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Effect of Organic and Inorganic Sources of Nutrients on Available Soil in Amrapali Mango (*Mangifera indica* L.) Under High Density Planting

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ABSTRACT

An experiment was carried out to evaluate the response of organic manures (FYM, Vermicompost), inorganic fertilizers (NPK), biofertilizers (Azotobacter and PSB) on nutrients available soil in mango cv. Amrapali under high density orcharding. The maximum amount of available nitrogen (152.53 and 156.80 kg/ha.), available phosphorus (17.94 and 18.30kg/ha.), available potassium (207.95 and 226.61kg/ha.) and available organic carbon (0.33 and 0.36%) 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,*

Key word: *Mango, NPK, PSB, Azotobacter, 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. Amrapali characteristically dwarf, precocious and regular in bearing has been found to be most suitable for high density plantation.

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.

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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*[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.*[8]. 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 nutrint uptake in mango under high density planting.

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 biofertilizers, namely, Azotobacter, PSB and phosphatic and potassic chemical fertilizers were applied in October in manuring ring (15-20 cm deep trench) made just below the outer edge of tree canopy (away from the trunk). While the nitrogenous fertilizer was applied in January, the organic manures were given in October in the tree basin (within the canopy) as per the recommended procedure[7].

Soil samples from the basin of mango tree were collected before the start and after the termination of the experiment at 0-15, 15-30, 30-45 and 45-60 cm depths with the help of soil auger. The samples were dried in air till the constant weight was obtained. The dried soil samples were then used for chemical analysis. Available nitrogen in soil sample was estimated by alkaline potassium permagnate method[5] as suggested by Baruah and Borthakur. The available nitrogen values were expressed in kg/ha. Available phosphorus in soil sample was estimated by Olsen's method as described by Baruah and Borthakur. The available phosphorus values were expressed in kg/ha. Available potassium in experimental soil was estimated by using the procedure described by Baruah and Borthakur. The available potassium values were expressed in kg/ha.The pH of each soil sample was estimated with the help of digital pH meter, using 1:2.5 soil water suspensions as advocated by Singh *et al*. (1999). Organic carbon in soil sample was estimated by Walkley and Black rapid titration method as described by Baruah and Borthakur. The organic carbon was expressed in per cent

RESULTS AND DISCUSSION

1. Available nitrogen- When different treatments consisting of different sources of nutrient, biofertilizers and inorganic fertilizers were applied, the available nitrogen in soil was significantly affected during both the years of study. Maximum amount of available nitrogen (152.58 and 156.80 kg/ha.) was recorded with combined application of 75 % RDF + 40 kg vermicompost + 250g Azotobacter + 250g PSB/plant followed by T_{13} (75 % RDF + 20 kg vermicompost + 250g Azotobacter + 250g PSB/plant) and T_6(140.07 and 148.43 kg/ha.) during both the years of study. Among all the treatments applied, the level of available nitrogen was found to be minimum (114.98 and 119.82 kg/ha.) with recommended dose of fertilizers (T_1) during both the years of investigation.

2. Available Phosphorus- Application of inorganic fertilizer, organic manure and biofertilizers also affected the level of available phosphorus in orchard soil. The data related to available phosphorus as affected by different sources of nutrient have been presented in the combined application of organic manure, biofertilizers and inorganic fertilizers showed better response in improving the content of available phosphorus in soil as compared to other treatments. Maximum amount of available phosphorus (17.94 and 18.30 kg/ha) was recorded with T_{14} (75 % RDF + 40 kg Vermicompost + 250g per plant of each Azotobacter and PSB) followed by T_{13} (75 % RDF + 20 kg Vermicompost + 250g per plant of each Azotobacter and PSB). The soil treated with recommended dose of fertilizers had lowest level of available phosphorus (14.89 and 15.03 kg/ha.) during both the years of experiment.

3. Available Potassium- The level of available potassium in soil was significantly influenced due to the application of different sources of nutrient, biofertilizers, and graded dose of NPK. The content of available potassium ranged from 189.28 to 226.61 kg/ha in different treatments during both the years of study. Maximum amount of available potassium (207.95 and 226.61 kg/ha.) was recorded with T_{14} (75 % RDF + 40 kg Vermicompost + 250g per plant of each Azotobacter and PSB) followed by T_{13} (75 % RDF + 20 kg Vermicompost + 250g per plant of each Azotobacter and PSB) The soil treated with recommended dose of fertilizer, when analyzed was found to contain lowest level of available potassium (189.28 and 190.77 kg/ha).

4. Organic carbon- There was a significant difference in organic carbon content of soil due to the application of different sources of nutrient, biofertilizers, and graded dose of NPK Table.2. The organic carbon content

(0.33 and 0.36%) in soil treated with T_{14} (75 % RDF + 40 kg Vermicompost + 250g per plant of each Azotobacter and PSB) was significantly higher than the same treatments. The minimum level of organic carbon (0.23 and 0.27%) was, however, recorded in soil applied with recommended dose of fertilizers. The content of organic carbon in other treatments (T_2, T_3, T_4, T_6, T_7, T_8, T_9, T_{10}, T_{11} and T_{12}) varied from 0.24 to 0.33 % during both the years of investigation.

6. Soil pH- Data recorded on soil pH as influenced due to the application of different sources of nutrient, biofertilizers, and graded doses of NPK have been presented in Table-2. Insignificant differences in soil pH of treated soil with different treatments were recorded during both the years of study. The pH of soil in different treatments varied from 7.67 to 7.81 during both the years of investigation. While minimum pH of soil (7.73 and 7.67) was observed in T_{14} followed by T_{13} (7.73 and7.68), the maximum pH of soil (7.80 and 7.81) was recorded in T_1. However, the values of soil pH in different treatments differed insignificantly during both the years of study.

