1}. The highest number of total tillers was recorded under hand weeding twice 25 & 45 DAS (W7) and it was at par with, chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6) & hand weeding intra row 25 DAS + hand weeding 45 DAS (W5) treatments. The lowest number of total tillers was recorded under unweeded check (W8). The highest leaf area and leaf area index were recorded under, hand weeding twice 25 & 45 DAS (W7). Chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), hand weeding intra row 25 DAS + hand weeding 45 DAS (W5), and mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6) were at par with the hand weeding twice 25 & 45 DAS (W7). Mechanical weeding 25 DAS (W2) and Hand weeding 25 DAS (W4) were superior over unweeded check (W8).

Table. Plant height (cm), dry matter accumulation (g $m^{-}2$), Leaf area index as influenced by FYM level and weed management practices of direct seeded rice under minimum tillage

		Plant height (cm)	**Dry matter accumulation (g m^{-2})**	**Leaf area index**
	Treatments	**80 DAS**	**80 DAS**	**60 DAS**
	Fertility evel			
F0	FYM @ 0 t ha^{-1}	89.05	395.70	9.08
F1	FYM @ 5 t ha^{-1}	86.07	463.00	8.69

	SEm±	**0.60**	13.10	**0.184**
	CD (0.05)	**1.75**	**37.85**	**NS**
	Weed management			
W1	Chemical weeding (Bispyribac sodium @ 20 g ha^{-1} 25 DAS)	93.56	525.30	9.62
W2	Mechanical weeding (25 DAS)	83.58	389.05	8.38
W3	Mechanical weeding (25 DAS) + hand weeding (45 DAS)	88.60	416.45	9.02
W4	Hand weeding (25 DAS)	83.89	391.40	8.58
W5	Hand weeding intra row (25 DAS) + hand weeding (45 DAS)	87.00	404.15	8.87
W6	Mechanical weeding (inter row) followed by hand weeding (intra row) (25 DAS)	86.21	395.70	8.70
W7	Hand weeding (25 & 45 DAS)	94.54	535.85	9.69
W8	Unweeded check	83.07	376.85	8.21
	SEm±	**1.21**	**26.20**	**0.368**
	CD(0.05)	**3.50**	**75.75**	**1.063**

Effect on Yield Attributes and Yield

Among different weed management practices, hand weeding twice 25 & 45 DAS (W7) gave highest panicle length over other weed management practices. Chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), hand weeding 25 DAS (W4), hand weeding intra row 25 DAS + hand weeding 45 DAS (W5) and mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6) were at par with the hand weeding twice 25 & 45 DAS (W7). The smallest panicles were observed under unweeded check (W8). Hand weeding twice 25 & 45 DAS (W7) increased effective tillers, total no. of grains panicle^{-1} and filled grains panicle^{-1} and found significantly superior over other weed management practices but it was at par with chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), hand weeding intra row 25 DAS + hand weeding 45 DAS (W5), and mechanical weeding inter row fb hand weeding intra row 25 DAS (W6). The lowest total no. of grains panicle^{-1} was recorded under unweeded check (W8). Hand weeding twice 25 & 45 DAS (W7) proved significantly superior over rest of the other weed management practices in producing higher test weight, but it was found at par to chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1) . Hand weeding twice 25 & 45 DAS (W7) proved significantly superior over rest of the other weed management practices in producing higher grain yield and straw yield but it was found at par to chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), and hand weeding intra row 25 DAS + hand weeding 45 DAS (W5). Higher grain yield under these treatments was due to the weed managed at critical period of weed-crop competition and early crop growth, higher dry matter accumulation, high growth in terms of tiller numbers, which resulted in higher production of photo synthesis, and acts as a source and greater translocation of food materials to the reproductive parts resulted in superiority of yield attributing characters (tillers, filled grains panicle^{-1}, test weight) and ultimately high yield. Lower weed density and higher weed control efficiency also resulted in higher grain yield. The lowest grain yield was observed under unweeded check (W8). Nagappa and Biradar, (2002), have also reported the higher grain yield under two hand weedings. Saha *et al.* (2005) also found the highest grain yield (2.92 t ha^{-1}) under hand weeding twice. The lowest straw yield were observed under unweeded check (W8) due to the less dry matter accumulation of rice, less CGR, high weed infestation and high competition during critical periods, which does not allow the crop to grow their potential, and vice versa. Dhawas *et al* (1992) also reported the highest grain and straw yield under hand weeding twice.

Economics

FYM @ 0 t ha^{-1} fetched the higher gross return (Rs. 39048.00 ha^{-1}) and lowest gross return (Rs. 37530.00 ha^{-1}) was obtained with FYM @ 5 t ha^{-1}. Similarly, the net return was highest with FYM @ 0 t ha^{-1} (Rs. 26901.00 ha^{-1}) and lowest with FYM @ 5 t ha^{-1} (Rs. 24333.00 ha^{-1}), likewise B:C ratio was higher with FYM @ 0 t ha^{-1} (2.21) and lowest with FYM @ 5 t ha^{-1} (1.84). Among different weed management practices, higher gross return (Rs. 42949.00 ha^{-1}) was obtained by hand weeding 25 & 45 DAS (W7). While highest net return (Rs. 27082.00 ha^{-1}), and B: C ratio (1.88) was obtained by chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1).

Table 3. Effective tillers (no m^{-2}), Panicle length (cm), Filled grains panicle^{-1} (no.), Test weight (g) as influenced by FYM level and weed management practices of direct seeded rice under minimum tillage

		Effective tillers (no m^{-2})	**Panicle length (cm)**	**Filled grains panicle^{-1} (no.)**	**Test weight (g)**
	Treatments				
	Fertility evel				
F0	FYM @ 0 t ha^{-1}	235.10	22.62	97.83	24.3
F1	FYM @ 5 t ha^{-1}	236.45	23.21	105.64	23.5
	SEm±	**6.77**	**0.19**	**3.043**	**0.1**
	CD (0.05)	**NS**	**0.55**	**NS**	**0.2**
	Weed management				
W1	Chemical weeding (Bispyribac sodium @ 20 g ha^{-1} 25 DAS)	259.15	23.30	102.7	25.3
W2	Mechanical weeding (25 DAS)	226.65	22.69	97.46	23.5
W3	Mechanical weeding (25 DAS) + hand weeding (45 DAS)	249.60	23.18	102.53	24.8
W4	Hand weeding (25 DAS)	200.40	22.77	99.9	23.6
W5	Hand weeding intra row (25 DAS) + hand weeding (45 DAS)	243.75	22.79	101.9	23.8
W6	Mechanical weeding (inter row) followed by hand weeding (intra row) (25 DAS)	245.40	22.77	100.07	23.6
W7	Hand weeding (25 & 45 DAS)	266.65	23.86	115.93	25.6
W8	Unweeded check	194.60	21.98	93.4	23.1
	SEm±	**13.54**	**0.38**	**6.09**	**0.1**
	CD(0.05)	**39.10**	**1.10**	**17.58**	**0.3**

Table 4. Effective tillers (no. m^{-2}) as influenced by interaction of FYM level and weed management practices of direct seeded rice under minimum tillage

	Treatments	**Effective tillers (no. m^{-2})**		
		FYM Level		
		F0 (0 t ha^{-1})	F1 (5 t ha^{-1})	**Mean**

	Weed management			
W1	Chemical weeding (Bispyribac sodium @ 20 g ha^{-1} 25 DAS)	243.35	275.00	259.15
W2	Mechanical weeding (25 DAS)	235.00	218.35	226.65
W3	Mechanical weeding (25 DAS) + hand weeding (45 DAS)	238.35	260.85	249.60
W4	Hand weeding (25 DAS)	230.85	170.00	200.40
W5	Hand weeding intra row (25 DAS) + hand weeding (45 DAS)	251.65	235.85	243.75
W6	Mechanical weeding (inter row) followed by hand weeding (intra row) (25 DAS)	270.85	220.00	245.40
W7	Hand weeding (25 & 45 DAS)	231.65	301.65	266.65
W8	Unweeded check	179.15	210.00	194.60
	Mean	235.10	236.45	
		SEm±	**CD(0.05)**	
	Interaction (F X W)	**19.15**	**55.3**	

Table 5. Grain yield (t ha^{-1}), B:C Ratio, Harvest index (%), Weed Index (%) as influenced by FYM level and weed management practices of direct seeded rice under minimum tillage

	Treatments	Grain yield (t ha^{-1})	B:C Ratio	Harvest index (%)	Weed Index (%)
	Fertility level				
F0	FYM @ 0 t ha^{-1}	3.47	2.21	43.69	17.57
F1	FYM @ 5 t ha^{-1}	3.63	1.84	44.02	13.77
	SEm±	**0.10**		**1.13**	-
	CD (0.05)	**NS**		**NS**	-
	Weed management				
W1	Chemical weeding (Bispyribac sodium @ 20 g ha^{-1} 25 DAS)	4.03	1.88	51.37	4.27
W2	Mechanical weeding (25 DAS)	3.31	1.57	37.96	21.37
W3	Mechanical weeding (25 DAS) + hand weeding (45 DAS)	4.01	1.53	47.37	4.75
W4	Hand weeding (25 DAS)	3.39	1.26	41.46	19.47
W5	Hand weeding intra row (25 DAS) + hand weeding (45 DAS)	3.69	1.30	46.48	12.35
W6	Mechanical weeding (inter row) followed by hand weeding (intra row) (25 DAS)	3.59	1.42	45.50	14.72

W7	Hand weeding (25 & 45 DAS)	4.21	1.35	51.54	-
W8	Unweeded check	2.16	0.92	29.16	48.69
	SEm±	**0.20**		**2.26**	-
	CD(0.05)	**0.59**		**6.54**	-

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IMPACT OF DIFFERENT SOURCES OF NUTRIENTS ON GROWTH AND FLOWERING IN CHRYSANTHEMUM *(CHRYSANTHEMUM MORIFOLIUM* RAMAT.*)* CV YELLOW GOLD

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Abstract: An investigation was carried out to study the combined applications of different sources of nutrients on vegetative growth and flowering characters of chrysanthemum cv. Yellow Gold. The treatments included *Azospirillum*, PSB, vermicompost and FYM with and without 100, 75 and 50% recommended dose of NPK. The experiment was laid out in Randomized Block Design (RBD) with three replications. The experiment consisted of ten treatments viz. $T_{1:}$ control (with out NPK), T_2 : 100% RDF(150:100:100), T_3: 75% RDF + 25% VC, T_4,: 75% RDF +25% Leaf Manure T_5: 75% RDF + 25% VC+ 2g/plant Azospirillum, T_6: 75% RDF+ 25% VC +2g/plant Azospirillum +2g/plant PSB, T_7: 50% RDF +50% VC T_8: 50% RDF + 50% VC+ 2g/plant Azospirillum, T_9: 50% RDF + 50% VC+ 2g/plant Azospirillum + 2g/plant PSB T_{10}: 50% RDF +50%Leaf Manure + 2g/plant Azospirillum +2g/plant PSB,. Analysis of results revealed that treatment T_4,: 75% RDF+ 25% VC + 2.0 g/plant Azospirillum + 2.0 g/ plant PSB,. significantly induced the days taken to sprouting and increased the height of plant, number of leaves per plant and length of longest leaf per plant. However, treatment T_{10} significantly gave maximum diameter of leaf. Treatment receiving 50% RDF+ 50% VC + 2.0 g/plant Azospirillum + 2.0 g/plant PSB emerged earlier spike while minimum days required for opening of first flower on spike and maximum longevity of spike was observed in treatment T_6. In terms of vase life of cut flowers at room temperature, treatment T_4 shown maximum vase life.

Keywords: Nutrients, INM, Chrysanthemum, Growth and flowering

INTRODUCTION

Chrysanthemum botanically known as (*Chrysanthemum morifolium* Ramat.) which occupies a prominent place in ornamental horticulture is one of the commercially exploited flower crops. In many countries, including the United States and Japan, it is considered as the number one crop. Chrysanthemum flowers are mainly used for cut flower, loose flower for garland making, general decoration, hair adornments and religious function. Among the various factors which are affected the growth and flowering of chrysanthemum, balanced nutrition is very important. The growth and development of a plant, generally depends on their judicious feeding right from the beginning. Use of inorganic fertilizers under intensive agriculture has been associated with reduced crop yield, soil acidity and nutrient imbalance. (Obi and Ebo 1995 and Obenivi, 2000). Also continuous application of imbalanced and excessive nutrients had led to decline in nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere and groundwater quality, causing health hazards. In recent times, FYM, vermicompost and biofertilizers have emerged as a supplement to mineral fertilizers and hold a promise to improve the yield as well as quality of the crop. Common bio-fertilizers used in horticultural crops are *Azotobacter, Azospirillum*, phosphate solubilizing bacteria and VAM fungi. *Azospirillum* is a symbiotic N-fixing bacterium. *Azotobacter* and *Azospirillum* both fix atmospheric nitrogen when inoculated to plants, which help to save the application of N-fertilizers to an extent of 20-25 per cent. Similarily, Phosphorous Solubilizing Bacteria (PSB) is chief microorganisms, which are capable of mobilizing nutritive elements like non-usable phosphorus to plant usable phosphorus by biological processes. Plants require both organic manures and inorganic fertilizers in an adequate combination to produce better production. Chrysanthemum also requires macro and micro nutrients in an adequate combination and it may be gained by supplemented sources of nutrients. Therefore, the present study has been carried to evaluate the different sources of nutrients in chrysanthemum to find out the better combination (organic with reduced doses of inorganic fertilizers) for better growth and flowering in chrysanthemum under agro-climatic conditions of Western Uttar Pradesh, India.

MATERIAL AND METHOD

The experiment was conducted at Horticultural Research Centre (HRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during Kharif season, 2013-14. The University is situated 8.0 km. away from Meerut city in the Western Uttar Pradesh. Geographically, Meerut is located at 29.01º north latitude, 77.75º east longitude and at an altitude of 297 m above the mean sea level. The soil of the field had (155.40 kg/ha alkaline permanganate oxidizable nitrogen (N) (Subbaiah and asija, 1956), 14.76 kg/ha available phosphorus (P) (Olsen et al, 1954), 139.86 kg/ha−1 1 *N* ammonium acetate exchangeable potassium (K) (Hanway and Heidal, 1952) and 0.45% organic carbon (C)

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(Walkey and Black, 1954). The pH of the soil was 7.6 was measured by Beckman's glass electrode pH meter method (Jackson 1973). The experiment was laid out in a simple randomized block design with 12 treatments and three replications. Well decomposed farmyard manure, vermicompost and leaf manure were applied treatment-wise before planting. Recommended fertilizer doses of 160:80:80 kg/ha NPK were also given treatment-wise as 100, 75 and 50%. These fertilizers were applied in the form of urea, single superphosphate and muriate of potash. Uniform sizes of rooted cuttings of chrysanthemum cv. "Yellow Gold" were planted on 25th August, 2013. Application of bio-fertilizers *viz*., *Azospirillum* and Phosphate Solubilizing Bacteria were applied before planting of rooted cuttings. A slurry of 200 g of the lignite based culture of *Azospirillum* and PSB were prepared in 1000 ml of water individually and combination of both 100 g *Azospirillum* and 100 g PSB were prepared in 1000 ml of water. Four week old rooted cutting of chrysanthemum dipped in the above slurry for 30 minutes before transplanting and treated cuttings were transplanted at spacing of 30x40 cm^2. The treatments imposed were were: $T_{1:}$ control (without NPK), T_2 : 100% RDF(150:100:100), T_3: 75% RDF + 25% VC, T_4,: 75% RDF +25% Leaf Manure T_5: 75% RDF + 25% VC+ 2g/plant Azospirillum, T_6: 75% RDF+ 25% VC +2g/plant Azospirillum +2g/plant PSB, T_7: 50% RDF +50% VC T_8: 50% RDF + 50% VC+ 2g/plant Azospirillum, T_9: 50% RDF + 50% VC+ 2g/plant Azospirillum + 2g/plant PSB T_{10}: 50% RDF +50%Leaf Manure + 2g/plant Azospirillum +2g/plant PSB,. The observations on various growth and flowering aspects were recordrd.

