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Effect of Integrated Nutrient Management on Fruit Yield and Quality of Amrapali Mango (*Mangifera indica* L.) under High Density Planting

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ABSTRACT

A field experiment was carried out to evaluate the response of organic manures (FYM, Vermicompost), inorganic fertilizers (NPK), biofertilizers (Azotobacter and PSB) on flowering, fruit yield and quality of mango cv. Amrapali under high density orcharding. The maximum Plant height (396.67 and 416.92 cm), Plant spread (311.67 and 337.67 cm), number of panicles per plant (98.00 and 240.00), was recorded with the application of T_{14} 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB /plant, closely followed by T_{13} 75%RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB/plant and fruit set (30.90 and 30.03%), fruit yield (22.72 and 23.36 kg/tree), fruit yield (363.47 and 373.81 q/ha) and physic-chemical parameters viz., maximum fruit length (9.62 and 9.70 cm), width (6.22 and 6.39 cm), weight (192.97 and 183.67 g) was recorded with the application of T_{13} 75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant closely followed by T_{14} 75%RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant. However, the chemical composition of fruit viz., maximum TSS (20.24 and 21.43 ^{0}Brix), reducing sugars (8.10 and 8.24%), non reducing sugar (9.65 and 9.94%), total sugar (17.75 and 18.18%) and minimum acidity content (0.124 and 0.121 %) were recorded with the application of T_{13} 75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant closely followed by T_{14} 75%RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant.

Key word: *Mango, Npk, Psb, Azotobacter and Vermicompost*

INTRODUCTION

Mango (*Mangifera indica* L.) is a premier fruit crop of India considering its acreage, production and popularity among the people and therefore it is designated as the 'National Fruit of India'. The fruit is excellent source of vitamin A, C and nutrients as well as carbohydrates[8]. No other fruits are so intimately connected with the history and literature of India as mango. This premium fruit has been in cultivation in Indian sub continent for well over 4000 years.

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Indiscriminate use of chemical fertilizers, pesticide and herbicides in horticultural crops over four decades has adversely affected the soil fertility, biodiversity, ground water pollution and human health. Owing to these limiting factors, conventional (chemical based) farming has became non-sustainable. There are sufficient evidences that the intensive agriculture system has also caused decline in vitamin and mineral contents of fresh fruit. A poor supply of nutrient seems to be one of the main causes for tree decline, low yield and poor fruit quality. Since mangoes are mostly consumed as fresh, they should be devoid of fertilizer and pesticide residue. An economically attractive and potential source of plant nutrients in a balanced proportion is the need of the day in maintaining the fertility and productivity of agricultural soil.

The integrated nutrient management refers to "a system which aims at improving and maintaining the soil fertility for sustaining increase in crop productivity and involves the use of inorganic fertilizers in conjunction with organic manures/wastes with inputs through biological processes". Therefore, it is a holistic approach, where we first know what is exactly required by the plant for an optimum level of production, in what different forms these nutrients should be applied in soil, at what different timings in the best possible method, and how best these forms should be integrated to obtain the highest productive efficiency on the economically acceptable limits in an environment friendly manner. The management of nutrients through organic and biological sources would be more beneficial and eco-friendly to improve the health of soils and quality of fruit produce.

The current trend is to explore the possibility of supplementing chemical fertilizers with organic fertilizers, especially bio-fertilizers of microbial origin Patil *et al.* 2005(4). Among the commercially grown mango cultivars, Amrapali being a dwarf and regular bearer has responded well to different cultural practices in high-density orcharding. Very little efforts have been made so for to study the response of organic, inorganic and biofertilizers on the sustainable production and fruit quality of Amrapali mango under high density planting Ahmad *et. al.*[2],and Yadav *et.al.*[10]. Recommendation is also not available for the integrated nutrient management system of crop production in Amarpali mango under the climatic conditions of western UP which has been recognised as Agri. export zone of mango by the government of India.

It was therefore realised that the investigation on the balanced use of nutrients through different sources in dwarf mango cultivar under high density planting would be useful for sustainable production of quality mango.

Keeping in view of above facts and the bearing potential of Amrapali mango in high density orcharding, the present investigation were undertaken to find out the combined effect of organic manures, inorganic manures and biofertilizers on flowering, fruiting, yield and quality of mango fruits.