Table 1: Effect of organic and inorganic sources of nutrients on available soil in Amrapali mango under high density planting

S.No.	Treatment details (per plant/year)	Available soil nitrogen (kg/ha.)		Available soil phosphorus (kg/ha.)		Available soil potassium (kg/ha.))	
		1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y
T_1	RDF (1000:500:1000g NPK + 100kg FYM)	114.98	119.82	14.89	15.03	189.28	190.77
T_2	100 % RDF + 250g Azotobacter .	128.71	128.70	15.58	15.35	193.39	202.35
T_3	100 % RDF + 250g PSB.	123.34	131.56	16.23	16.46	195.25	206.83
T_4	100 % RDF + 250g Azotobacter + 250g PSB.	131.70	140.07	16.22	16.66	196.37	209.81
T_5	100 % RDF + 20 kg Vermicompost.	135.88	144.25	16.92	16.99	203.09	210.93
T_6	100 % RDF + 40 kg Vermicompost.	140.07	148.43	17.01	17.03	204.59	211.68
T_7	75 % RDF + 20 kg Vermicompost.	119.16	123.34	15.29	15.57	190.03	200.11
T_8	75 % RDF + 40 kg Vermicompost.	131.67	138.26	15.89	16.32	199.73	212.80
T_9	75 % RDF + 20 kg Vermicompost + 250g Azotobacter.	121.13	125.44	15.70	15.77	193.39	200.85
T_{10}	75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	134.10	148.43	16.04	16.77	201.60	217.28
T_{11}	75 % RDF + 20 kg Vermicompost + 250g PSB.	119.16	127.52	15.57	16.28	191.52	205.33
T_{12}	75 % RDF + 40kg Vermicompost + 250g PSB.	135.89	140.07	16.81	16.97	202.72	224.37
T_{13}	75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB.	144.25	155.28	17.69	17.93	206.08	225.95
T_{14}	75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB.	152.58	156.80	17.94	18.30	207.95	226.61
SEm ±		7.08	4.68	0.45	0.48	3.23	2.93
CD at 5 %		20.69	13.68	1.31	1.42	9.45	8.55

Table 2: Effect of organic and inorganic sources of nutrients on available soil in Amrapali mango under high density planting

S.No.	Treatment details (per plant/year)	Soil organic carbon (%)		Soil pH	
		1st Y	2nd Y	1st Y	2nd Y
T_1	RDF (1000:500:1000g NPK + 100kg FYM)	0.23	0.27	7.80	7.81
T_2	100 % RDF + 250g Azotobacter .	0.25	0.29	7.76	7.74
T_3	100 % RDF + 250g PSB.	0.26	0.29	7.76	7.73
T_4	100 % RDF + 250g Azotobacter + 250g PSB.	0.27	0.30	7.75	7.72
T_5	100 % RDF + 20 kg Vermicompost.	0.30	0.31	7.80	7.70
T_6	100 % RDF + 40 kg Vermicompost.	0.31	0.33	7.77	7.69
T_7	75 % RDF + 20 kg Vermicompost.	0.24	0.31	7.78	7.78
T_8	75 % RDF + 40 kg Vermicompost.	0.29	0.34	7.75	7.72
T_9	75 % RDF + 20 kg Vermicompost + 250g Azotobacter.	0.25	0.31	7.78	7.74
T_{10}	75 % RDF + 40 kg Vermicompost + 250g Azotobacter.	0.29	0.35	7.75	7.71
T_{11}	75 % RDF + 20 kg Vermicompost + 250g PSB.	0.26	0.32	7.77	7.73
T_{12}	75 % RDF + 40kg Vermicompost + 250g PSB.	0.28	0.34	7.76	7.70
T_{13}	75 % RDF + 20 kg Vermicompost + 250g Azotobacter + 250g PSB.	0.32	0.35	7.73	7.68
T_{14}	75 % RDF + 40 kg Vermicompost + 250g Azotobacter + 250g PSB.	0.33	0.36	7.73	7.67
SEm ±		0.008	0.009	0.04	0.01
CD at 5 %		0.024	0.025	N.S.	N.S.

CONCLUSION

The levels of organic carbon, available nitrogen, phosphorus and potassium in soil were influenced significantly due to integrated application of organic (biofertilizers and vermicompost) and inorganic (NPK) nutrients. While the highest content of organic carbon, nitrogen, phosphorus and potassium was recorded in treated soil of Amrapali mango with 75 % RDF + 20 kg Vermicompost + 250g Azatobacter + 250g PSB followed by 75 % RDF + 40 kg Vermicompost + 250g Azatobacter + 250g PSB, the lowest amount of organic carbon, available nitrogen, phosphorus and potassium was found to be with treatment consisting of recommended dose of fertilizers. The pH of the treated soil was not affected due to the application of INM treatments in the present study. The results of the study clearly indicate that the level of organic carbon, available nitrogen, phosphorus and potassium increased significantly only in those treatments containing, biofertilizers and organic manure as compared to the treatments containing only recommended dose of fertilizers without biofertilizers and vermicompost. This might be because Azotobacter when applied as biofertilizer fixed the atmospheric nitrogen in soil due to its nitrogen fixing properties, while PSB was involved in increasing the availability of phosphorus in soil due to its solubilising properties and thus compensated the reduced dose of nitrogen and phosphorus and maintain the better soil environment which ultimately reflect on fertility status of soil. The organic carbon content in soil differed statistically under different treatments and was found to be maximum with treatment containing the higher levels of vermicompost and biofertilizers along with ¾th of inorganic fertilizers. The increase in organic carbon level in soil might be due to the breakdown of organic matter after the incorporation of both biofertilizers and vermicompost in the orchard soil. 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).

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