RESULT AND DISCUSSION

A perusal of data (Tables 1) revealed that all the growth and flowering characteristics of chrysanthemum were significantly affected by different treatments. Treatment comprising Azospirillum and PSB had shown a significant effect on plant height and it was maximum (79.24 cm) in the treatment T_6, and minimum height of the plant (64.24 cm) was recorded under the treatment T_1 i.e. control. The increase in the plant height in the treatment T_6 might be due to the beneficial effects of vermicompost and biofertilizers and inorganic fertilizers. The decrease in the plant height in control may be due to unavailability of sufficient nutrients at critical developmental stages which decrease growth rate. (Preethi et al, 1999) explained the activities of the inoculants viz., nitrogen fixation, released of P from insoluble phosphate, production of phytohormones etc. with simultaneous uptake of nutrients. It may also be increased cell elongation and cell multiplication which enhanced nutrient uptake by plants following inoculation *of Azospirillum* and P-solubilizing bacteria (PSB) might have caused the increased plant height (Preethi *et al.*, 1999). Our results are close conformity with (Verma *et al.*, 2011 and Pandey *et al.*, 2010.) These results are in line with the findings of (Vasanthi, 1994, Chandrikapure et al., 1999, Chaitra, 2006 and Ali et al, 2014) who had also reported similar results in different crops. Significant variations in the diameter of stem among the treatments were also observed with different sources of nutrients. The plant treated with (75% RDF+ 25% VC + 2.0 g/plant Azospirillum + 2.0 g/ plant PSB) under the treatment T_6 significantly gave maximum diameter of stem (1.18 cm) and minimum diameter of stem (0.95 cm) was observed in control. It could be explained by the activities of the inoculants viz., nitrogen fixation, released of P from insoluble phosphate, production of phytohormones etc. with simultaneous uptake of nutrients. Increased cell elongation and cell multiplication due to enhanced nutrient uptake by plants following inoculation *of Azospirillum* and P-solubilizing bacteria (PSB) might have caused the increased diameter of stem (Preethi et al)**.** Treatment T_6 resulted maximum stem internode length (2.15cm) and minimum internode length was observed in control. The increased internode length could be due to better nutrient uptake, photosynthesis, source-sink relationship, besides excellent physiological and bio-chemical activities due to presence of *Azospirillum,* and PSB. (Tien *et al.*), while working on bio-fertilizers like *Azospirillum* found the similar results and suggested that they synthesize growth promoting hormones like IAA, IBA, GA and vitamins, which may induce better growth of the plants. The treatment receiving 50% reduced doses of inorganic fertilizers which was supplemented by organic and biofertilizers under the treatment T_9 significantly produced maximum number of primary branches (11.66) followed by (10.23) in treatment T_6 when plants were grown 25% reduced doses of inorganic fertilizers and minimum number of branches showed under control. These results for number of branches could be attributed because of better micro and macro nutrients flow along with plant growth substances into the plant system in the treatments applied with vermicompost and bio-fertilizers in combination with inorganic fertilizers. The growth regulators like NAA and cytokinins released by *biofertilizers* might have resulted in breaking of apical dominance and accelerated higher number of branches. The above results are collaborated with the findings of (Ajitkumar, 2002) in marigold and (Sunita *et al.,* 2007) in African marigold. Similar trends in increased number of branches due to biofertilizer treatment were reported by (Chaitra and Patil, 2007) and Moghadam *et al*. (2013) in Petunia. Plant spread was also influenced by different treatments and varied from 31.70-61.93 cm. The maximum plant spread (61.93 cm) was observed in T_6 when plant received 75% RDF+ 25% VC +2g/plant Azospirillum + 2g/plant PSB followed by

(59.83 cm) in treatment T_2 when plants received 100% recommended doses of fertilizers by inorganic method and it was minimum (31.70 cm) in control. Leaf length also differed due to different treatments, treatment $T_{6,}$ when plant receiving 75% RDF + 25% VC+2.0 g/plant Azospirillum + 2.0 g/ plant PSB exhibited maximum leaf length(10.80 cm) followed by (10.27 cm) under the treatment T_2 when plants were grown fully inorganic fertilizers and it was minimum (5.97 cm) under control. The leaf width also showed significant variations in sizes due to various treatments and it was maximum in treatment T_6 (7.73 cm) followed by T_6 (7.33 days) and minimum width of leaf (3.53 cm) were observed in control i.e. $T_{1.}$ Similarily, leaf length and width ratio was also affected by different treatments and it was maximum (1.85) noted in control and minimum ratio was observed when plant were grown with 50% reduced dose of inorganic method under the treatment T_{10}. Treatment T_6 resulted maximum leaf length of lower tube (3.93 cm) followed by (3.83 cm) under the treatment T_2 when plants obtained 100% recommonded doses of fertilizers by inorganic fertilizers and it was minimum (2.09 cm) under control. Increased in leaf area (leaf length and width) in these treatments could be attributed to enhanced cell division and cell elongation by the production of bio-active substances produced by *Azospirillum*, PSB. Similar observations have been reported by Jayamma et al (2008) in Jasmine. . The results of our experiments are in confirmation with the findings of Gayathri *et al.* (2004) who also reported that combined application of biofertilizers, vermicompost and inorganic fertilizers significantly increased the number of leaves, leaf area and stem girth In *Limonium.*

It is clear from the present study that combined applications of inorganic, organic and biofertilizers like Azospirillum and PSB significantly showed the beneficial effect on various flowering attributes in chrysanthemum. The treatment receiving 25% reduced doses of inorganic fertilizers which was supplementd by organic and biofertilizers significantly showed maximum peduncle thicknes of terminal flower (0.22 cm) under the treatment T_6 followed by (.20 cm) under the treatment T_2 and T_9 and it was minimum (0.12 cm) under control. Further, significant influence of different combinations of reduced doses of inorganic fertilizers along with organic fertilizers on flowering characters of chrysanthemum was observed. Treatment, T_6 resulted in maximum length of outer ray of floret (4.67 cm) followed by treatment T_9 (3.95 cm) and it was minimum (1.85 cm) in control. The conjunctive effect of vermicompost and biofertilizers with 50 per cent reduced doses of chemical fertilizers in enhancing the diameter of flower though it varied 4.46-6.80 cm among the treatments .The maximum flower diameter (6.80 cm) was observed in treatment T_9 followed by treatment T_6 (6.47 cm) when plants were treated with 25% reduced doses of inorganic fertilizers which was supplemented bo organic and biofertilizers and minimum flower diameter (4.46 cm) observed in control. The same treatment was also superior in terms of number of flowers per plant and it was maximum (89.15) while minimum number of flowers (52.84) were recorded in control. The increase in number of flowers may be explained by the role of *Azospirillum* though atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water, higher leaf number and area. Higher photosynthesis enhanced food accumulation which might have resulted in better plant growth and subsequently higher number of branches and flowers per plant and hence, more flower yield per plant. Present results are close conformity with Jayamma et al (2008) in jasmine. Similarly, Chandrikapure *et al.* (1999) reported higher flower yield in marigold. The higher flower yield due to application of vermicompost has been reported in China Aster (Nethra *et al.*, 1999; Chaitra and Patil, 2007) marigold (Sunita *et al., 2007)* and Verma *et al*. (2011) in chrysanthemum. It is clear from the present study that combined applications of inorganic, organic and biofertilizers like Azospirillum and PSB significantly showed the beneficial effect on various growths and flowering attributes in tuberose. It might be due to that Azospirillum accumulate the nitrogen near the root zone of plant and PSB convert unavailable phosphorus to available form and increase the availability of phosphorus to plants. Similar findings were also reported by (Bhalla *et al.* 2006).

Table 1. Impact of different sources of nutrients in Chrysanthemum cv. Yellow Gold

	Treatment	Plant height (cm)	Stem diameter (cm)	Stem internode lengtht (cm)	No. of prim. Branche/plant	Plant spread (cm)	Leaf length (cm)	Leaf width (cm)	Leaf Length: Width ratio (cm)	Leaf Length of lower tube (cm)	Peduncle thickness of terminal flower (cm)	Length of outer row floret (cm)	Flower diame-ter (cm)	No. of flower/plant
T_1	control	64.24	0.95	1.11	5.50	31.70	5.97	3.53	1.85	2.09	0.12	1.85	4.46	52.84
T_2	100% RDF	74.52	1.17	2.03	10.50	59.83	10.27	7.33	1.55	3.83	0.20	4.23	6.57	86.80
T_3	75% RDF +25% VC	72.24	1.05	1.72	9.13	51.77	7.92	5.00	1.83	2.92	0.13	2.87	5.35	61.90
T_4	75% RDF +25% Leaf Manure	70.12	0.99	1.60	9.27	51.27	7.59	5.47	1.54	2.99	0.15	3.25	5.55	64.48

T_5	75% RDF + 25% VC+ 2g/plant Azospirillum	72.15	0.98	1.69	9.47	54.23	7.99	6.05	1.49	3.12	0.16	3.65	5.63	68.42
T_6	75% RDF+ 25% VC +2g/plant Azospirillum + 2g/plant PSB	79.24	1.18	2.15	10.23	61.93	10.80	7.73	1.51	3.93	0.22	4.67	6.47	83.85
T_7	50% RDF +50% VC	72.24	1.02	1.72	8.93	51.82	7.30	6.02	1.37	2.68	0.15	2.87	5.58	64.45
T_8	50% RDF + 50% VC+ 2g/plant Azospirillum	71.85	1.12	1.73	8.83	49.67	7.99	6.20	1.30	3.43	0.16	3.03	5.68	66.68
T_9	50% RDF + 50% VC+ 2g/plant Azospirillum +2g/plant PSB	75.89	1.11	1.99	11.66	55.18	8.90	6.40	1.35	3.79	0.20	3.95	6.80	89.15
T_{10}	50% RDF +50%Leaf Manure + 2g/plant Azospirillum +2g/plant PSB	71.15	1.04	1.84	9.23	59.33	7.93	6.73	1.19	3.68	0.19	3.81	5.92	83.75
	MSE	**2.712**	**0.005**	**0.004**	**0.287**	**2.587**	**0.094**	**0.037**	**0.002**	**0.261**	**0.000**	**0.021**	**0.037**	**1.259**
	CD at 5%	**1.345**	**0.059**	**0.054**	**0.437**	**1.313**	**0.250**	**0.157**	**0.041**	**0.417**	**0.008**	**0.118**	**0.157**	**0.916**

CONCLUSION

On the basis of present study, It may be concluded that by different sources of nutrients practices, we can minimize the cost of inorganic fertilizers, reduces soil pollution, which is beneficial for the present problems of high cost of fertilizers and environmental pollution and also can get good vegetative growth and flowering in gladiolus under agro-climatic condition of Western Uttar Pardesh, India.

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POPULATION DYNAMICS OF SORGHUM SHOOT FLY, *ATHERIGONA SOCCATA* (RONDANI) INFESTING SORGHUM

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Abstract: The present investigation carried out at Sorghum Research Station, SDAU, Deesa, and Gujarat, to study the population dynamics, varietal screening of sorghum and management of shoot fly *A. soccata*during *kharif*2012. The shoot fly incidence (1.52 eggs/plant) started from 7 days after germination (last week of July). The number of eggs per plant gradually increased with crop growth and maximum number of eggs *i.e.* 3.08/plant were observed after 21st days of germination (second week of August). Dead hearts due to shoot fly also started from 7 days after germination (last week of July) *i.e.* 8.15 per cent which increased with crop growth with maximum dead hearts (47.36%) and observed after 21st days of germination *i.e.* second week of August. It can be concluded that peak periods of shoot fly incidence and dead heart were from 21 days to 28 days after germination of the crop.

Keywords: Population, Sorghum, Shoot

INTRODUCTION

Sorghum [*Sorghum bicolor* (Linnaeus.) Moench] popularly known as jowar, belongs to the family gramineae. Cultivated sorghum is diploid (2n=2x=20) species and the genus sorghum is native to Africa and Asia. In India, sorghum is cultivated on an area of 2.68 million hectares and harvests 3.00 million tonnes with a productivity of 1117 kg/ha (Anonymous, 2011). It is extensively grown in Northern, Central and North-west regions of the country. States like Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu and Gujarat have major area and production of sorghum. In Gujarat, it occupied an area of about 125800 hectares with annual production of 139000 tonnes and productivity of 1119.5 kg/ha (Anonymous, 2011). In Banaskantha district, sorghum is grown on an area of 13200 ha with the production of 5700 tonnes and productivity of 434 kg/ha (Anonymous, 2011). Sorghum is also a traditional crop for Gujarat state.

More than 150 species of insects have been reported to damage sorghum. However, over a dozen species are serious and constitute a major constraint in sorghum production (Atwal and Dhaliwal, 2010). Major insect pest species attacking sorghum are sorghum shoot fly, *Atherigonasoccata*Rondani., stem borer, *Chilopartellus* Swinhoe., Gujarat hairy caterpillar, *Amsactamoore i*Butler., aphid, *Rhophalosiphum maidis* Fitch., armyworm, *Mythimnaseparata* Walker., gram pod borer, *Helicoverpa armigera* (Hubner)., thrips, *Caliothripsjonnuphilus* Rank., sugarcane leaf hopper, *Pyrillaperpusilla* Walker., sorghum midge, *Contariniasorghicola* Coquillett., sorghum earhead bug, *Calocorisangu status* Lethiery etc. Among these insect pests, shoot fly is one of the most important and destructive pests at seedling stage, which causes yield losses of 75.6 per cent in grain and 68.6 per cent in fodder (Mudigoudra*et al.*, 2009). Nearly 32 per cent of the crop is lost due to insect pests in India (Borad and Mittal, 1983).

MATERIAL AND METHOD

In order to study the population dynamics of shoot fly in sorghum in relation to weather parameters, a field experiment was carried out on variety GJ-38. Plot was kept completely free from the insecticidal spray.

Experimental details

Location	:	Sorghum Research Station, SDAU, Deesa.
Season and Year	:	*Kharif*, 2012
Plot size	:	20 m x 20 m
Fertilizer	:	80:40:0 (N:P:K), Kg/ha
Seed Rate	:	12 kg/ha
Spacing	:	45 cm x 15 cm

The crop was raised as per all the recommended agronomical practices and the crop was kept unsprayed throughout the crop period. For recording the population (eggs and dead heart) of *A. soccata*, twenty five plants from the net plot were selected randomly. The weekly observations on number of eggs and dead hearts were recorded from each randomly selected plant starting to germination. Mean egg population per plant as well as per cent dead heart were worked out and the data thus obtained were subjected to correlation with weather parameters to ascertain the population fluctuation of the pest in relation to various weather factors.

RESULT AND DISCUSSION

An experiment was conducted to study the population dynamics of shoot fly *A. soccata* on

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sorghum in relation to weather parameters. The activity of *A. soccata* was recorded as mean number of eggs per plant and mean per cent dead heart on sorghum crop periodically at weekly interval. The data on incidence of sorghum shoot fly on the crop cultivar GJ-38 during *kharif* season 2012 are presented in Table 1

Number of eggs per plant

The data summarized in Table 1 showed that the shoot fly incidence (1.52eggs/plant) started from 7 days after seed germination (last week of July). The number of eggs per plant gradually increased with crop growth and maximum number of eggs *i.e.* 3.08/plant were observed after 21 days of germination (second week of August). Thereafter, the number of eggs/plant declined and reached at its minimum *i.e.* 0.28 egg/plant after 63 days of germination (fourth week of September). After this period, eggs were not noticed on the plants up to harvesting of crop.

Per cent dead heart

The data summarized in Table 1 showed that dead hearts due to shoot fly (8.15 per cent) also started from 7 days after germination (last week of July) was increased with crop growth with maximum dead heart(47.36%) observed after 21days of germination *i.e.* second week of August. Further, per cent dead heart declined and reached at its minimum (6.52%) 70 days of germination (last week of September) of the crop.

Thus, it can be concluded that sorghum shoot fly laid eggs from last week of July to fourth week of September (*i.e.* 1st to 9th week after germination) in the crop. The peak periods of shoot fly incidence and dead heart were from 21 days to 35 days after germination of the crop. It was in concurrence with the study of Jotwani*et al.*, (1970) who also reported the most suitable crop age for shoot fly,*A. soccata*was within 21 days after germination.

Correlation with weather parameters

Correlation coefficient between numbers of eggs laid by shoot fly and weather parameters were calculated and presented in Table 2. It's clear from the data that all the weather parameters except bright sunshine hours had non-significant effect on the eggs laid by shoot fly on sorghum. Among these parameters maximum temperature (r= 0.02), minimum temperature (r=0.16), mean temperature (r=0.08) and wind speed (r= 0.08) had positive association while, rainfall (r= -0.03), morning relative humidity (r=-0.08), evening relative humidity (r= -0.03) and mean relative humidity (r= -0.06) were negatively associated with number of eggs of shoot fly per plant. However, the effect of bright sunshine was significantly negative (r= -0.65) with respect to number of eggs laid by shoot fly.

