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Studies on integrated nutrient management in flowering, fruiting, yield and quality of mango cv. Amrapali under high density orcharding

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ABSTRACT

An experiment was carried out to evaluate the response of organic nutrients (FYM, Vermicompost and Biodynamic compost), inorganic manures (NPK), biofertilizers (*Azotobacter* and PSB), micronutrients (zinc and iron) and paclobutrazol (Cultar) on flowering, fruiting, yield and quality of mango cv. Amrapali under high density orcharding. The maximum panicle length (23.92 and 23.96 cm), number of flowers per panicle (1710.67 and 1756.00), fruit set per panicle (194.67 and 201.33) and sex ratio (0.690 and 0.691) were recorded with T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) which was at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol). The fruit physical parameters *viz*., maximum fruit length (9.88 and 10.08 cm), width (6.62 and 6.48 cm), weight (151.25 and 153.00 g), pulp weigh (97.06 and 97.08 g), stone weight (26.45 and 26.62 g), pulp : stone ratio (3.693 and 3.694), number of fruits per tree (163.33 and 184.67) and fruit yield (25.00 and 26.72 q/ha) was recorded with T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) closely followed by T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol). However, the chemical composition of fruit *viz*., maximum TSS (23.72 and 23.91 °Brix), TSS: acid ratio (191.60 and 197.76), ascorbic acid content (44.13 and 45.63 mg/100 g), carotenoids (18.91 and 18.63 mg/100 g), reducing sugars (8.35 and 8.39%), non reducing sugar (9.94 and 9.95%), total sugars (18.29 and 18.34%) and minimum acidity content (0.120 and 0.121%) were recorded with the application of T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) which was at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) during both the years of experimentation.

Key words: INM, flowering, fruiting, yield, quality**,** *Mangifera indica.*

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important fruits of India and refered to as the king of fruits. Besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamins A&C. Mango fruit is utilized at all stages of its development in its immature and mature stages. Raw fruits are used for making chutney, pickles and juices. The ripe fruits besides being used for desert are also utilized for preparing several products like squash, syrup, nectar, leather, jams and jelly. Mango can be grown under both tropical and sub-tropical climate. In high-density orcharding, there is need to study the effect of pruning intensity, balance use of nutrients and micronutrients and flower inducing plant growth regulators for regulation of flowering and development of better fruit quality.

Integrated nutrient management (INM) refers to maintenance of 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. Therefore, it is a holistic approach where we first know what exactly is required by plants for optimum level of production, in what different forms at what different timings in best possible method, and how best these forms can be integrated to obtain highest productivity levels with efficiency at economically acceptable limits in environmental friendly way.

Inorganic fertilizers are one of the most expensive inputs in orchard management. Besides, continuous application of huge amount of chemical fertilizers hampers the quality, soil health and soil productivity. As such, it is necessary that fertilizer application should be made through inorganic, organic sources and micronutrients. Keeping in view the bearing potential of mango cv. Amrapali in high density orcharding, the nutrient management through use of organic sources, biofertilizers, micronutrients and supplemented with flower inducing plant growth substance was very much essential to improve the flowering, fruiting and fruit quality. Singh *et al.* (7) reported that foliar application of micronutrients and PGRs improved the yield and quality of *aonla*. Mahendra *et al.* (4) in *ber* and Singh

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et al. (9) in *bael* also reported similar results. Therefore, the present studies were undertaken to find out the combined effect of organic manures, micronutrients and paclobutrazol on flowering, fruiting, yield and quality of mango fruits.

MATERIALS AND METHODS

The experiment was carried out on fifteen years old pruned tree of mango cv. Amrapali, uniform in vigour and growth, planted under sodic soil conditions with the spacing of 2.5 m x 2.5 m, at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during the year 2004-05 and 2005-06. The experiment was laid out in Randomized Block Design (RBD), replicated thrice with the treatment combination of T_1 (FYM + recommended NPK), T_2 (recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol), T_3 (recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol), T_4 (recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol), T_5 (vermicompost + recommended NPK), T_6 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol), T_7 (recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol), T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol), T_9 (biodynamic compost + recommended NPK), T_{10} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol), T_{11} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol) and T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol.