MATERIAL AND METHODS

The field investigations were laid out on 13 years old "Amrapali' mango trees which were planted at a distance of 2.5×2.5 m in an orchard of HRC, at Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.) during the year 2010-11 and 2011-12. All the trees of uniform growth and vigour were selected for the study and they were maintained healthy following timely and uniformly application of appropriate pesticides. The experiment was laid out in Randomized Block Design (RBD), replicated thrice with the treatment combination of T_1 (RDF 1000, 500, 1000 g NPK + 100 kg FYM)), T_2 (100 % RDF + 250g Azotobacter), T_3 (100 % RDF + 250g PSB), T_4 (100 % RDF + 250g Azotobacter + 250g PSB), T_5 (100 % RDF + 20 kg Vermicompost), T_6 (100 % RDF + 40 kg Vermicompost), T_7 (75 % RDF + 20 kg Vermicompost), T_8 (75 % RDF + 40 kg Vermicompost), T_9 (75 % RDF + 20 kg Vermicompost + 250 Azotobacter), T_{10} (75 % RDF + 40 kg Vermicompost + 250 Azotobacter), T_{11} (75 % RDF + 20 kg

Vermicompost + 250 PSB), T_{12} (75 % RDF + 40 kg Vermicompost + 250 PSB) T_{13} (75 % RDF + 20 kg Vermicompost + 250 Azotobacter +250g PSB), T_{14} (75 % RDF + 40 kg Vermicompost + 250 Azotobacter+ 250g PSB).

The organic sources of nutrients, i.e. FYM,(100 Kg/plant) and vermicompost two type dose 20Kg and 40 Kg/plant were applied around tree basin during first week of September. The biofertilizers, *Azotobacter* and PSB @ 250 g per tree each were applied in first week of October at a depth of 30 cm around the tree trunk in respective treatment. The RDF of NPK (1000, 500, 1000g/tree) was applied to two type different dose (100%, 75%, RDF). The observations were recorded on flowering, fruiting, yield and quality was analysed as per AOAC (1).

RESULTS AND DISCUSSION

The application of organic sources of manure, biofertilizers and inorganic nutrient, improved the plant height, plant spread, number of panicles/plant, fruit set per panicle during both the years of experimentation (Table 1). The maximum plant height, plant spread, number of panicles/plant and fruit set per panicle was recorded with T_{13} (75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant (T_{14}). These values were minimum with T_1 (FYM + recommended NPK).The results were in accordance with the findings of Singh *et al.* (8) in *bael*. The flowering pattern was influenced due to treatments containing biofertilizers (*Azotobacter* and PSB) showed better results other than non-biofertilizer treatments. The role of *Azotobacter* in fixation of atmospheric nitrogen and PSB involved in solubilisation of phosphate in soil are responsible to compensate the reduced 1/4th dose of NPK and maintaining better soil environment which ultimately reflect on the flowering of the tree. Positive response of *Azotobacter* and PSB were also reported in mango by Yadav *et al*.[10]. Results are in close conformity with the findings of Singh *et al.*[8] in *bael*. The data presented in Table 2 revealed that the improvement in physical characters of fruits with respect to fruit size (fruit length and width), fruit weight in response to organic source of nutrients, Similar results have been reported by in Yadav et al.(9) in aonla and Yadav *et al.*[10] in mango. The maximum fruit size (length and width) was recorded with T_{13}(75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant). However, fruit weight showed similar pattern as for as the size of fruit. The fruit yield per tree influenced due to various treatments and recorded maximum with T_{13} (75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant). Similar findings were recorded by Ram and Rajput (5) and Yadav *et al.* (10). Increase in yield attributing characters with reduced NPK doses in association of biofertilizers 75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant. Biofertilizers and organic fertilizers was due to the optimum supply of plant nutrients and growth hormones at desired amount during entire period of fruit growth, ultimately resulted in accumulation of more photosynthetic resulted into more length, diameter, fruit weight and yield of fruit. At same level of organic source of nutrient, biofertilizers was found more effective to improve yield and yield attributing