Further, the correlation coefficient between per cent dead hearts and weather parameters calculated (Table 2) indicated that all the weather parameters except bright sunshine had non-significant effect on the dead hearts on sorghum. Among the parameters, maximum temperature (r=-0.44), minimum temperature (r=-0.11), mean temperature (r=-0.35), and morning relative humidity (r=-0.01) had negative association while, wind speed (r= .03), rainfall (r=.30), evening relative humidity (r=0.18) and mean relative humidity (r=0.006) were positively associated with per cent dead heart. However, the effect of bright sunshine was significantly negative (r=-0.64) with per cent dead heart incidence in sorghum.

Table 1. Seasonal abundance of *A. soccata* in sorghum during *kharif* 2012

Month	week	SMW	Number of eggs/plant	Per cent dead heart
July	IV	30	1.52	8.15
August	I	31	1.96	24.58
	II	32	3.08	47.36
	III	33	2.24	39.50
	IV	34	2.76	31.78
September	I	35	1.64	30.58
	II	36	0.96	20.54

	III	37	0.56	18.02
	IV	38	0.28	10.61
	V	39	0.00	6.52

SMW = Standard Meteorological Week

Table 2. Correlation coefficient between eggs and dead heart caused by *A. soccata*with weather parameters in sorghum during *kharif* 2012

Weather parameters	No. of eggs/plant	Per cent dead heart
Maximum Temperature (MaxT^{0}c)	0.02	-0.44
Minimum Temperature (MinT^{0}c)	0.16	-0.11
Mean Temperature (MT ^{0}c)	0.08	-0.35
Relative Humidity Morning (RH_1 %)	-0.08	-0.01
Relative Humidity Evening (RH_2%)	-0.03	0.12
Mean Relative Humidity (MRH %)	-0.06	0.006
Rainfall (RF, cm)	-0.03	0.30
Bright Sunshine hours (BSS)	-0.65*	-0.64*
Wind Speed (WS, km/hour)	0.080	0.03

* Significant at 5% level

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POPULATION DYNAMICS OF GREEN LEAF HOPPER, *NEPHOTETTIX* SPP. AND SPIDERS IN UPLAND TRANSPLANTED RICE AGRO-ECOSYSTEM: A BIO-METEOROLOGICAL INTERACTION STUDY

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Abstract: Rice occupies the prominent place in Indian agriculture. Rice fields are very important and environmental buffers. Field experiment was conducted at research farm of Indira Gandhi Krishi Vishwa Vidyalaya, Raipur during *kharif* season 2013-14. The maximum population green leaf hopper (GLH) was recorded in 1^{st} week (40 SMW) of October with 53.25 nymph/adult/25 sweeps showed non-significant negative correlation with minimum temperature, average temperature, morning relative humidity, evening relative humidity and average relative humidity while non-significant positive correlation with minimum temperature and sunshine hours in upland transplanted rice agro-ecosystem. The maximum population of spiders were recorded during 4^{th} week (43 SMW) of October with 11.00 adult/25 sweeps and showed significant negative correlation with Rainfall (r = - 0.656*) while positive correlation with maximum temperature and sunshine hours. GLH and spiders populations showed non-significant positive correlation (r = + 0.230) at 1% and 5% level of significance in upland transplanted rice agro-ecosystem.

Keywords: Ecosystem, Green leaf hopper, Rice, Upland, Weather parameters

INTRODUCTION

Chhattisgarh state is known as the rice (*Oryza sativa* L.) bowl of India because nearly 74-76 per cent area during rainy season is under rice cultivation. In Chhattisgarh there are 5 agro-ecosystems in which rice is cultivated with different practices. These ecosystems are: Upland ecosystem, 2. Midland ecosystem, 3. Lowland ecosystem: Drought prone and Lowland favourable, 4. Submergence prone and 5. Irrigated ecosystem: Controlled irrigation and Flood irrigated ecosystem (Annonymous, 2009). Raipur is situated in central-eastern part of Chhattisgarh and lies between 21^o 6' North latitude and 18^o 36' East longitude with an altitude of 289.56 meters above from the mean sea level. Two species of green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) are most common in upland transplanted rice ecosystem at Raipur rice agro-ecosystem. Both nymphs and adults suck the sap from the phloem. While direct damage seldom causes economic loss, viral disease (rice tungro, grassy stunt and yellow orange leaf) transmitted by both the species results in economic loss. Particularly in tungro endemic areas, suitable prophylactic measures need to be taken up. Pest outbreaks are sudden explosive increases in a pest population which are often associated with changes in the ecosystem caused by external environmental disturbances include very dry weather, elevated temperatures, floods, gales, and pesticide sprays (Heong,2009). Upland rice is usually grown in unfavourable soil and weather conditions and needs regular attention for obtaining good productivity. Insect pests menace is one among the many hurdles in reaching comprehensive rice grain productivity. The diversity of upland rice environments gives rise to a more heterogeneous insect fauna compared with the more homogeneous lowlands. A wide array of soil-inhabiting pests -ants, termites etc. common in upland rice cannot tolerate flooding. The less stable upland environment more restricted growing season, smaller area planted, greater drought stress-poses greater problems of survival to insects, which have overcome them by polyphagy, greater longevity, off-season dormancy and dispersal. In upland rice a rich fauna of natural enemies exists, but they face even greater problems of survival than the pests (Litsinger *et al.*, 1987). Aerobic rice is direct seeded in non-puddled field requires less water and labour than flooded rice established via transplanting thus aerobic rice system can reduce water application relative to conventionally transplanted system. Populations of leaf hopper and spiders in upland transplanted rice agro-ecosystem are influenced by ecological and biological factors, crop physiology, climate changed and farmer's control practices. The aims of this study was to determine the changes in population dynamics of green leaf hopper and spiders in rice field between the developments stages of rice and it's relation with the biotic and abiotic factors. It is hoped that the findings from the study can contribute to the more ecological precise ways in dealing with outbreaks and control of insect pests of rice.

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MATERIAL AND METHOD

The population of rice green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) and spiders was recorded through sweeping net. Sweeping net sampling device is usefull for catching immature and adult stages of insect pest and their natural enemies present in rice ecosystem. A specification of sweep net is 30 cm diameter and 65cm depth. Sampling was done randomly four places by 25 sweep of rice field in morning, at weekly interval. The observations on occurrence of green leaf hopper and spiders were recorded by taking total 4 samples from 4 locations in rice ecosystem. All samples were collected near the center of the ecosystem, at least 5 m from the edge in order to reduce edge effects. Weekly collection were calculated for determining the population dynamics of rice green leaf hopper and spiders according to standard meteorological weeks prescribed by the Agro-meteorological Department, Raipur IGKV (C.G.) were used. Correlation analysis was carried out between field incidence and weather parameters of GLH during *kharif* season 2013-14. Regression analysis was worked out as per method given by Gomez and Gomez (1985).

RESULT AND DISCUSSION

Population dynamics of green leaf hopper, *Nephotettix virescens* (Distant) and *N.nigropictus* (Stal.) in upland transplanted rice ecosystem

Green leaf hopper, *Nephotettix* spp. nymph/adult population initiated in the upland transplanted rice ecosystem (UTP) during 1st week (36 SMW) of August with 0.75 nymph/adult/25 sweeps and remain up to crop harvesting. The maximum population of rice green leaf hopper was recorded in 1st week (40 SMW) of October with a population of 53.25 nymph/adult/25 sweeps. The average population varied from 0.00 to 53.25 nymph/adult/25 sweeps during *kharif* season (Table 1). The seasonal mean of green leaf hopper, *Nephotettix* spp. population was 2.98 nymph/adult/25 sweeps) during cropping season. The present findings are corroborates with Shukla *et al.,* (2008), Dogra and Chaudhary (2005), Shamim *et al.,* (2009) and Garg (2012) reported that the maximum populations of green leaf hoppers were observed during October- November, August-September, October (43 SMW) and 2nd fort night of October respectively. Girish (2010) reported that the green leaf hopper population appeared at 45 DAS and their population (nymphs and adults) increased to attain peak at 75 DAS in month of September and disappeared at 120 DAS in month of October in upland in transplanted method at Mugad, Karnataka.

Population dynamics of spiders in upland transplanted rice ecosystem

The spider populations mainly *Tetragnatha* spp., *Oxyopes* spp. and *Araneus* spp. were recorded from 30 days old crop up to maturity with varied population level in rice ecosystem. The maximum population of spiders was recorded during 4th week (43 SMW) of October with 11.00 adult/25 sweeps in upland transplanted rice ecosystem. The average population varied from 0.00 to 11.00 nymph/adult/25 sweeps during *kharif* season. The seasonal mean population of spiders was 5.29 adult/25 sweeps) during cropping season (Table 1).The present findings on the population dynamics of spiders are in agreement with Girish (2010) reported that the population of spider highest during October (105 DAS) in upland transplanted rice ecosystem. Rajendra (2009) Spiders were common predators on many rice insects, species identified in upghat transplanted ecosystem were *Pardosa heteropthalmus, P. pseudoannulata, Tetragnatha* sp., *Argiope bruennichi* and *Leucauge decorate.* The spiders were noticed throughout the cropping period starting from transplanting to till harvest and maximum during reproductive stage of crop. These findings also corroborates with the reports of Shivamurthappa (1993) and Venkateshalu (1996) and Schoenly *et al.* (1998) from India and China. Okuma *et al.,* (1978) who also reported that the spiders fauna as relatively poor in the early period of crop growth (July) and from August onwards, spider fauna became rich. On the contrary, Garg (2012) reported the spider was most active during September.

Correlation co-efficient between green leaf hopper and abiotic factors in lowland rice field

It was evident from the data (Table 2) that the green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) showed non-significant positive correlation with maximum temperature (r = + 0.097) and sun shine hours (r= + 0.194) but non-significant negative correlation with minimum temperature (r = - 0.092), average temperature (r = - 0.025), morning relative humidity (r = - 0.420), evening relative humidity (r = - 0.187), average relative humidity (r = - 0.269) and average rainfall (r = - 0.444) at 5 and 1 per cent level of significance. The regression equation for weather parameter like maximum temperature are [$y = 0.007x + 30.11$, $R^2 = 0.009$], minimum temperature [$y = -0.011x + 23.65$, $R^2 = 0.008$], Average temperature [$y = -0.001x + 26.88$, $R^2 = 0.000$], Rainfall(mm) [$y = -1.947x + 94.96$, $R^2 = 0.196$], morning relative humidity [$y = -0.074x + 93.74$, $R^2 = 0.176$] evening relative humidity [$y = -0.132x + 73.80$, $R^2 = 0.034$], average relative humidity[$y = -0.103x + 83.77$, $R^2 = 0.072$] and bright sunshine hours[$y = 0.028x + 3.849$, $R^2 = 0.037$].

Correlation co-efficient between spiders and abiotic factors in lowland rice field

Perusal of data presented (Table 3) mean population of spiders showed non-significant positive correlation with maximum temperature (r = + 0.100) and sun shine hours (r= + 0.308) but non-significant negative correlation with minimum temperature (r = - 0.400), average temperature (r = - 0.270), morning relative humidity (r = - 0.297), evening relative humidity (r = - 0.473), average relative humidity (r =

- 0.505) while spiders showed significant negative correlation with average rainfall (r = - 0.656*) at 5 per cent level of significance. The regression equation for weather parameter like maximum temperature are [y = 0.044x + 29.98, R^2 = 0.010], minimum temperature [y = -0.281x + 24.99, R^2 = 0.16], Average temperature [y = -0.118x + 27.48. R^2 = 0.073], Rainfall (mm) [y = -16.56x + 157.2, R^2 = 0.429], morning relative humidity [y = -0.303x + 94.37, R^2 = 0.087] evening relative humidity [y = -1.927x + 82.28, R^2 = 0.223], average relative humidity[y = -1.115x + 88.32, R^2 = 0.254] and bright sunshine hours[y = 0.255x + 2.862, R^2 = 0.094]. These findings also corroborates with Chau (1987) reported highest peak of spiders at mean temperature of 23-25°C and with relative humidity of 89.94 per cent. On the contrary Rajendra (2009) reported that the correlation studies has been made on spider population revealed negative and non significant relationship with maximum temperature (r = -0.804). Whereas, positive and significant relationship with minimum temperature (r = +0.851*) and morning relative humidity (r = + 0.889*). Similarly positive non significant correlation with average rainfall (r = + 0.676) and evening relative humidity (r = + 0.692). Venkateshalu (1996) also reported during *kharif* season, spider population showed significant negative correlation with maximum temperature and evaporation.

Correlation co-efficient between green leaf hopper and spiders

It was evident from the data (Table 4) that the spiders showed non-significant positive correlation with green leaf hopper, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal.) (r = + 0.230) at 5 and 1 per cent level of significance. These findings are in agreement with Kaushik *et al.*,1985 who reported that the *Lycosa pseudoannualata* exhibited positive correlation with the hopper population having the regression equation of 3.14 = - 4.09 + 42.8x1 – 3.42x2 + 19.7x3. High positive correlations for spiders with the delphacids and cicadellids were obtained in Kiangan, IRRI and Bayombong, but significantly lower correlation in Cabantuan and Banaue during the survey conducted in the Philippines (Heong and Rubia, 1990). The fluctuation of plant hoppers and leaf hoppers population in the rice fields was closely correlated to that of the spiders (Ye and Wang, 1987; Cheng, 1989).

Table 1. Population of Green leaf hopper, *Nephotettix* spp. and spiders in upland transplanted rice ecosystem

S. No	SMW	Date of observation	Mean population of GLH in upland transplanted rice ecosystem	Mean population of spiders in upland transplanted rice ecosystem	Temperature (^{0}C)			Rainfall (mm)	Relative humidity (%)			Sun shine (hours)
					Maxi. Temp.	Mini. Temp.	Avg. Temp.		Morn.	Even.	Avg.	
1	31	01/08/2013	0.75	0	28.30	23.90	26.10	255.80	95.10	83.90	89.50	1.30
2	32	08/08/2013	0	2	31.10	24.70	27.90	87.40	93.10	76.00	84.55	3.30
3	33	15/08/2013	2.25	3.5	31.30	24.40	27.85	177.00	94.70	79.60	87.15	3.30
4	34	22/08/2013	0	3	27.80	23.80	25.80	60.50	92.00	83.60	87.80	1.50
5	35	29/08/2013	1	6	29.30	24.50	26.90	120.80	94.90	78.10	86.50	3.10
6	36	05/09/2013	3.5	4.25	31.10	24.80	27.95	54.80	92.60	75.70	84.15	4.20
7	37	12/09/2013	6	7.25	31.90	25.20	28.55	11.60	91.70	73.30	82.50	6.20
8	38	19/09/2013	9.75	6.5	29.90	24.10	27.00	92.60	93.40	76.90	85.15	2.50
9	39	26/09/2013	16	5	32.00	24.90	28.45	28.60	93.00	68.00	80.50	6.30
10	40	03/10/2013	53.25	3	30.10	24.20	27.15	45.20	95.00	75.30	85.15	4.20
11	41	10/10/2013	45	8.5	30.20	23.30	26.75	8.60	83.70	71.10	77.40	3.50
12	42	17/10/2013	22.25	6	30.70	21.40	26.05	0.00	91.40	56.30	73.85	8.60
13	43	24/10/2013	13	11	28.80	22.60	25.70	32.60	95.90	73.10	84.50	2.10
14	44	31/10/2013	9	8	30.50	17.30	23.90	0.00	92.30	38.40	65.35	8.90
Seasonal mean/25 sweeps			12.98	5.29								

Table 2. Correlation coefficient (r) between mean population of *Nephotettix* spp. in upland transplanted rice ecosystem and abiotic factors