The organic sources of nutrients, i.e. FYM, vermicompost and biodynamic compost each of thirty kg per tree 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. Paclobutrazol (Cultar) @ 5 ml/tree was applied in soil in first week of October. However, micronutrients (zinc and iron) @ 0.40% were sprayed twice in first week of October and at pea stage of fruit. The NPK (500:250:250 g/tree) was applied to all treatments but dose of nitrogen and phosphorus was reduced to half in the treatments consisting of biofertilizers. 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 nutrients, micronutrients, biofertilizers, inorganic manures and paclobutrazol improved the panicle length, number of flowers per panicle, fruit set per panicle and sex ratio during both the years of experimentation (Table 1). The maximum panicle length, number of flowers per panicle, fruit set per panicle and sex ratio was recorded with T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) it was at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) and T_9 (biodynamic compost + recommended NPK). These values were minimum with T_1 (FYM + recommended NPK). The results were in accordance with the findings of Singh *et al.* (9) in *bael*. The flowering pattern was influenced due to paclobutrazol with reduced vegetative growth. This may be due to low activity of GA (Voon *et al.* 12). However, 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 solubulisation of phosphate in soil are responsible to compensate the reduced half 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 Kulkarni and Hamilton (2). Results are in close conformity with the findings of Singh *et al.* (9) 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, pulp weight, stone weight and pulp: stone ratio in response to organic source of nutrients, micronutrients and paclobutrazol can be related to assimilate accumulation of the plant. Similar results have been reported by Verma (11). The maximum fruit size (length and width) was recorded with T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) which was statistically at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol). However, fruit weight, pulp weight, stone weight and pulp: stone ratio showed similar pattern as for as the size of fruit. The number of fruit per plant and fruit yield per tree influenced due to various treatments and recorded maximum with T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) closely followed by T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol). Similar findings were recorded by Ram and Rajput (5), Singh *et al*. (10), and Yadav *et al.* (13). Increase in yield attributing characters with reduced NPK doses in association of biofertilizers, micronutrients and paclobutrazol was due to the optimum supply of plant nutrients and growth hormones at desired amount during entire period of

Table 1. Effect of organic sources of nutrient, micronutrients and paclobutrazol on flowering and fruiting of mango cv. Amrapali under high density orcharding.

Treatment		Panicle length (cm)		No. of flowers/ panicle		Fruit set per panicle		Sex ratio	
		1st y	2nd y	1st y	2nd y	1st y	2nd y	1st y	2nd y
T_1	FYM + recommended NPK	21.16	21.18	1260.33	1310.33	156.33	166.33	0.565	0.578
T_2	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol	18.32	19.01	1464.00	1532.00	182.00	189.00	0.639	0.639
T_3	Recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol	17.65	19.05	1442.67	1498.33	174.33	182.33	0.621	0.623
T_4	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	18.60	19.13	1580.33	1651.67	183.00	190.33	0.679	0.669
T_5	Vermicompost + recommended NPK	20.00	20.12	1350.67	1423.67	166.33	180.67	0.613	0.610
T_6	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol	20.21	20.12	1169.33	1671.00	189.33	193.67	0.662	0.663
T_7	Recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol	20.00	19.85	1530.33	1602.33	183.33	198.33	0.659	0.659
T_8	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	23.92	23.96	1710.67	1756.00	194.67	201.33	0.690	0.691
T_9	Biodynamic compost + recommended NPK	21.88	21.42	1384.00	1458.00	162.33	180.00	0.628	0.631
T_{10}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol	19.54	20.20	1650.33	1704.33	180.00	189.00	0.667	0.669
T_{11}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol	19.25	19.78	1571.00	1645.33	178.33	184.33	0.621	0.642
T_{12}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	23.23	23.89	1680.67	1740.67	190.33	194.67	0.673	0.672
CD at 5%		2.06	2.06	155.87	157.56	17.54	18.55	0.06	0.06

Y = year

fruit growth, ultimately resulted in accumulation of more photosynthate resulted into more length, diameter, fruit weight and yield of fruit. At same level of organic source of nutrient, biofertilizers and paclobutrazol, the combined application of Zn and Fe was found more effective to improve yield and yield attributing characters but differences were non-significant for most of the parameters.

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_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol), which was at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) during both the years and

Table 2. Effect of organic sources of nutrient, micronutrients and paclobutrazol on physical characteristics of mango cv. Amrapali under high density orcharding.