The qualitative parameters of fruit were affected by different treatments and showed in Table 3. The results obtained from the study revealed the maximum total soluble solids with the application of T_{13} (75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant.) during both the years and it was minimum with T_1while, reducing sugars, non-reducing sugar, total sugars, However, maximum reduction of acidity was noted with the application of T_{13} (75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant followed by 75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plant). This results are in accordance with the findings of Singh et al.(8) in aonla and Mahendra *et al.* (3) in *ber* and Yadav *et al.* (10) in mango. The quality improvement in fruits may be due to proper supply of nutrients and induction of growth hormones, which stimulated cell division, cell elongation, increase in number and weight of the fruits, better root development and better translocation of water uptake and deposition of nutrients. This may be attributed due to the improved fertilizer use efficiency with the application of organic sources of nutrients, micronutrients, biofertilizers[6] in sweet orange and *aonla*[8] apart from nutrient supply and availability. On the basis of experimental findings, it can be concluded that the among the different treatment application of T_{13} (75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB /plant gave best results in respect of flowering, fruiting, yield and quality of fruit in high density orcharding of mango cv. Amrapali, followed by T_{14} (75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB/plan).

Table 1: Effect of organic and inorganic sources of nutrient on vegetative growth, flowering and fruiting in Amrapali mango under high density planting

Treatments	Plant height (cm)		Plant spread (cm)		No.of panicles/plant		Fruit set (%)	
	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y
T_1- RDF (1000 : 500 : 1000g NPK + 100 kg FYM)	368.00	373.50	280.67	284.33	68.33	152.67	19.53	20.36
T_2- 100 % RDF + 250g Azotobacter	378.33	388.83	291.00	307.00	75.00	193.33	21.32	22.54
T_3- 100 % RDF + 250g PSB	379.00	386.75	292.33	310.17	76.00	206.67	20.76	21.83
T_4- 100 % RDF + 250g Azotobacter +250 g PSB	382.00	392.25	294.33	320.67	77.33	209.33	22.14	23.78
T_5- 100% RDF + 20 kg Vermicompost	384.33	401.58	298.00	330.83	83.67	228.67	28.82	28.98
T_6- 100% RDF + 40kg Vermicompost	385.33	402.89	300.67	331.67	84.67	230.33	28.56	29.37
T_7- 75 % RDF + 20 kg Vermicompost	371.67	382.42	286.67	290.33	69.33	155.33	23.73	24.11
T_8- 75 % RDF + 40 kg Vermicompost	382.33	394.18	295.00	323.83	78.00	219.00	24.56	25.53
T_9- 75 % RDF + 20 kg Vermicompost + 250g Azotobacter	373.00	386.85	287.00	298.67	71.33	163.67	27.39	28.49
T_{10}- 75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	385.33	401.59	296.00	326.00	79.67	223.67	28.12	29.71
T_{11}- 75 % RDF + 20 kg Vermicompost + 250g PSB.	376.00	388.15	289.33	301.00	73.33	189.00	25.55	26.40
T_{12}- 75% RDF + 40 kg Vermicompost + 250g PSB	383.67	396.52	297.67	329.33	81.67	225.00	26.56	27.91
T_{13}- 75% RDF+ 20 kg Vermicompost+ 250g Azotobacter+250g PSB	394.33	413.28	308.33	336.50	95.00	237.67	30.90	30.03
T_{14}- 75% RDF+ 40 kg Vermicompost+ 250g Azotobacter+250g PSB	396.67	416.92	311.67	337.67	98.00	240.00	29.69	29.78
SEm+	4.56	4.55	2.62	3.15	4.39	4.55	0.93	0.86
CD at 5%	13.55	13.29	7.62	9.21	12.85	13.30	2.72	2.51

Table 2: Effect of organic and inorganic sources of nutrient on physical characteristics of mango cv. Amrapali mango under high density planting