Correlation with			Correlation coefficient(r)	Coefficient of determination (r^2)	Coefficient of variation	Regression equation value
Rice insect	Weather parameter					
Mean population of GLH in upland	Temperature(^{0}C)	Maxi. Temp.	0.097	0.009	0.932	y = 0.007x + 30.11, R^2 = 0.009
		Mini.	-0.092	0.008	0.840	y = -0.011x + 23.65, R^2 =

transplanted rice ecosystem		Temp.				0.008
		Average Temp.	-0.025	0.001	0.062	y = -0.001x + 26.88, R² = 0.000
	Rainfall (mm)		-0.444	0.197	19.684	y = -1.947x + 94.96, R² = 0.196
	Relative humidity (%)	Morning	-0.420	0.177	17.678	y = -0.074x + 93.74, R² = 0.176
		Evening	-0.187	0.035	3.481	y = -0.132x + 73.80, R² = 0.034
		Average	-0.269	0.072	7.247	y = -0.103x + 83.77, R² = 0.072
	Sun shine (hours)		0.194	0.038	3.779	y = 0.028x + 3.849, R² = 0.037

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

Table 3. Correlation coefficient (r) between mean population of spiders in lowland rice ecosystem and abiotic factors

Correlation with			**Correlation coefficient(r)**	**Coefficient of determination (r^2)**	**Coefficient of variation**	**Regression equation value**
Rice insect	**Weather parameter**					
Mean population of spiders in upland transplanted rice ecosystem	Temperature(^{0}C)	Maxi. Temp.	0.100	0.010	1.008	y = 0.044x + 29.98, R² = 0.010
		Mini. Temp.	-0.400	0.160	16.000	y = -0.281x + 24.99, R² = 0.16
		Average Temp.	-0.270	0.073	7.302	y = -0.118x + 27.48. R² = 0.073
	Rainfall (mm)		-0.656*	0.430	42.989	y = -16.56x + 157.2, R² = 0.429
	Relative humidity (%)	Morning	-0.297	0.088	8.794	y = -0.303x + 94.37, R² = 0.087
		Evening	-0.473	0.224	22.380	y = -1.927x + 82.28, R² = 0.223
		Average	-0.505	0.255	25.469	y = -1.115x + 88.32, R² = 0.254
	Sun shine (hours)		0.308	0.095	9.466	y = 0.255x + 2.862, R² = 0.094

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

Table 4. Correlation coefficient (r) between mean population of *Nephotettix* spp. and spiders in upland transplanted rice ecosystem

Correlation with		**Correlation coefficient (r)**	**Coefficient of determination (r^2)**	**Coefficient of variation**	**Regression equation value**
Mean population of GLH in upland transplanted rice ecosystem	Mean population of spiders in upland transplanted rice ecosystem	0.23	0.053	5.273	y = 0.039x + 4.767, R² = 0.052

*Significant at 5 % level (2.179), **Significant at 1 % level (3.055)

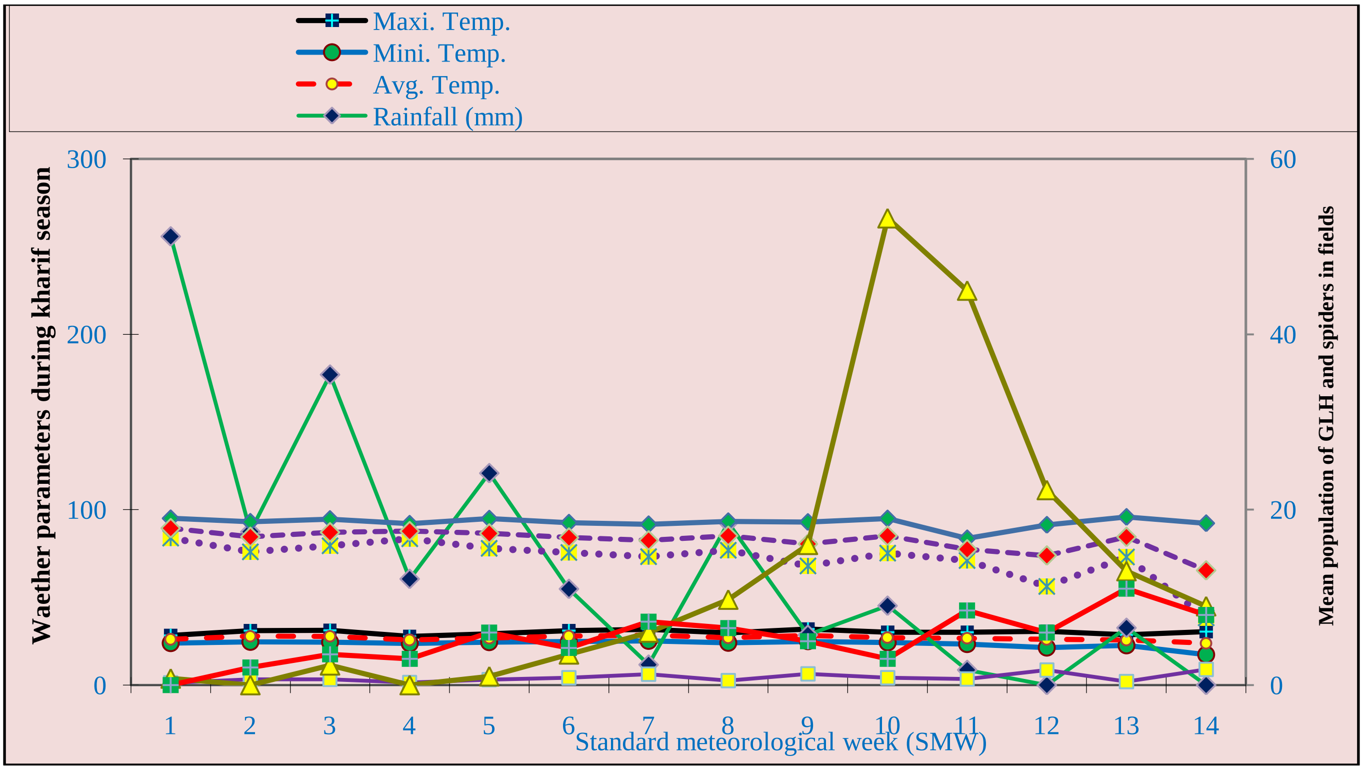

Fig: 1. Field population of Green leaf hopper, spiders and weather parameters

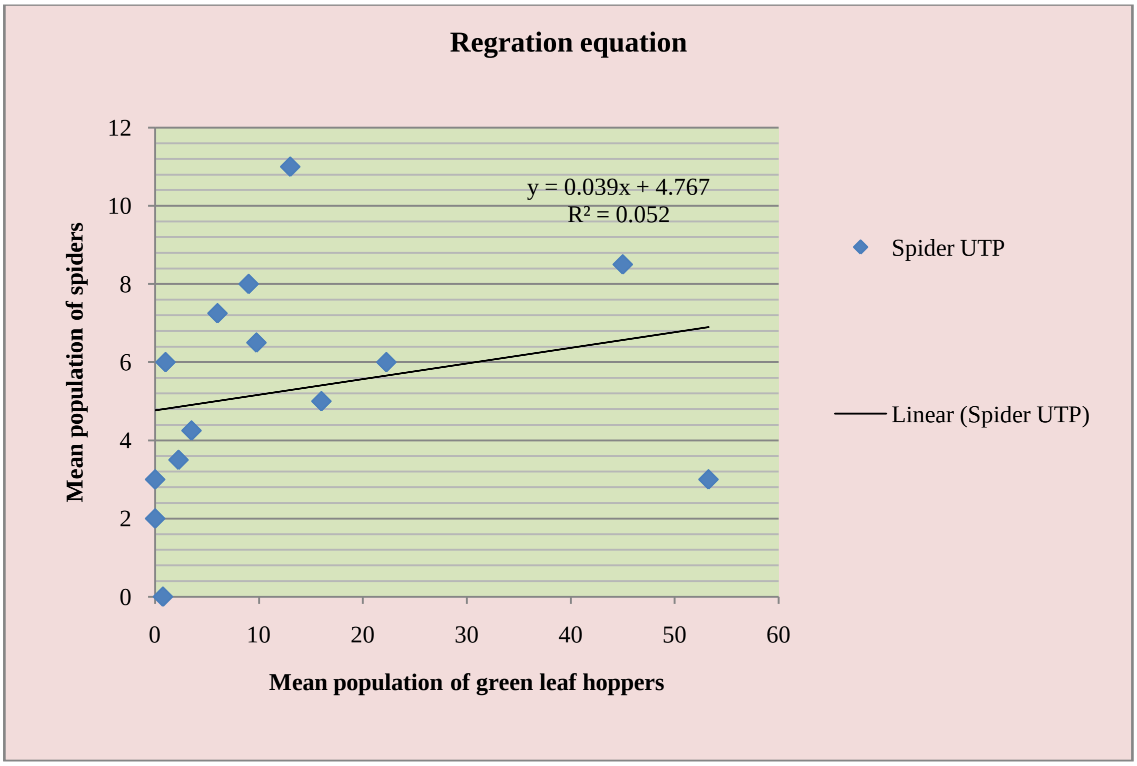

Fig: 2. Regression equation between mean populations of green leaf hopper and spiders in upland transplanted rice ecosystem (UTP).

CONCLUSION

From the above study it can be concluded that the October month is a crucial periods for pest and natural enemies protections because it is clear that the maximum population of green leaf hoppers and spiders were observed during 40 SMW and 43 SMW of October respectively. In bio-meteorological interaction study spiders showed negative significant correlation with average rainfall (r = - 0.656*) at 5 per cent level of significance and non-significant positive correlation with green leaf hopper, *Nephotettix* spp. (r = + 0.230) at 5 and 1 per cent level of significance.

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IN VITRO ANTIMICROBIAL ACTIVITY OF NOVEL FUNCTIONALIZED CHALCONES

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Abstract: Two series of novel chalcones (4a-4g, 5a-5g) have been synthesized by solution phase Claisen-Schmidt condensation. All the new final products have been purified by silica gel column chromatograpgy and characterized on the basis of their infrared (IR) and proton nuclear magnetic resonance (^{1}H NMR) spectroscopic data, and elemental analysis. All the final compounds (4-5) were exploited for their antimicrobial activity by the cup-plate method. From the antibacterial screening it was observed that the compounds, 4 (a, d, f and g), 5 (b, c, d, e and f), shows good antibacterial activity against *Staphylococcus aureus* (zone of inhibition,10-16 mm) as compared to standard streptomycin (zone of inhibition, 18 mm) whereas compounds 4 (a and b), 5 (b, c and d), showed good antibacterial activity against *Escherichia coli* (zone of inhibition,10-18 mm) as compared to streptomycin (zone of inhibition, 22 mm). Fungicidal screening data also revealed that compounds 4 (b and d), 5 (a and e), imparted maximum activity against *Aspergillus niger* (zone of inhibition, 10-15 mm) as compared to standard griesofulvin (zone of inhibition, 17 mm), whereas compounds 4 (b, c, f and g), 5b, showed good activity against *Candida albicans* (zone of inhibition, 10-16 mm) as compared to griesofulvin (zone of inhibition, 20 mm).

Keywords: Chalcones, Condensation, Antimicrobial activity

INTRODUCTION

Chalcones, 1,3-diarylprop-1-enones, are a class of compounds consisting of two aryl rings linked by an α,β- unsaturated ketone moiety. Chalcones moieties are common substructures in numerous natural products belonging to the flavonoid family. The compounds with the backbone of chalcone have been reported to exhibit a wide variety of pharmacological effects including, antimalarial, antiviral, antibacterial, antituberculosis, antifungal, anticancer, antileishmaninal, antiinflammatory, antipyretic, analgesic, antiulcerative, antihyperglycemic, antioxidant, antiinvasive, antiplatelet and insect antifeedent. A number of chalcone derivatives have also been found to inhibit several important enzymes in cellular systems, including xanthine oxidase, aldose reductase, epoxide hydrolase, protein tyrosine kinase and quinone reductase. Interest in chalcones as antimalarials was initiated by the discovery of antiplasmodial activity of Licochalcone A, an oxygenated chalcone isolated from the roots of the Chinese licorice during routine screening. Computational structural analysis also identified chalcones as potential plasmodial cysteine protease inhibitors consistent with the experimental data.
Herein, we designed and synthesized new chalcone derivatives and evaluated their antimicrobial activity.

MATERIAL AND METHOD

All the reagents used were of analytical grade and purchased from Sigma-Aldrich, Merck, CDH, SRL and Spectrochem. Solvents were used after their purification by suitable methods and distillation.

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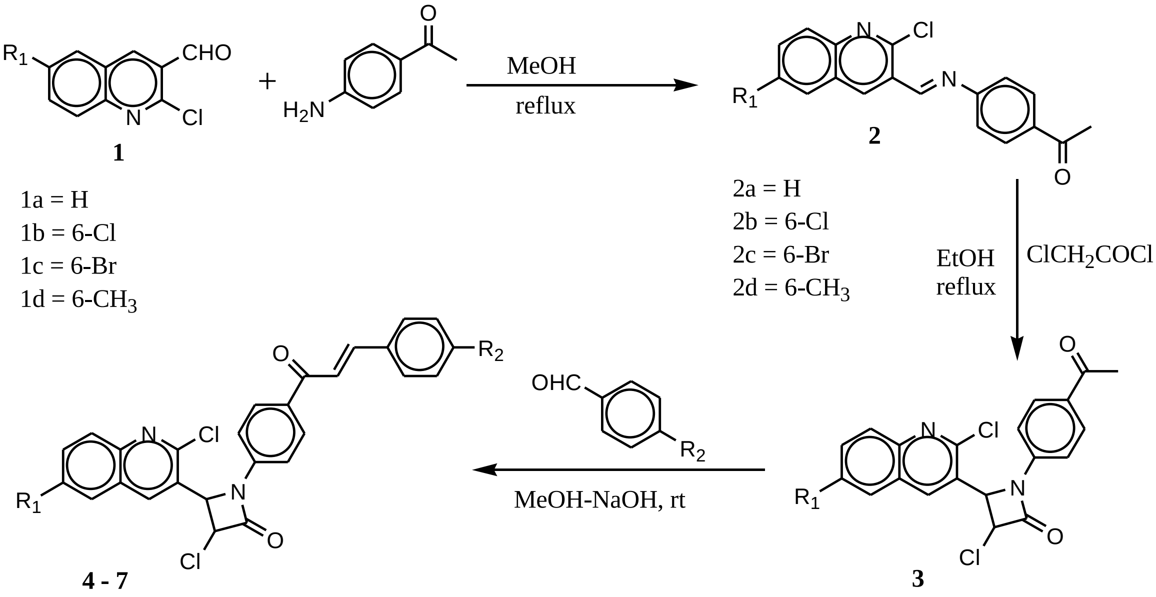
Test of homogeneity/purity
Homogeneity / purity of all products were tested by conducting their thin-layer chromatography with silica gel "G" adsorbant. Sample solutions of last step products in MeOH were loaded on silica gel layers and plates were developed in petroleum ether-Ethyl acetate (8:2, v/v) solvent. Chromatograms with multispots visualized in Iodine fumes, indicate impurity of samples. Impure samples were then purified by crystallization in ethanol to obtain pure products.

Analyses and physical measurements
Melting points determined in the open capillaries were uncorrected. IR spectra and microanalyses for carbon, hydrogen and nitrogen contents of samples were obtained from I.I.T., Delhi. ^{1}H NMR spectra were recorded in DMSO-d_6 medium on Brucker-400 MHz spectrometer at Jamia Hamdard University, Delhi.

Antimicrobial activity, Syntheses
Twenty eight compounds have been synthesized in solution phase according to, Antimicrobial activity, following scheme.
In vitro antimicrobial screening
The synthesised compounds (4-5) were screened for their in vitro antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli* and antifungal activity against *Aspergillus niger*, *Candida albicans* by measuring the zone of

inhibition in mm. The antimicrobial activity was performed by cup plate method at concentration 500 μg/mL and reported in Table 1. Nutrient agar was employed as culture medium and DMSO was used as solvent control for antimicrobial activity. Streptomycin and griseofulvin were used as standard for antibacterial and antifungal activities respectively.

Scheme



1a = H
1b = 6-Cl
1c = 6-Br
1d = $6\text{-}CH_3$

2a = H
2b = 6-Cl
2c = 6-Br
2d = $6\text{-}CH_3$

3a = H
3b = 6-Cl
3c = 6-Br
3d = $6\text{-}CH_3$

4a R_1 = H, R_2 = H
4b R_1 = H, R_2 = Cl
4c R_1 = H, R_2 = Br
4d R_1 = H, R_2 = Me
4e R_1 = H, R_2 = OMe
4f R_1 = H, R_2 = $N(Me)_2$
4g R_1 = H, R_2 = $N(Et)_2$

5a R_1 = Cl, R_2 = H
5b R_1 = Cl, R_2 = Cl
5c R_1 = Cl, R_2 = Br
5d R_1 = Cl, R_2 = Me
5e R_1 = Cl, R_2 = OMe
5f R_1 = Cl, R_2 = $N(Me)_2$
5g R_1 = Cl, R_2 = $N(Et)_2$

6a R_1 = Br, R_2 = H
6b R_1 = Br, R_2 = Cl
6c R_1 = Br, R_2 = Br
6d R_1 = Br, R_2 = Me
6e R_1 = Br, R_2 = OMe
6f R_1 = Br, R_2 = $N(Me)_2$
6g R_1 = Br, R_2 = $N(Et)_2$

7a R_1 = CH_3, R_2 = H
7b R_1 = CH_3, R_2 = Cl
7c R_1 = CH_3, R_2 = Br
7d R_1 = CH_3, R_2 = Me
7e R_1 = CH_3, R_2 = OMe
7f R_1 = CH_3, R_2 = $N(Me)_2$
7g R_1 = CH_3, R_2 = $N(Et)_2$

Scheme General route for the synthesis of new chalcones.

Table 1. Antimicrobial activity of chalcones (4-7)

S. No	Compounds	Antibacterial[a]		Antifungal[a]	
		S. aureus	*E. coli*	*A. niger*	*C. albicans*
1	4a	13	14	06	09
2	4b	06	13	14	12
3	4c	08	05	07	10
4	4d	15	07	15	05
5	4e	09	06	09	07
6	4f	12	08	08	15
7	4g	10	07	10	13
8	5a	07	05	12	09
9	5b	13	15	06	14
10	5c	15	10	07	05

11	5d	12	11	09	03
12	5e	16	09	10	07
13	5f	15	05	05	04
14	5g	09	07	04	06
15	Streptomycin	18	22	--	--
16	Griesofulvin	--	--	17	20

[a]zone of inhibition was measured in mm. *Staphylococcus aureus* (*S. aureus*), *Escherichia coli* (*E. coli*), *Aspergillus niger* (*A. niger*) and *Candida albicans* (*C. albicans*).

RESULTS AND DISCUSSION

The antimicrobial activity of synthesized chalcones (4-5) were performed against two bacteria, *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*) and two fungi, *Aspergillus niger* (*A. niger*) and *Candida albicans* (*C. albicans*) by cup plate method. Streptomycin and Griesofulvin were used as antibacterial and antifungal drug control. The activity was measured as zone of inhibition in mm and the values are depicted in table 1. From the antimicrobial screening it was observed that all the compounds exhibited activity against all the organisms employed. The compounds, 4 (a, b, d, f and g), 5 (b, c, d, e, f), shows good antibacterial activity where as other compounds showed moderate to good activity. Fungicidal screening data also revealed that compounds, 4 (b, c, d, f and g), 5 (a, b and e), imparted maximum activity against *Aspergillus niger*, where as other compounds showed moderate activity. Perusal of all results obtained from antibacterial and antifungal tests together it is concluded that entire compounds tested are active towards bacteria and fungi.

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MORPHOLOGICAL AND BIOCHEMICAL STUDIES IN HEALTHY AND INFECTED PLANT PARTS OF *TRITICUM AESTIVUM*

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Abstract: Pollen morphology is of great significance particularly in plant taxonomy. Results of present investigation revealed the effect of infection on the uptake rates of total N and P and its distribution in selected plant parts clearly define the nutritional aspects and role of macronutrients and pigments in growth and development. Our observation indicates that non-acetolysed pollen grains of *Triticum aestivum* show reduction in size as compared than that of acetolysed pollen grains. Likewise total N, P and chlorophyll content uptake and its distribution in plant parts decline in infected plant parts as compared to healthy plant parts as in stem, leaf, anther & pollen grains.

Keywords: Wheat, Pollen, Grain, Nitrogen, Phosphorus, Chlorophyll

INTRODUCTION

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

MATERIAL AND METHOD

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

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

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

Total N content of Stem, leaf, anther and pollen grains was done according to Snell and Snell (1954). While the total P content was done according to Allen (1960) method. For estimation of chlorophyll development in healthy and infected leaf disc of wheat plant the amount of chlorophyll- a and chlorophyll-b was estimated according to Arnon (1949) formulae which are shown below-

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

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

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

OBSERVATION

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

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Table 1. Size of pollen grains in *Triticum aestivume* (µm) acetolysed and non-acetolysed, pore diameter, annulus diameter and exine thickness.

Acetolysed Diameter (µm)	Non-Acetolysed Diameter (µm)	Pore diameter (µm)	Annulus diameter (µm)	Exine thickness (µm)
31.40 ±2.58	27.50 ±2.95	4.00 ±0.30	9.50 ±0.36	1.60 ±0.25

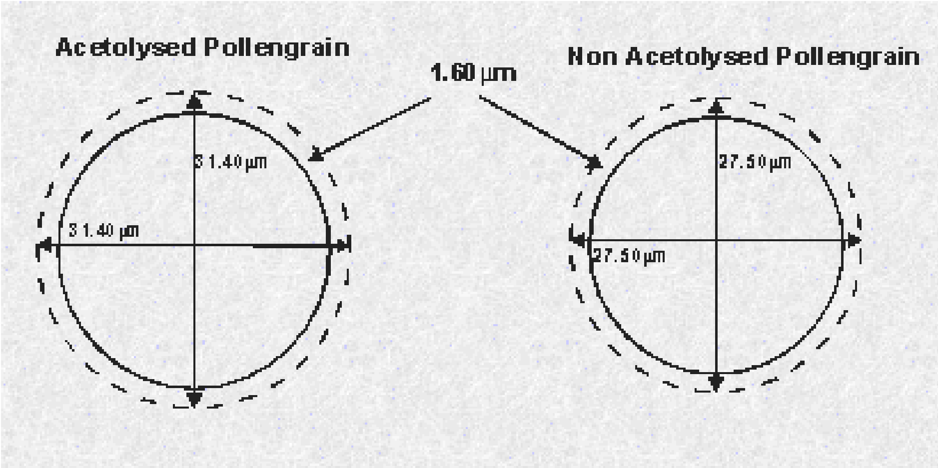

Fig 1. Size of pollen grains in *Triticum aestivum* (µm)

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

Days from emergence	Soil with plant (Blank) mg/kg	Soil with plant mg/kg	Total nitrogen level in			
			Stem	Leaf	Anther	Pollen Grains
			mg/gm dry wt.			
Plant without infection (Control)						
0	640.0	640.0	.....	......	.....	......
40	636.0	632.0	12.10	18.20	…..	…..
80	622.0	600.0	20.10	20.10	15.10	13.65
Plant with infection						
0	640.0	640.0	.....	......	......	.....
40	630.0	626.0	10.30	16.00	......	.....
80	610.0	590.0	12.00	17.00	12.60	10.55

Figure 2: Total nitrogen content in (mg/gm) dry wt. of stem in *Triticum aestivum* with and without infection after 40 and 80 days of emergence.

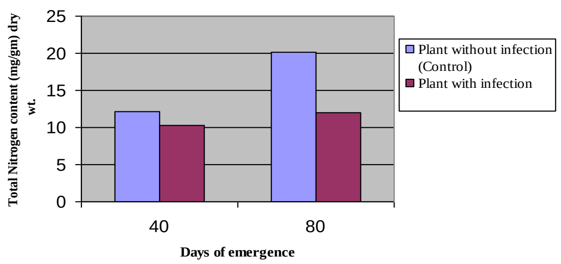

Figure 3: Total nitrogen content in (mg/gm) dry wt. of Leaf in *Triticum aestivum* with and without infection after 40 and 80 days of emergence.

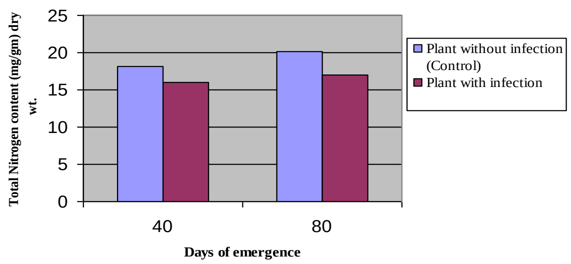

Figure 4: Total nitrogen content in (mg/gm) dry wt. of anthers in *Triticum aestivum* with and without infection after 80 days of emergence.

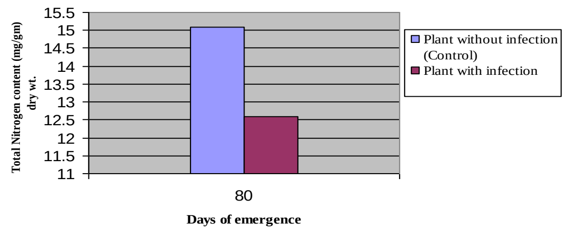

Figure 5: Total nitrogen content in (mg/gm) dry wt. of pollen grains in *Triticum aestivum* with and without infection after 80 days of emergence.

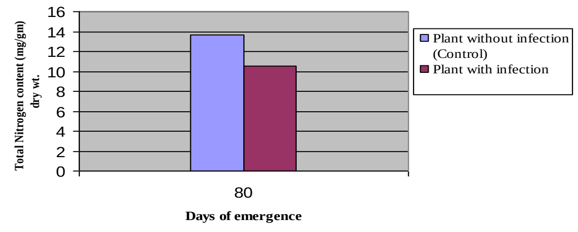

Table 3. Total Phosphate (per gram dry weight) uptake and distribution in healthy and infected plant parts of *Triticum aestivum*

Days from emergence	Soil with plant (Blank) mg/kg	Soil with plant mg/kg	Total phosphate level in			
			Stem	Leaf	Anther	Pollen Grains
			mg/gm dry wt.			
Plant without infection (Control)						
0	390.0	390.0	.....	.....	.....	......
40	380.0	370.0	13.20	17.00	…..	…..
80	370.0	360.0	14.20	18.00	2.56	13.80
Plant with infection						
0	390.0	390.0	....	....	.....	.....
40	382.0	378.0	12.51	16.00	......	.....
80	356.0	344.0	10.00	15.80	2.00	12.00

Figure 6: Total phosphate content in (mg/gm) dry wt. of stem in *Triticum aestivum* with and without infection after 40 and 80 days of emergence.

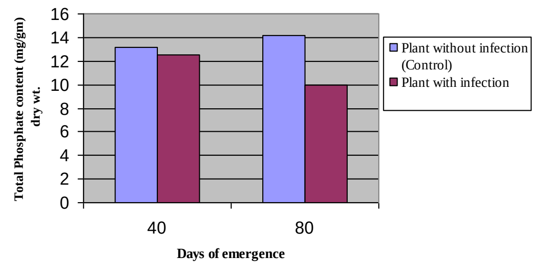

Figure 7: Total phosphate content in (mg/gm) dry wt. of Leaf in *Triticum aestivum* with and without infection after 40 and 80 days of emergence.

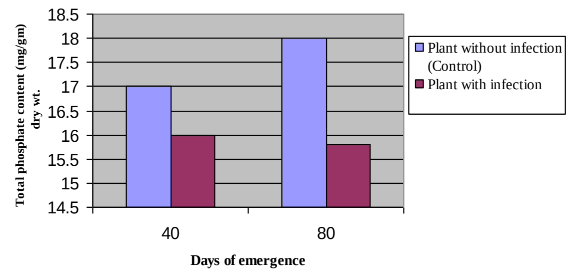

Figure 8: Total phosphate content in (mg/gm) dry wt. of anthers in *Triticum aestivum* with and without infection after 80 days of emergence.

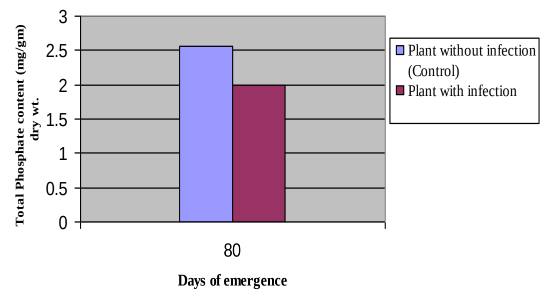

Figure 9: Total phosphate content in (mg/gm) dry wt. of pollen grains in *Triticum aestivum* with and without infection after 80 days of emergence.

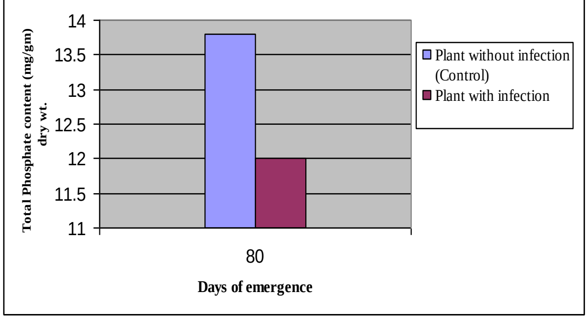

Table 4. Chlorophyll development in healthy and infected leaf disc in *Triticum aestivum*

Treatment	Leaf disc		Chlorophyll content in healthy and infected plant							
	Fresh weight mg, leaf disc^{-1}	Dry weight mg, leaf disc^{-1}	mg/g fw^{-1}				mg/g dw^{-1}			
			chl-a	chl-b	chl-a+b	chl-a/b	chl-a	chl-b	chl-a+b	chl-a/b
Healthy plant	21.50	5.50	0.25	0.24	0.49	1.04	1.20	1.30	2.50	0.92
Infected plant	21.60	5.40	0.23	0.21	0.44	1.09	1.10	1.20	2.30	0.90

RESULT AND DISCUSSION

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

Table-2, fig-2-5 show decline of total N content in infected plant parts as compared to healthy plant parts. At 80th days pollen grains of infected plant contain 72.2% of total N as compared to pollen grains of healthy (control) plant. Similarly total N content of infected leaf was 87% and 84.5% respectively at 40th days and 80th days as compared to healhy plant leaf. Total N per plant organ is suppressed in infected plant. In case of soil without plant the total N content per kg decline from 0- 80th days in both healthy and infected plant (Table-2). Our finding of total N in various plant parts of healthy and infected plant are agreement with previous work done by Vasil (1987) Dhingra & Verghese (1990), Singh (2002), Divya (2003), Pridhi (2004), Bhargava (2006), Reshu (2006).

Total P uptake and its distribution were found decreased in fungal infected plant parts which also inhibited the growth rate of plants. It was 94.1 % and 87.7 % in the infected leaf at 40th and 80th days respectively as compared to non- infected (control) leaf. Translocation of P from vegetative part to pollen grains is much affected in the infected (86.9%) plant as compared to healthy (control) plant pollen grains. Similarly total P at 80th days is 78.1% as compared to healthy plant anther (Table 3 & fig-5-9).

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

Result shows that there is an increase in chlorophyll development in healthy leaf disc as compared to infected leaf disc. In healthy plant leaf disc total chlorophyll development is promoted by 13% as compared to infected leaf disc on mg/ g fresh weight, in which it was found retarted. Total chlorophyll on g fw- 1 basis was 89.7% in healthy plant leaf disc (Table -4).

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

CONCLUSION

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

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PATH COEFFICIENT ANALYSIS IN MUNGBEAN UNDER IRRIGATED AND MOISTURE STRESS CONDITIONS

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Abstract: An investigation was carried out with fifty eight mungbean genotypes to understand direct and indirect effects of yield attributes and drought related traits on seed yield per plant under both irrigated (E_1) and moisture stress (E_2) conditions for yield components. Path analysis revealed that, harvest index had positive direct effect on seed yield per plant per plant under both irrigated (E_1) and moisture stress conditions (E_2). However, days to maturity, number of pods per plant and number of pods per cluster in E_1 and number of clusters of plant, number of pods per plant, plant height, 100 seed weight and relative water content in E_2 contributed moderate and direct effect on seed yield per plant.

Keywords: Mungbean, Path analysis, Yield, Drought, Parameters

INTRODUCTION

Vigna radiata (L.) Wilczek, commonly called as mungbean or greengram, and it is known for easily digestable protein component. The seed yield of mungbean is low, the productivity of this crop is stepped up by evolving high yielding varieties. Therefore, there is need to explore the possibility of increasing the productivity through better understanding of constraints of its production. The low production may be due to various abiotic and biotic factors. Among abiotic factors, drought is a major determinant causing tremendous yield losses and low crop productivity globally. Drought problems for mungbeans are worsening with the rapid expansion of water stressed areas of the world including 3 billion people by 2030 (Postel, 2000). Drought stress inhibits the photosynthesis of plants by causing changes in chlorophyll content and reducing relative water content. Genetic improvement in mungbean for drought resistance requires investigation of possible physiological traits related to drought along with yield and exploitation of their genetic variation. To evolve suitable genotypes for drought, information on cause-effect relationship between yield, yield attributes and drought related parameters is very essential. Hence, the present study was under taken to estimate path coefficients for yield, yield attributes and drought related parameters in munbean under both irrigated (E_1) and moisture stress (E_2) conditions.