Treatments	Fruit length (cm) 1st Y	Fruit length (cm) 2nd Y	Fruit width (cm) 1st Y	Fruit width (cm) 2nd Y	Fruit weight (g) 1st Y	Fruit weight (g) 2nd Y	Fruit yield (kg/tree) 1st Y	Fruit yield (kg/tree) 2nd Y
T_1- RDF (1000 : 500 : 1000g NPK+ 100 kg FYM)	**8.42**	**8.58**	**5.09**	**5.68**	**145.09**	**156.00**	**9.68**	**13.85**
T_2- 100 % RDF + 250g Azotobacter	**8.83**	**8.86**	**5.82**	**5.91**	**147.39**	**161.33**	**12.55**	**15.85**
T_3- 100 % RDF + 250g PSB	**8.93**	**8.83**	**5.84**	**5.97**	**146.58**	**160.33**	**11.13**	**16.01**
T_4- 100 % RDF + 250g Azotobacter + 250g PSB	**8.96**	**9.00**	**5.90**	**6.01**	**149.08**	**162.50**	**13.53**	**16.06**
T_5- 100 % RDF + 20 kg Vermicompost	**9.36**	**9.31**	**6.04**	**6.24**	**165.60**	**175.89**	**19.09**	**19.83**
T_6- 100 % RDF + 40kg Vermicompost	**9.37**	**9.28**	**6.12**	**6.29**	**169.26**	**176.17**	**20.23**	**21.43**
T_7- 75 % RDF + 20 kg Vermicompost	**8.65**	**9.03**	**5.35**	**5.72**	**151.11**	**164.48**	**14.02**	**14.87**
T_8- 75 % RDF + 40 kg Vermicompost	**8.99**	**9.06**	**5.95**	**6.02**	**154.90**	**169.12**	**15.51**	**17.07**
T_9- 75 % RDF + 20 kg Vermicompost + 250g Azotobacter	**8.68**	**9.26**	**5.56**	**5.73**	**159.19**	**172.95**	**17.95**	**15.53**
T_{10}- 75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	**9.04**	**9.28**	**6.01**	**6.18**	**160.89**	**174.73**	**18.63**	**18.46**
T_{11}- 75 % RDF + 20 kg Vermicompost + 250g PSB.	**8.70**	**9.17**	**6.11**	**5.81**	**155.42**	**170.27**	**16.04**	**15.69**
T_{12}- 75% RDF + 40 kg Vermicompost + 250g PSB	**9.33**	**9.24**	**6.04**	**6.21**	**158.09**	**171.94**	**17.63**	**18.80**
T_{13}- 75% RDF+ 20 kg Vermicompost+ 250g Azotobacter+250g PSB	**9.62**	**9.70**	**6.22**	**6.39**	**192.97**	**183.67**	**22.72**	**23.36**
T_{14}- 75% RDF+ 40 kg Vermicompost+ 250g Azotobacter+250g PSB	**9.45**	**9.63**	**6.15**	**6.32**	**190.71**	**181.53**	**21.48**	**22.93**
SEm+	**0.17**	**0.08**	**0.22**	**0.13**	**2.51**	**1.74**	**0.56**	**1.14**
CD at 5%	**0.48**	**0.22**	**0.65**	**0.39**	**7.36**	**5.08**	**1.64**	**3.34**

Table 3: Effect of organic and inorganic sources of nutrient on fruit yield and chemical composition of mango cv. Amrapali mango under high density planting