MATERIAL AND METHOD

Fifty eight mungbean genotypes were evaluated for yield and other nine yield component characters during *kharif,* 2012 at dry land farm, Sri Venkateswara Agricultural College, Tirupati, Andhrapradesh. The experimental material was sown in two sets simultaneously in field (E_1) as well as in rainout shelter (E_2) by adopting augmented block design -II (Federer, 1956) having 6 blocks and 4 checks. Each entry was sown in single row of plot of 3 m length, with a spacing of 30 cm between the rows and 10 cm between the plants. Rainout shelter was utilized to impose moisture stress as well as to avoid natural precipitation. The crop under rainout shelter was imposed to moisture stress by withholding irrigation from 42 days after sowing to crop maturity. This moisture stress treatment was synchronized with pod development stage of the crop. Common agronomic practices and plant protection measures were taken up for both the conditions during the crop growth period, as per the standard recommended package of practices. Observations were recorded on randomly selected five plants from each genotype on plant height (cm), number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, 100 seed weight (g), harvest index (%), SCMR (SPAD Chlorophyll Meter Reading), specific leaf area (cm^2 g^{-1}), relative water content (%), relative injury (%), chlorophyll stability index (%) and seed yield per plant (g) except days to 50% flowering and days to maturity which could be taken on plot basis. Path coefficient analysis was carried out by the procedure originally proposed by Wright (1921) which was subsequently elaborated by Dewey and Lu (1959) to estimate the direct and indirect effects of the individual characters on yield.

RESULT AND DISCUSSION

Path coefficient analysis accommodates anassistance for categorizing the total correlation into direct and indirect effects. The results of path analysis showed (Table 1) harvest index (E_1=0.4951; E_2=0.3070) had high and positive direct effect on seed yield per plant under both E_1 and E_2.

Under E_1, days to 50 per cent flowering (0.2703) had high and positive direct effect on seed yield per plant; number of pods per plant (0.2347) and number of pods per cluster (0.2024) showed moderate direct effect on seed yield per plant. Though number of branches per plant (0.1967), SCMR (0.1240) and relative water content (0.1074) had positive direct

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Table 1. Direct and indirect effects of yield components and drought related traits as partitioned by path analysis in mungbean under irrigated (E_1) and moisture stress (E_2) conditions

Character		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches / plant	No. of clusters/ plant	No. of pods/ cluster	No. of pods/ plant	100 seed weight (g)	Harvest index (%)	SCMR	Specific leaf area ($cm^2 g^{-1}$)	Relative water content (%)	Relative injury (%)	Chlorophyll stability index	Seed yield/ plant (g)
Days to 50% flowering	E_1	**0.2703**	-0.0973	-0.0215	0.043	-0.0146	0.0494	0.0658	0.0312	-0.0044	-0.0001	-0.0016	0.0328	0.0146	-0.0056	0.362*
	E_2	**0.0329**	0.0273	0.0759	0.0257	-0.0044	-0.0039	-0.0072	-0.0728	0.0405	-0.0037	0.0004	0.0286	0.0116	0.0115	0.162
Days to maturity	E_1	0.142	**-0.1852**	-0.0239	0.0359	-0.019	0.0691	0.0936	0.0596	0.025	0.0089	-0.0023	0.0062	-0.0073	-0.0101	0.193
	E_2	0.0158	**0.0567**	0.0652	-0.0346	0.0132	-0.0112	0.0531	-0.0391	0.0409	0.0058	0.0006	0.047	0.0156	0.0409	0.270
Plant height (cm)	E_1	0.0614	-0.0467	**-0.0947**	0.061	-0.0087	0.0713	0.0912	0.0168	0.0381	-0.0026	-0.0021	0.0016	0.0182	0.0052	0.210
	E_2	0.0117	0.0174	**0.2127**	-0.0551	0.0359	0.0025	0.0499	-0.0219	0.0859	0.0039	0.0002	-0.0191	-0.0193	-0.0058	0.299**
No. of branches/ plant	E_1	0.0591	-0.0337	-0.0294	**0.1967**	-0.0069	0.0433	0.1236	0.0358	-0.2008	-0.026	-0.0019	0.0011	0.0165	-0.0018	0.176
	E_2	-0.0026	0.006	0.0358	**-0.3278**	0.1252	0.0012	0.0886	-0.0268	-0.098	-0.0028	0.0002	0.0144	0.0123	0.0187	-0.156
No. of clusters/ plant	E_1	0.0700	-0.0625	-0.0147	0.0243	**-0.0563**	0.0098	0.1307	0.058	-0.0149	-0.0349	-0.0132	-0.0007	0.0179	-0.0068	0.107
	E_2	-0.0006	0.003	0.0301	-0.1618	**0.2537**	-0.0279	0.1313	-0.0757	-0.0688	-0.0084	-0.0006	-0.0143	0.0017	0.0056	0.067
No. of pods/ cluster	E_1	0.0660	-0.0632	-0.0333	0.0421	-0.0027	**0.2024**	0.0727	0.0190	-0.0468	-0.0023	0.0053	0.018	0.0219	-0.0069	0.292**
	E_2	-0.0009	-0.0044	0.0037	-0.0028	-0.0495	**0.1429**	0.1106	-0.0566	0.0465	0.0032	-0.0002	-0.0028	-0.028	-0.0081	0.154
No. of pods/ plant	E_1	0.0758	-0.0739	-0.0368	0.1036	-0.0313	0.0627	**0.2347**	0.0621	-0.086	-0.0139	-0.002	-0.0008	0.0264	-0.0054	0.315*
	E_2	-0.0011	0.0136	0.0479	-0.1309	0.1503	0.0713	**0.2218**	-0.1021	0.0118	-0.0021	-0.0004	0.0032	-0.0011	0.0089	0.291**
100 seed weight (g)	E_1	-0.0516	0.0676	0.0097	-0.0431	0.0200	-0.0236	-0.0893	**-0.1633**	0.0711	0.0396	0.0091	0.0231	0.0003	0.0079	-0.122
	E_2	-0.0117	-0.0109	-0.0228	0.0431	-0.0941	-0.0396	-0.1108	**0.2043**	0.0544	0.0126	0.0006	0.0368	-0.0041	-0.0157	0.042
Harvest index (%)	E_1	-0.0024	-0.0093	-0.0073	-0.0798	0.0017	-0.0191	-0.0408	-0.0235	**0.4951**	0.0436	0.0042	0.0146	-0.0152	-0.0056	0.356**
	E_2	0.0043	0.0076	0.0596	0.1046	-0.0569	0.0216	0.0085	0.0362	**0.3070**	0.0063	0.0005	-0.0133	-0.0163	0.0051	0.475*
SCMR	E_1	-0.0002	-0.0134	0.002	-0.0413	0.0158	-0.0038	-0.0262	-0.0522	0.174	**0.1240**	0.0106	0.002	-0.0231	-0.0013	0.167
	E_2	-0.0041	0.0110	0.0279	0.0313	-0.0717	0.0152	-0.0157	0.0865	0.0646	**0.0298**	0.0008	0.0127	-0.0188	0.0041	0.173
Specific leaf area ($cm^2 g^{-1}$)	E_1	0.0147	-0.0141	-0.0065	0.0125	-0.0248	-0.036	0.0157	0.0496	-0.0695	-0.0437	**-0.0300**	-0.0181	0.0405	0.0017	-0.108
	E_2	-0.0046	-0.0121	-0.0173	0.0222	0.0519	0.0086	0.0302	-0.0412	-0.0561	-0.0079	**-0.003**	-0.0395	-0.0187	-0.0223	-0.11
Relative water content (%)	E_1	0.0826	-0.0106	-0.0014	0.0021	0.0004	0.0339	-0.0017	-0.0351	0.0674	0.0023	0.0051	**0.1074**	0.0064	-0.0106	0.248*
	E_2	0.0047	0.0133	-0.0203	-0.0234	-0.018	-0.002	0.0035	0.0374	-0.0203	0.0019	0.0006	**0.2010**	0.0207	0.0448	0.244**
Relative injury (%)	E_1	-0.0303	-0.0104	0.0132	-0.0248	0.0077	-0.034	-0.0475	0.0004	0.0576	0.022	0.0093	-0.0052	**-0.1304**	0.0042	-0.168
	E_2	-0.0028	-0.0065	0.0302	0.0295	-0.0031	0.0293	0.0019	0.0062	0.0367	0.0041	-0.0004	-0.0306	**-0.1362**	-0.031	-0.073
Chlorophyll stability index	E_1	0.0383	-0.0469	0.0124	0.009	-0.0096	0.0353	0.0319	0.0323	0.069	0.0039	0.0013	0.0285	0.0138	**-0.0398**	0.179
	E_2	0.0028	0.0171	-0.009	-0.0451	0.0106	-0.0085	0.0145	-0.0237	0.0115	0.0009	0.0005	0.0664	0.0311	**0.1357**	0.205

Residual effect (E_1): 0.5342; Residual effect (E_2): 0.5145; Bold: Direct effects; Normal: Indirect effects; * Significant at 5% level; ** Significant at 1% level effect on seed yield per plant but it was low. On contrary, relative injury (-0.1304) had negative direct effect on seed yield per plant but it was low. Hence selection based on these traits would be effective in increasing the seed yield per plant. On contrary, the traits specific leaf area (-0.0300), chlorophyll stability index (-0.0398), 100 seed weight (-1633), days to maturity (-0.1852), number of clusters per plant (0.0276) and plant height (-0.0947) contributed negative direct effect on seed yield per plant per plant.

Under E_2, path coefficient analysis among seed yield per plant and it's components, revealed that number of clusters per plant (0.2537) exhibited the highest positive direct effect along with significant positive association with seed yield per plant. While, number of pod per plant (0.2218), plant height (0.2127), 100 seed weight (0.2043) and relative water content (0.2010) showed moderate direct effect and on seed yield per plant. Hence selection based on these traits would be effective in increasing the seed yield per plant. In contrast, chlorophyll stability index (0.1357) and relative injury (-0.1362) exhibited low positive and negative direct effect on seed yield per plant. Negligible direct effect on seed yield per plant was exhibited by days to maturity (0.0567), days to 50 per cent flowering (0.0329) and SCMR (0.0298). On contrary, specific leaf area (-0.0030) and number of branches per plant (-0.3278) contributed negative direct effect on seed yield per plant.

Similar findings were also reported by Rao *et al*. (2006), Pandey *et al*. (2007), Ajmal *et al*. (2001) for harvest index; Reddy *et al*. (2005) for days to 50 per cent flowering; Zubair and Srinives (1986), Lakshman and Ruben (1989), Lavanya and Toms (2009), Kumar *et al*. (2013), Srikanth *et al*. (2013) for number of clusters per plant; Naidu *et al*. (1994), Venkateswarulu (2001), Wani *et al*. (2007), Lavanya and Toms (2009), Reddy *et al*. (2011), Ahmad *et al*. (2013) for number of pod per plant; Swathi (2013) for SCMR and Meenakshi (2004) for relative water content.

Path analysis revealed that, harvest index had positive direct effect on seed yield per plant per plant under both irrigated and moisture stress conditions. Due to its direct contribution which was highest in magnitude, there by indicating a true correlation and could be taken as components for the improvement of yield under both irrigated and moisture stress conditions. However, days to maturity, number of pods per plant and number of pods per cluster in E_1 and number of clusters of plant, number of pods per plant, plant height, 100 seed weight and relative water content in E_2 contributed moderately to seed yield per plant. Although, number of branches per plant, SCMR, relative injury and relative water content in E_1 and number of pods per cluster, relative injury and chlorophyll stability index in E_2 had positive direct effect on seed yield per plant but it was low. Hence selection based on these traits also helps in increasing the seed yield per plant under both irrigated and moisture stress conditions. Negligible direct effect on seed yield per plant was shown by days to 50 per cent flowering and days to maturity in moisture stress condition. Hence direct selection of this trait could not help in improvement in yield under moisture stress conditions.

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RESPONSE OF *RABI* ONION (*ALLIUM CEPA* L.) TO VARYING LEVELS OF NITROGEN UNDER SEMI-ARID CONDITIONS

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Abstract: An experiment was conducted to study the effected of different levels of nitrogen on yield attributes and yield of onion under semi arid conditions at Horticulture farm, S.K.N. College of Agriculture, Rajasthan Agricultural University, Jobner during *rabi* season. The experiment was comprised of three levels of nitrogen 50 kg ha^{-1}, 100 kg ha^{-1} and 150 kg ha^{-1}. The experiment was laid out in randomized block design with three replications. Onion variety RO-1 was taken up in experiment. Results of study revealed that application of 100 kg N ha^{-1} being at par with 150 kg N ha^{-1} significantly increased in yield attributes and yield of onion.

Keywords: Onion, Nitrogen, Yield, Economic

INTRODUCTION

Onion is one of the most important vegetable cum condiment crop grown throughout the world including India. Onion (*Allium cepa* L.) is a bulbous biennial herb of Alliaceae family. It is a unique vegetable that is used throughout the year in the form of salad or condiments or for cooking with other vegetables. Onion is also used in preparing soups, sauces, curries, pickles and for flavouring or seasoning foods. Onion bulbs have many medicinal properties. In India, the major onion producing states are Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Bihar, Orissa, Tamil Nadu, Uttar Pradesh, Madhya Pradesh and Rajasthan. These states together accounted for 96 per cent of total area and production of onion in the country. It is evident now that nitrogen is the most deficient element. Availability of nitrogen is of prime importance for growing plants as it is major and indispensable constituent of protein and nucleic acid molecules. It is an integral part of chlorophyll molecules, which are responsible for photosynthesis. An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs finally leading to higher productivity. Patel *et al.* (1992) and Sharma (1992) reported that the application of nitrogen with different doses increased plant growth and yield of onion. Therefore, keeping all the points in view, the present study was under taken to evaluate the response of *rabi* onion (*Allium cepa* L.) to varying levels of nitrogen under semi-arid conditions.

MATERIAL AND METHOD

The experiment was laid out at Horticulture farm, S.K.N. College of Agriculture, Rajasthan Agricultural University, Jobner during *rabi* season 2009. Jobner is situated at 26.5^0 North latitude, 75.20^0 East longitude and an altitude of 427 metres above mean sea level, in Jaipur district of Rajasthan. This region falls under Agro-climatic zone IIIA (Semi-Arid Eastern Plain) of the state.

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The climate of Jobner is typically semi arid characterized by extremes of temperature both in summer and winter with low rainfall and moderate relative humidity. Maximum temperature in summer is as high as 45 ^{0}C and minimum temperature in winters fall around 0 ^{0}C. The average rainfall of the locality is about 500 mm, most of which is received in rainy season from July to September. Yearly pan evaporation ranges from 1900-2000 mm. the soil was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon with low available nitrogen, phosphorus and sulphur and medium in potassium status. The experiment was comprised of three levels of nitrogen 50 kg ha^{-1}, 100 kg ha^{-1} and 150 kg ha^{-1}. The experiment was laid out in randomized block design with three replications. Onion variety RO-1 was taken up in experiment.

RESULT AND DISCUSSION

Yield attributes

The data regarding yield attributes including plant height, number of leaves per plant, weight of leaves per plant at harvest, neck thickness neck length, equatorial diameter, polar diameter, and number of scales per bulb are presented in Table 1. The data presented in table show that plant height of onion influenced significantly with application of nitrogen. Application of 100 kg N ha^{-1} resulted in significantly higher plant height in onion as compared to 50 kg N ha^{-1} but statistically at par with 150 kg N ha^{-1}. The per cent increase in plant height by the application of 150 kg N ha^{-1} was 17.33 and 5.86 over 50 and 100 kg N ha^{-1}, respectively.

It is obvious from the data in table that application of 150 kg N ha^{-1} produced significantly higher number of leaves per plant as compared to 50 kg N ha^{-1} while it was statistically at par with 100 kg N ha^{-1}. The per cent increase in the number of leaves per plant with

150 kg N ha^{-1} was 15.48 and 5.87 over 50 and 100 kg N ha^{-1}, respectively. The weight of leaves per plant at harvest was recorded significantly higher with the application of 150 kg N ha^{-1} over 50 kg N ha^{-1} but statistically at par with 100 kg N ha^{-1}.