Treatments	Fruit yield (q/ha.) 1st Y	Fruit yield (q/ha.) 2nd Y	TSS (^{0}Brix) 1st Y	TSS (^{0}Brix) 2nd Y	Fruit Acidity (%) 1st Y	Fruit Acidity (%) 2nd Y	Reducing sugars (%) 1st Y	Reducing sugars (%) 2nd Y
T_1- RDF (1000 : 500 : 1000g NPK + 100kg FYM)	**154.88**	**221.60**	**18.22**	**19.20**	**0.132**	**0.138**	**7.16**	**7.18**
T_2- 100 % RDF + 250g Azotobacter	**200.85**	**253.60**	**18.95**	**19.40**	**0.129**	**0.133**	**7.59**	**7.48**
T_3- 100 % RDF + 250g PSB	**178.08**	**256.11**	**18.98**	**20.53**	**0.128**	**0.132**	**7.65**	**7.55**
T_4- 100 % RDF + 250g Azotobacter + 250g PSB	**216.43**	**256.96**	**19.09**	**19.83**	**0.127**	**0.133**	**7.73**	**7.60**
T_5- 100 % RDF + 20kg Vermicompost	**305.60**	**317.33**	**19.43**	**20.17**	**0.126**	**0.132**	**7.85**	**7.68**
T_6- 100 % RDF + 40kg Vermicompost	**323.73**	**342.93**	**19.62**	**20.50**	**0.125**	**0.133**	**7.91**	**7.75**
T_7- 75 % RDF + 20 kg Vermicompost	**224.27**	**237.97**	**18.72**	**19.50**	**0.129**	**0.132**	**7.46**	**7.33**
T_8- 75 % RDF + 40 kg Vermicompost	**248.11**	**273.07**	**19.22**	**19.85**	**0.126**	**0.130**	**7.75**	**7.80**
T_9- 75 % RDF + 20 kg Vermicompost + 250g Azotobacter	**287.25**	**248.43**	**18.75**	**19.70**	**0.129**	**0.130**	**7.48**	**7.39**
T_{10}- 75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	**298.03**	**295.31**	**19.37**	**20.10**	**0.128**	**0.128**	**7.79**	**7.91**
T_{11}- 75 % RDF + 20 kg Vermicompost + 250g PSB.	**256.59**	**250.99**	**18.93**	**20.13**	**0.128**	**0.127**	**7.56**	**7.46**
T_{12}- 75% RDF + 40 kg Vermicompost + 250g PSB	**282.03**	**300.80**	**19.55**	**20.37**	**0.126**	**0.128**	**7.80**	**8.07**
T_{13}- 75% RDF+ 20 kg Vermicompost+ 250g Azotobacter +250g PSB	**363.47**	**373.81**	**20.24**	**21.43**	**0.124**	**0.121**	**8.10**	**8.24**
T_{14}- 75% RDF+ 40 kg Vermicompost+ 250g Azotobacter +250g PSB	**343.68**	**366.93**	**19.83**	**21.03**	**0.125**	**0.125**	**7.97**	**8.15**
SEm+	**8.96**	**18.29**	**0.26**	**0.31**	**0.001**	**0.002**	**0.09**	**0.06**
CD at 5%	**26.21**	**53.47**	**0.78**	**0.90**	**0.003**	**0.006**	**0.28**	**0.18**

Treatments	Non-reducing sugars (%) 1st Y	Non-reducing sugars (%) 2nd Y	Total sugars (%) 1st Y	Total sugars (%) 2nd Y	Per cent increase (+) or decrease (-) in fruit yield/q/ha over RDF
T_1- RDF (1000 : 500: 1000g NPK+ 100 kg FYM)	**8.48**	**8.31**	**15.64**	**15.50**	**-**
T_2- 100 % RDF + 250g Azotobacter	**8.97**	**8.90**	**16.56**	**16.38**	**(+) 20.70**
T_3- 100 % RDF + 250g PSB	**9.02**	**9.10**	**16.67**	**16.65**	**(+) 15.32**
T_4- 100 % RDF + 250g Azotobacter + 250g PSB	**9.05**	**9.12**	**16.78**	**16.73**	**(+) 25.73**
T_5- 100 % RDF + 20kg Vermicomost	**9.38**	**9.69**	**17.23**	**17.37**	**(+) 65.45**
T_6- 100 % RDF + 40kg Vermicompost	**9.07**	**9.72**	**16.98**	**17.37**	**(+) 77.07**
T_7- 75 % RDF + 20 kg Vermicompost	**8.60**	**8.42**	**16.06**	**15.76**	**(+) 22.77**
T_8- 75 % RDF + 40 kg Vermicompost	**9.17**	**9.63**	**16.92**	**17.43**	**(+) 38.43**
T_9- 75 % RDF + 20 kg Vermicompost + 250g Azotobacter	**8.73**	**8.77**	**16.21**	**16.17**	**(+) 42.28**
T_{10}- 75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	**9.19**	**9.74**	**16.98**	**17.65**	**(+) 57.60**
T_{11}- 75 % RDF + 20 kg Vermicompost + 250g PSB.	**8.93**	**8.91**	**16.49**	**16.38**	**(+) 34.82**
T_{12}- 75% RDF + 40 kg Vermicompost + 250g PSB	**9.35**	**9.65**	**17.15**	**17.73**	**(+) 54.80**
T_{13}- 75% RDF+ 20 kg Vermicompost+ 250g Azotobacter+250g PSB	**9.65**	**9.94**	**17.75**	**18.18**	**(+) 95.83**
T_{14}- 75% RDF+ 40 kg Vermicompost+ 250g Azotobacter+250g PSB	**9.56**	**9.85**	**17.54**	**18.00**	**(+) 88.74**
SEm+	**0.15**	**0.09**	**0.16**	**0.09**	
CD at 5%	**0.44**	**0.27**	**0.46**	**0.27**	

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