A dose of 100 kg N ha^{-1} recorded significantly higher neck thickness over 50 kg N ha^{-1} but it was statistically at par with 150 kg N ha^{-1}. Application of 150 kg N ha^{-1} resulted in 11.23 and 3.12 per cent higher neck thickness over 50 and 100 kg N ha^{-1}, respectively. The data revealed that the maximum neck length was recorded with application of 150 kg N ha^{-1} being at par with 100 kg N ha^{-1} but both are found superior over 50 kg N ha^{-1}. The increase in neck length by the application of 150 kg N ha^{-1} over 50 and 100 kg N ha^{-1} was 9.74 and 3.48 per cent, respectively.

A dose of 150 kg N ha^{-1} recorded significantly higher equatorial diameter over 50 kg N ha^{-1} but it was statistically at par with 100 kg N ha^{-1}. Application of 150 kg N ha^{-1} resulted in 15.14 and 4.95 per cent higher equatorial diameter over 50 and 100 kg N ha^{-1}, respectively. the polar diameter significantly increase with the application of 100 kg N ha^{-1} which was significantly higher than 50 kg N ha^{-1} but statistically at par with 150 kg N ha^{-1}. The increase in polar diameter by the application of 150 kg N ha^{-1} over 50 and 100 kg N ha^{-1} was 13.48 and 4.94 per cent, respectively.

Application of 150 kg N ha^{-1} resulted in significantly higher number of scales per bulb as compared to 50 kg N ha^{-1} but statistically at par with 100 kg N ha^{-1}. The per cent increase recorded in number of scales per bulb by the application of 150 kg N ha^{-1} was 14.4 and 5.14 over 50 and 100 kg N ha^{-1}, respectively.

The significant improvement in yield attributes of onion with the nitrogen fertilization could be described to overall improvement in vigour of the crop growth. Since an adequate supply of nitrogen in the life of a plant is considered important in promoting rapid vegetative growth, number of leaves per plant, plant height and fresh weight of leaves thereby increasing the sink size in terms of bulb size. Thus, nitrogen fertilization stimulated neck thickness, bulb diameter and number of scales per bulb. Nitrogen application further helps in the translocation of photosynthates in storage organ of bulb resulting in increased diameter and weight of bulb.

Yield

The data pertaining to fresh weight of bulb, Volume of bulb and Bulb yield per hectare are presented in Table 2. It is evident that average fresh weight of individual bulb at harvest, volume of bulb and bulb yield per hectare were influenced significantly due to application of N. It is obvious from the data that increase in weight of bulb due to application of 150 kg N ha^{-1} was significantly higher over application of 50 kg N ha^{-1} while it was statistically at par with 100 kg N ha^{-1} and corresponding per cent increase was 16.17 and 5.70, respectively. Application of 150 kg N ha^{-1} significantly increased the volume of bulb over 50 kg N ha^{-1} but statistically at par with 100 kg N ha^{-1}. The higher value of (59.59 cc) bulb volume have been recorded with the application of 150 kg N ha^{-1} as compared to 52.12 cc and 56.68 cc over 50 and 100 kg N ha^{-1}, respectively. Data indicate that bulb yield of onion was increased significantly up to 100 kg N ha^{-1}. The highest bulb yield (247.25 q ha^{-1}) was recorded with the application of 150 kg N ha^{-1} which was significantly superior over 50 kg N ha^{-1}, while, it was statistically at par with 100 kg N ha^{-1}. The application of 100 kg N ha^{-1} increased the bulb yield over 50 kg N ha^{-1} by 23.29%.

The bulb yield, being a function primarily of the cumulative effect of these parameters, increased significantly by 232.43 q ha^{-1} (Table 2) with nitrogen fertilization led at 100 kg N ha^{-1} improved fresh weight of bulb and fresh weight of leaves as explained earlier with nitrogen fertilization led to significant improvement in biological yield and resulted in better source and sink relationship as a result of nitrogen application. The present trend of increase in bulb yield with application of nitrogen is in close conformity with the findings of Pandey *et al.* (1991) and Amin *et al.* (1995).

Table 1. Effect of different levels of nitrogen on yield attributes of onion

Treatments	Plant height (cm) at harvest	Number of leaves per plant at harvest	Fresh weight of leaves per plant at harvest (g)	Neck thickness of bulb (cm)	Neck length of bulb (cm)	Equatorial diameter (cm)	Polar diameter (cm)	Number of scales per bulb
N_{50}	38.94	5.62	21.72	0.89	5.95	5.15	4.30	6.25
N_{100}	43.16	6.13	23.60	0.96	6.31	5.65	4.65	6.80
N_{150}	45.69	6.49	24.78	0.99	6.53	5.93	4.88	7.15
S.Em $\pm$	0.99	0.14	0.56	0.02	0.12	0.12	0.09	0.15
CD (P=0.05)	2.84	0.39	1.60	0.06	0.36	0.33	0.26	0.42

Table 2. Effect of different levels of nitrogen on fresh weight of bulb, volume of bulb, yield of bulb and economics

Treatments	Fresh weight of bulb (g)	Volume of bulb (cc)	Yield of bulb (q ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
N_{50}	47.55	52.12	200.50	38514	1.78
N_{100}	52.26	56.68	232.43	47549	2.14
N_{150}	55.24	59.59	247.25	51452	2.26
S.Em $\pm$	1.00	1.17	6.02	1806	0.08
CD (P=0.05)	2.89	3.36	17.30	5191	0.23

Economics

It is explicit from data (Table 2) that application of 100 kg N ha^{-1} recorded significantly higher net return (Rs. 47549) and B:C ratio (2.14) compared to 50 kg N ha^{-1} (Rs. 38514 and 1.78), respectively. However, application of 150 kg ha^{-1} recorded maximum net returns and B:C ratio (Rs. 51452 and 2.26) being at par with 100 kg N ha^{-1}. The results of the present study clearly indicate that net returns and B:C ratio significantly increased with increasing levels of nitrogen upto 100 kg N ha^{-1}. The 100 kg N ha^{-1} recorded net return of Rs. 47549 ha^{-1} with a B:C ratio of 2.14. This may be ascribed due to increase in bulb yield significantly upto 100 kg N ha^{-1}.

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SHORT COMMUNICATION

INFLUENCE OF CHEMICAL FERTILIZERS AND ORGANICS ON GROWTH, FLOWERING, FRUIT YIELD AND QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV L-49 UNDER CHHATTISGARH PLAINS

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Abstract: A field experiment was carried out during the year 2013-14 for Mrig bahar crop of guava at Horticulture Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) to studies on Influence of chemical fertilizer and organics on growth, flowering, fruit yield and quality of guava (*Psidium guajava* L.) cv. L-49 under Chhattisgarh plains". The experiment was laid out in Randomized Block Design (RBD) with four replications and twelve treatments. Treatment of 75% RDF+ Cowdung Slurry (T_2) resulted significantly maximum tree height (5.27 m), East West tree spread (7.04 m), North South tree spread (7.34 m) at harvesting stage, minimum number of days for flowering (33.51 days), maximum number of flowers per m^2 (17.62) and number of fruits per m^2(14.50), fruit set per m^2 (90.18%) and fruit retention (93.11%), fruit diameter (9.54 cm), fruit weight (205.41 g) and pulp weight (198.17 g), yield attributing characters, number of fruits per tree (250.57), fruit yield per tree (54.66 kg) and per hectare (14.31 t ha^{-1}).

Keywords: Organics, Chemical Fertilizers, Growth, Yield, Quality, Guava

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most important fruit crops of tropical and sub-tropical regions of India. It can be grown satisfactorily on marginal soils with minimum care and is also called as 'Apple of the Tropics'. It is largely grown in warmer tropical countries of the world. It is a rich source of ascorbic acid in human diet, content of which is three to five times more than that in fresh orange juice. Chhattisgarh has covered an area of 15.6 thousand hectares with an annual production of 121300 metric tonnes and a productivity of 7.78 metric tonnes ha^{-1} (Anon., 2012) The recent concept of integrated nutrient supply involving organic, inorganic and bio -fertilizers has developed to meet the growing need for nutrients under intensive cultivation. In integrated plant nutrition supply system, the basic goal is to maintain or possibly improve the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. Guava is very hardy to soil and agro-climatic conditions and gives good response to manuring in terms of increasing fruit production and quality. Fertilizer experiments conducted in India showed that guava has given good response to balanced use of inorganic fertilizers along with organic manures. It is reported that application of organics and chemical fertilizers not only increased the yield, but also improved the fruit quality in guava (Naik and Babu, 2007).

MATERIAL AND METHOD

Field experiment was carried out during the year 2013-14 for Mrig bahar crop of Guava (*Psidium guajava* L.) cv. L-49 at Horticulture Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The soil of the experimental field was classified as *vertisol* and texturally known as clay. The mechanical composition were recorded as sand (21.42%), silt (35.50%) and clay (43.08%) and chemical composition as soil pH (7.21) available soil N (219 kg ha^{-1}), available soil phosphorus (14.72 kg ha^{-1}) and available soil K (360.40 kg ha^{-1}) (Jackson,1973) The experiment was laid out in Randomized Block Design (RBD) with fourreplications and twelve treatments namely T_0 (Control, without nutrient application), T_1 (100% RDF 600:300:300 gm NPK/tree), T_2 (75% RDF + Cowdung Slurry 10 litre/tree), T_3 (50% RDF + Cowdung Slurry 10 litre/tree), T_4 (75% RDF + *Azospirillum* 100 gm/tree), T_5 (50% RDF + *Azospirillum* 100 gm/tree), T_6 (75% RDF + PSB 100 gm/ tree), T_7 (50% RDF + PSB 100 gm/tree), T_8 (75% RDF + Vermiwash 10 litre/tree), T_9 (50% RDF + Vermiwash 10 litre/tree), T_{10} (75% RDF +*Azospirillum* + PSB) and T_{11} (50% RDF + *Azospirillum* + PSB). The tree height of guava trees was measured from the ground level to the tip of the tree canopy, trunk girth of tree was measured at 10 cm above the ground level and the canopy of tree from North-South and East-West were recorded by using measuring tape and average was calculated. The fertilizers were applied in the form of urea, single super phosphate and muriate of potash. organics like cow dung slurry and Vermiwash 10 lit $tree^{-1}$, respectively were applied, on the onset of monsoon by making ring 15 cm deep and 30 cm away from the main trunk. (1 ml = 1 crore cfu / ml.) Cultural

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practices such as weeding, inter-culturing, earthing up, digging in the ring, removal of water shoots and dead limbs were done as and when required. The trees were irrigated immediately after application of fertilizers. The data collected for different observations were subjected to statistical analysis by the statistical software developed by department of Agricultural Statistics and social Science (Language).

RESULT AND DISCUSSION

Growth, yield and quality parameters

Data presented in Table 1 shows significant differences for height of the trees at initial stage, indicating homogeneity of tree height in experimental plot. The treatment T_2 (Treatment of 75% RDF+ Cowdung Slurry) recorded significantly higher tree height (5.27 m) at harvesting stage, East-West tree spread (7.04 m) and, North-South tree spread (7.34 m). Similar findings were reported by Ram *et al.* (2005), Shukla *et al.* (2009) in guava and Baviskar *et. al.* (2011) in Sapota. The treatment T_2 also recorded significantly minimum days required for flowering (33 days), higher number of flowers per m^2 (17.62), number of fruits per m^2 (14.50), maximum fruit set (90.18%) and fruit retention (93.11%) was also reported by Dheware and Waghmare (2009) in sweet orange, Mitra *et al.* (2010) and Shukla *et al.* (2009) in guava. In addition the treatment T_2 recorded maximum tree height, higher fruit diameter (9.54 cm), fruit weight (205.41 g) and maximum pulp weight (198.17 g) and minimum peel weight (23.04 g), number of seeds (216.45) and weight of seeds per fruit (3.58 g). These observations are in agreement with the findings of Athani *et al.* (2007) and Ram *et al.* (2007) in guava and Patel and Naik (2010) in sapota. Significantly highest number of fruits per tree (250.57), highest fruit yield per tree (54.66 kg) and highest fruit yield quintal per hectare (14.31 t ha^{-1}) were also recorded with treatment T_2. This enhanced fruit yield might be due to increased flowering and fruit set with reduced fruit drop in respective treatment. (Gobindam and Purshottam, 1984) and Yadav *et al.* (2011) in papaya. Significantly maximum total soluble solids (14.80 ^{0}Brix) were recorded with treatment T_2 75% RDF+ Cowdung Slurry. Maximum shelf life of 5ml fruits (12.50 days) was recorded in treatment T_2. Significant influence of organics and chemical fertilizers on fruit quality was also reported by Athani *et al.* (2007), Muhammad *et al.* (2000) and Ram *et al.* (2007) in guava and Madhavi *et al.* (2008) in mango.

Table 1. Effect of chemical fertilizers and organics on growth of guava (*Psidium guajava* L.) cv. L-49

Treatments	Tree height at initial stage (m)	Tree height at harvesting stage (m)	Tree spread (m)		Tree spread (m)		Days to flowering
			E-W at initial stage	E-W at harvesting stage	N-S at initial stage	N-S at harvesting stage	
T_0	2.90	3.52	3.29	5.10	3.40	5.25	54.82
T_1	3.50	4.27	4.02	5.75	3.90	5.85	33.41
T_2	3.70	5.27	4.44	7.04	4.33	7.34	33.51
T_3	3.42	4.83	4.22	6.63	4.22	6.74	40.52
T_4	3.33	4.62	3.99	5.91	3.98	5.95	39.81
T_5	3.19	3.88	3.95	5.59	4.03	5.69	45.72
T_6	3.21	4.67	3.90	6.25	4.01	6.16	43.91
T_7	3.18	3.86	4.23	5.51	3.75	5.45	48.81
T_8	3.61	4.86	4.06	6.93	4.08	7.17	34.74
T_9	3.33	4.75	4.09	6.49	3.92	6.55	48.00
T_{10}	3.55	4.85	4.02	6.85	4.01	6.94	36.70
T_{11}	3.20	4.74	4.07	6.36	3.86	6.33	46.22
SEm	**0.01**	**0.11**	**0.05**	**0.16**	**0.10**	**0.18**	**0.32**
CD at 5%	**0.03**	**0.33**	**0.14**	**0.46**	**0.31**	**0.52**	**0.95**

T_0 Control (Without nutrient application)

T_1 100% RDF (600:300:300 gm NPK/tree)

T_2 75% RDF + Cowdung slurry (10 litre/tree)

T_3 50% RDF + Cowdung slurry (10 litre/tree)

T_4 75% RDF + *Azospirillum* (100 gm/tree)

T_5 50% RDF + *Azospirillum* (100 gm/tree)

T_6 75% RDF + PSB (100 gm/ tree)

T_7 50% RDF + PSB (100 gm/tree)

T_8 75% RDF + Vermiwash (10 litre/tree)

T_9 50% RDF + Vermiwash (10 litre/tree)

T_{10} 75% RDF + *Azospirillum* + PSB

T_{11} 50% RDF + *Azospirillum* + PSB

Table 2. Effect of chemical fertilizers and organics on fruit set and fruit characters of guava (*Psidium guajava* L.) cv. L-49

Treatments	Number of flowers/m^2	Number of fruits/m^2	Fruit set per m^2 (%)	Fruit retention per m^2 (%)	Fruit diameter (cm)	Fruit weight (g)	Pulp weight (g)	Peel weight (g)
T_0	9.44	5.35	60.89	75.55	6.22	91.96	65.47	29.03
T_1	12.42	7.80	65.77	74.43	7.92	145.52	135.07	26.92
T_2	17.62	14.50	90.18	93.11	9.54	205.41	198.17	23.04
T_3	15.45	10.52	80.33	76.22	9.00	175.46	164.75	25.97
T_4	13.00	8.54	82.99	82.99	8.23	152.71	142.28	26.26
T_5	11.65	7.65	78.46	78.33	7.51	135.66	125.10	28.51
T_6	13.50	8.92	76.92	76.92	8.50	159.49	146.75	23.81
T_7	10.23	6.32	85.11	85.11	6.70	125.57	108.24	24.30
T_8	16.50	12.44	87.33	90.44	9.26	195.45	173.31	23.55
T_9	14.65	9.96	86.31	89.39	8.96	170.71	157.48	27.88
T_{10}	16.00	11.45	86.40	86.31	9.15	187.79	170.59	24.33
T_{11}	14.33	9.54	75.99	74.44	8.75	164.74	152.10	22.51
SEm	**0.39**	**0.72**	**0.16**	**0.21**	**0.09**	**2.57**	**2.24**	**1.01**
CD at 5%	**1.13**	**2.08**	**0.48**	**0.61**	**0.27**	**7.40**	**6.45**	**2.96**

Table 3. Effect of chemical fertilizers and organics on fruit quality and fruit yield of guava (*Psidium guajava* L.) cv. L-49

Treatments	**Number of seeds per fruit**	**Seed weight per fruit (g)**	**TSS (^{0}Brix)**	**Number of fruits per tree**	**Fruit yield per tree (kg)**	**Fruit yield per hectare (t/ha)**
T_0	360.28	7.61	11.95	175.72	15.91	4.47
T_1	308.46	6.56	12.92	215.78	26.75	8.33
T_2	216.45	3.58	14.80	250.57	54.66	14.31
T_3	257.35	5.32	14.35	234.47	41.50	11.43
T_4	301.22	6.41	13.48	216.69	28.52	9.14
T_5	336.18	6.63	12.50	203.75	24.50	7.72
T_6	287.53	6.25	13.58	226.58	33.76	9.84
T_7	354.14	6.88	12.46	200.55	23.75	6.94
T_8	225.54	4.72	14.75	240.41	48.52	12.54
T_9	265.27	5.79	14.12	230.65	38.16	10.94
T_{10}	244.25	5.11	14.50	238.46	43.25	12.42
T_{11}	271.37	6.14	13.90	229.18	35.75	10.33
SEm	**1.81**	**0.12**	**0.36**	**6.76**	**1.77**	**0.28**
CD at 5%	**5.22**	**0.37**	**1.03**	**19.54**	**5.11**	**0.83**

CONCLUSION

The results and discussion of the present study showed that the different treatments having different levels of chemical fertilizers and organics have significant influence on growth, flowering, yield and quality of guava. The application of 75% RDF + Cowdung Slurry 10 litre/tree (T_2) has produced significantly superior effects on most of the growth parameters, yield and quality of guava. The performance of some other treatments like T_8 (75% RDF + Vermiwash 10 litre/tree), T_{10} (75% RDF + *Azospirillum* + PSB) and T_6 (75% RDF + PSB 100 gm/tree) for growth and yield parameters was found *at par* with the treatment T_2. The application level of inorganic fertilizers can be reduced by 25% without much reduction in fruit quality with the application of cowdung slurry @10 lit./tree.

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SHORT COMMUNICATION

EFFECT OF FYM AND WEED MANAGEMENT ON WEED DYNAMICS AND YIELD OF DIRECT SEEDED RICE (*ORYZA SATIVA* L.) UNDER MINIMUM TILLAGE

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Abstract: Results revealed that, FYM @ 5 t ha^{-1} (F1) has significant impact on total tillers m^{-2} and effective tillers m^{-2}. Hand weeding twice at 25 & 45 DAS (W7) produced significantly highest number of effective tillers $meter^{-2}$, test weight (g). Highest grain yield (4.21 t ha^{-1}) , straw yield (5.52 t ha^{-1}) and harvest index (51.54 %) was recorded under hand weeding twice at 25 & 45 DAS (W7), followed by Chemical weeding with bispyribac Sodium @ 20 g ha^{-1} 25 DAS (W1), which gave grain yield (4.03 t ha^{-1}), straw yield (5.25 t ha^{-1}) and harvest index (51.37 %) . The lowest was recorded under unweeded check (W8). In the experimental field, *Commelina benghalensis* L., *Cyanotis axillaris* Schult. F., *Cyperus difformis* L., *Echinochloa colona* (L.) Link, *Monochoria vaginalis (Burm.f.) Kunth* were dominant weeds. The lowest weed density, weed dry matter production and relative weed density were recorded under hand weeding twice at 25 & 45 DAS (W7), followed by Chemical weeding with bispyribac Sodium @ 20 g ha^{-1} 25 DAS (W1).

Keywords: *Oryza sativa*, Weed management, Yield

INTRODUCTION

Rice is the most important cereal food crop of India, which occupies about 24 per cent of gross cropped area of the country. It contributes 42 per cent of total food grain production and 45 per cent of total cereal production of the country. Rice accounts for 35 to 75 per cent of the calories consumed by more than 3 billion Asians (Kumar *et al*., 2006) and is planted to about 154 millions hectare annually or on about 11 per cent of the total world's cultivated land. The FYM is common source of nutrients to the farmers, which can be prepared easily and contains substantial amount of plant nutrients. Incorporation of organic sources viz., FYM along with chemical fertilizers is effective in alleviating the nutrient deficiency in soil and enhance the yield potential as well. Line sowing coupled with application of herbicide may prove to be very promising on farmer's field. Most of the field experiments and on farm researches have established that direct seeded rice, if properly managed, can yield as high as transplanted rice (Singh and Bhatacharya, 1987). Change in the method of crop establishment from traditional *biasi* or manual transplanting of seedlings to direct line seeding has occurred in many Asian countries in the last two decades in response to rising production costs, especially for labour and water. Weeds are foremost barrier in enhancing yield of direct seeded rice. The extent of yield reduction of rice crop due to weeds is estimated from 15 to 95 per cent (Gogoi *et al.*, 1996). Weeds compete for moisture, nutrients, light and space and a consequence, weeds infestation in direct seeded rice (DSR) to the tune of 30 to 90 % yield loss, reduces grain quality and enhance the cost of production (Singh *et al*., 2009). Similarly weeds demand high lobour inputs for control (Labrada, 1998). Stale seedbed, tillage practices for land leveling, choice of competitive rice cultivars, mechanical weeders, herbicides and associated water management are component technologies essential to the control of weeds in DSR. Herbicides, in particular, are an important tool of weed management, but hand weeding is either partially or extensively practiced in India. Mechanical weeder can reduce the time required for weeding and the corresponding cost involved compared to hand weeding.

MATERIAL AND METHOD

The experimental site was located at Instructional cum-Research Farm, College of Agriculture, IGKV, Raipur (C.G.) during *kharif*, 2012 where adequate facilities for irrigation and drainage existed. Raipur is situated in central part of Chhattisgarh and lies at latitude, longitude of 21°16' N, 81°26' E, respectively and 290.20 meters above mean sea level. Climatologically, Raipur is classified as slightly moist hot zone. It receives an average annual rainfall of 1326 mm (based on 80 years mean). The soil of the experimental field was clay loam in texture *(Alfisols)* locally known as *"Dorsa"* soil. The soil was neutral in reaction (pH 7.41). It had low available nitrogen (220.00 kg ha^{-1}), medium available phosphorus (18.10 00 kg ha^{-1}) and potassium contents (313.00 kg ha^{-1}). The experiment was laid out in Factorial randomized block design (F-RBD) and treatments were replicated thrice. The treatments comprised of two fertility (FYM) level and eight weed management practices. Fertility level consists of FYM, 0 t ha^{-1} and FYM, 5 t ha^{-1}. Weed management consist of Chemical weeding with bispyribac sodium @ 20 gm ha^{-1}, 25 DAS (W1), Mechanical weeding 25 DAS (W2), Mechanical weeding 25 DAS + hand weeding 45 DAS (W3), Hand weeding 25 DAS (W4), Hand weeding intra row 25 DAS + hand weeding 45 DAS (W5), Mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6), Hand weeding 25 &

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45 DAS (W7) and unweeded check (W8). Rice variety "MTU-1010" was grown as test crop. FYM was applied manually @ 5 ton ha^{-1} after layout of the field then incorporated manually. Hebicide was sprayed with the help of knapsack sprayer and mechanical weeding was done with the help of ambika paddy weeder. Recommended dose of N; P_2O_5 and K_2O i.e. 80:40:30 kg ha^{-1} was applied through urea, Di-ammonium phosphate and Muriate of potash, respectively, The whole amount of P_2O_5 & K_2O was applied as basal, while nitrogen was applied in three splits *viz.* 50% as basal , 25% at 25 and remaining 25% at 45 DAS. Seeds rate was taken @ 80 kg ha^{-1} and treated with Carbendazim @ 2g kg^{-1} seeds and then sown at the depth of 4-5 cm. keeping the row distance of 20 cm on 12 july, 2012. The crop was harvested on 19 November, 2012. The data on pre harvest crop observations *viz.* Plant height (cm), , Number of total tillers (m^{-2}), Dry matter accumulation (g) were recorded at 20, 40, 60, 80 DAS and at harvest. Leaf Area (cm^2) was recorded up to 60 DAS. The data on weed density and weed dry matter production were recorded at 25, 30, 45 and 50 DAS from randomly selected two places from each net plot by using quadrate of 0.25 m^2 size and they were subjected to square root transformation before statistical analysis. The average values of weed control index for different weed management practices falling in particular fertility level were obtained by following standard method.

RESULT AND DISCUSSION

Effect of FYM and weed management on Weeds

Predominant weed species observed in the experimental field were *Commelina benghalensis*, *Cyanotis axillaris*, *Cyperus difformis*, *Echinochloa colonum* and *Monocharia vegenalis.*

FYM @ 5 t ha^{-1} produced higher weed density and dry weight.At 50 DAS, , the lower total weed density and total weed dry matter production was observed under hand weeding 25 & 45 DAS (W7), mechanical weeding 25 DAS + hand weeding 45 DAS (W3) and hand weeding intra row 25 DAS + Hand weeding 45 DAS (W5) than others. The highest total weed density was observed under unweeded check (W8). Among different weed management practices, hand weeding twice was effective in reducing weed dry matter production up to 50 DAS. Mechanical weeding 25 DAS+ hand weeding 45 DAS(W3) and hand weeding intra row 25 DAS+ hand weeding 45 DAS(W5) were also effective in reducing weed dry matter production up to 50 DAS because of complete removal of weeds. Mechanical weeding at 25 DAS was not effective in reducing weed dry matter production because some weeds were left in between rows and weeds were incorporated in inter row spaces, which can grow and multiply again and increase in dry matter production . While hand weeding in 25 DAS (W4) was effective in reducing dry matter production up to 45 DAS because of completes removal and uprooting of weeds at 25 DAS. Mechanical weeding 25 DAS and hand weeding intra row 25 DAS were not sufficient in reducing dry matter production at 30 DAS. While mechanical weeding 25 DAS + hand weeding 45 DAS (W3) and hand weeding intra row 25 DAS+ hand weeding 45 DAS (W5) were effective in reducing weed dry matter production up to 50 DAS. When mechanical weeding weeding 25 DAS was supported by hand weeding 25 DAS (W6) it was effective in reducing dry matter production up to 45 DAS.

		Total weed density No. m^{-2}	**Total weed dry weight g m^{-2}**	**Weed Control Efficiency (%)**
	Treatments	**50 DAS**	**50 DAS**	**50 DAS**
	Fertility level			
F0	FYM @ 0 t ha^{-1}	4.80 (22.56)	2.60 (6.24)	60.49
F1	FYM @ 5 t ha^{-1}	6.18 (37.72)	3.22 (9.88)	52.77
	SEm±	**0.48**	**0.05**	
	CD 0.05	**0.33**	**0.16**	
	Weed management			
W1	Chemical weeding Bispyribac Sodium @ 20 g ha^{-1} 25 DAS	7.36 (53.60)	3.53 (11.96)	71.38
W2	Mechanical weeding 25 DAS	9.91 (97.80)	6.26 (38.64)	37.56
W3	Mechanical weeding 25 DAS + Hand weeding 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W4	Hand weeding 25 DAS	8.51 (71.84)	5.09 (25.40)	27.90

W5	Hand weeding intra row 25 DAS + Hand weeding 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W6	Mechanical weeding inter row followed by Hand weeding intra row 25 DAS	7.12 (50.24)	4.77 (22.28)	32.04
W7	Hand weeding 25 & 45 DAS	0.71 (0.00)	0.71 (0.00)	80.38
W8	Unweeded check	14.30 (204.00	7.43 (54.64)	-
	SEm±	**0.23**	**0.11**	
	CD0.05	**0.67**	**0.32**	

*Original data are given in parenthesis

Effect on Yield Attributes and Yield

Among different weed management practices, hand weeding twice 25 & 45 DAS (W7) gave highest panicle length over other weed management practices. Chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), hand weeding 25 DAS (W4), hand weeding intra row 25 DAS + hand weeding 45 DAS (W5) and mechanical weeding inter row followed by hand weeding intra row 25 DAS (W6) were at par with the hand weeding twice 25 & 45 DAS (W7). The smallest panicles were observed under unweeded check (W8). Hand weeding twice 25 & 45 DAS (W7) increased effective tillers, total no. of grains panicle^{-1} and filled grains panicle^{-1} and found significantly superior over other weed management practices but it was at par with chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), hand weeding intra row 25 DAS + hand weeding 45 DAS (W5), and mechanical weeding inter row fb hand weeding intra row 25 DAS (W6). The lowest total no. of grains panicle^{-1} was recorded under unweeded check (W8). Hand weeding twice 25 & 45 DAS (W7) proved significantly superior over rest of the other weed management practices in producing higher test weight, but it was found at par to chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1) . Hand weeding twice 25 & 45 DAS (W7) proved significantly superior over rest of the other weed management practices in producing higher grain yield and straw yield but it was found at par to chemical weeding with bispyribac sodium @ 20 g ha^{-1} 25 DAS (W1), mechanical weeding 25 DAS + hand weeding 45 DAS (W3), and hand weeding intra row 25 DAS + hand weeding 45 DAS (W5). Higher grain yield under these treatments was due to the weed managed at critical period of weed-crop competition and early crop growth, higher dry matter accumulation, high growth in terms of tiller numbers, which resulted in higher production of photo synthesis, and acts as a source and greater translocation of food materials to the reproductive parts resulted in superiority of yield attributing characters (tillers, filled grains panicle^{-1}, test weight) and ultimately high yield. Lower weed density and higher weed control efficiency also resulted in higher grain yield. The lowest grain yield was observed under unweeded check (W8). Nagappa and Biradar, (2002), have also reported the higher grain yield under two hand weedings. Saha *et al* (2005) also found the highest grain yield (2.92 t ha^{-1}) under hand weeding twice. The lowest straw yield were observed under unweeded check (W8) due to the less dry matter accumulation of rice, less CGR, high weed infestation and high competition during critical periods, which does not allow the crop to grow their potential, and vice versa. Dhawas *et al* (1992) also reported the highest grain and straw yield under hand weeding twice.

		Effective tillers (no m^{-2})	**Filled grains panicle^{-1} (no.)**	**Grain yield (t ha^{-1})**	**Test weight (g)**	**Harvest index (%)**	**Weed Index (%)**
	Treatments						
	Fertility evel						
F0	FYM @ 0 t ha^{-1}	235.10	97.83	3.47	24.3	43.69	17.57
F1	FYM @ 5 t ha^{-1}	236.45	105.64	3.63	23.5	44.02	13.77

	SEm±	**6.77**	**3.043**	**0.10**	**0.1**	**1.13**	-
	CD (0.05)	**NS**	**NS**	**NS**	**0.2**	**NS**	-
	Weed management						
W1	Chemical weeding (Bispyribac sodium @ 20 g ha^{-1} 25 DAS)	259.15	102.7	4.03	25.3	51.37	4.27
W2	Mechanical weeding (25 DAS)	226.65	97.46	3.31	23.5	37.96	21.37
W3	Mechanical weeding (25 DAS) + hand weeding (45 DAS)	249.60	102.53	4.01	24.8	47.37	4.75
W4	Hand weeding (25 DAS)	200.40	99.9	3.39	23.6	41.46	19.47
W5	Hand weeding intra row (25 DAS) + hand weeding (45 DAS)	243.75	101.9	3.69	23.8	46.48	12.35
W6	Mechanical weeding (inter row) followed by hand weeding (intra row) (25 DAS)	245.40	100.07	3.59	23.6	45.50	14.72
W7	Hand weeding (25 & 45 DAS)	266.65	115.93	4.21	25.6	51.54	-
W8	Unweeded check	194.60	93.4	2.16	23.1	29.16	48.69
	SEm±	**13.54**	**6.09**	**0.20**	**0.1**	**2.26**	-
	CD(0.05)	**39.10**	**17.58**	**0.59**	**0.3**	**6.54**	-

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