Treatment		Fruit length (cm)		Fruit width (cm)		Fruit wt. (g)		Pulp wt. (g)	
		1st y	2nd y	1st y	2nd y	1st y	2nd y	1st y	2nd y
T_1	FYM + recommended NPK	8.56	8.84	5.63	5.60	126.25	124.52	78.12	77.54
T_2	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol	9.26	9.22	6.06	6.00	140.24	135.10	88.35	86.56
T_3	Recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol	9.21	9.10	5.93	5.91	136.45	131.25	84.02	82.32
T_4	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	9.37	9.24	6.32	6.38	146.00	143.21	92.14	90.14
T_5	Vermicompost + recommended NPK	8.64	8.78	5.96	5.94	134.25	130.34	85.58	83.54
T_6	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol	9.86	9.92	6.30	6.25	150.56	146.58	94.32	92.56
T_7	Recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol	9.65	9.74	6.24	6.21	146.89	144.63	90.05	90.14
T_8	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	9.88	10.08	6.62	6.48	151.25	153.00	97.06	97.08
T_9	Biodynamic compost + recommended NPK	9.15	9.08	5.82	5.85	134.52	137.65	82.32	81.54
T_{10}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol	9.45	9.85	6.10	6.13	145.54	133.75	88.58	83.89
T_{11}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol	9.57	9.65	6.02	5.29	140.75	138.00	85.14	84.00
T_{12}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	9.97	9.98	6.60	6.54	150.75	152.55	93.22	93.24
CD at 5%		0.93	0.94	0.60	0.60	14.06	15.92	9.50	10.02

Y = year

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it was minimum with T_1, while, reducing sugars, non-reducing sugar, total sugars, carotenoids and ascorbic acid content in fruits were also in similar trend as the TSS. However, maximum reduction of acidity was noted with the application of T_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) closely followed by T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol). This results are in accordance with the findings of Singh *et al*. (8) in *aonla*, Mahendra *et al.* (4) in *ber* and Robertse and Stassen (7) 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

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Treatment		Stone wt. (g)		Pulp : stone ratio		No. of fruits/tree		Fruit yield (q/ha)	
		1st y	2nd y	1st y	2nd y	1st y	2nd y	1st y	2nd y
T_1	FYM + recommended NPK	23.41	23.16	3.337	3.348	135.00	150.33	16.73	17.65
T_2	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol	26.02	24.25	3.395	3.569	153.33	165.00	20.52	21.14
T_3	Recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol	25.32	24.45	3.318	3.367	148.67	158.33	19.56	19.66
T_4	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	26.14	25.65	3.525	3.514	162.23	170.67	23.60	23.20
T_5	Vermicompost + recommended NPK	24.51	23.44	3.492	3.564	143.67	160.33	19.16	22.11
T_6	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol	25.72	25.65	3.667	3.609	161.00	178.33	24.04	25.04
T_7	Recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol	24.85	24.41	3.624	3.593	152.00	170.00	22.12	23.50
T_8	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	26.45	26.62	3.693	3.694	163.33	184.67	25.00	26.72
T_9	Biodynamic compost + recommended NPK	23.55	24.54	3.496	3.323	139.67	155.33	18.65	19.67
T_{10}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol	25.65	24.21	3.453	3.465	155.00	174.00	22.18	23.00
T_{11}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol	24.11	24.65	3.531	3.408	153.33	169.33	21.50	21.77
T_{12}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	25.24	25.24	3.670	3.692	163.00	180.67	24.52	25.58
CD at 5%		2.51	2.83	0.33	0.35	15.37	17.02	2.21	2.20

Y = year

with the application of organic sources of nutrients, micronutrients, biofertilizers (Ranjan and Gosh, 6) in sweet orange and *aonla* (Singh *et al.*, 1) 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_8 (recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol) gave best results in respect of flowering, fruiting, yield and quality of fruit in high density orcharding of mango cv. Amrapali, which was at par with T_{12} (recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol).

REFERENCES

1. A.O.A.C. 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists. (15th edn.), Washington, D.C.

Table 3. Effect of organic sources of nutrient, micronutrients and paclobutrazol on chemical composition of mango cv. Amrapali under high density orcharding.

Treatment		TSS (^{0}Brix)		Acidity (%)		TSS: acid ratio		Ascorbic acid (mg/100 g)	
		1st y	2nd y	1st y	2nd y	1st y	2nd y	1st y	2nd y
T_1	FYM + recommended NPK	20.28	20.45	0.133	0.131	152.48	156.11	37.61	38.69
T_2	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol	23.90	23.84	0.132	0.134	181.06	177.91	41.32	42.01
T_3	Recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol	22.54	22.65	0.139	0.136	162.16	166.54	38.32	40.21
T_4	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	23.76	23.88	0.122	0.124	194.75	192.58	44.35	42.30
T_5	Vermicompost + recommended NPK	21.16	21.02	0.136	0.135	155.59	155.70	39.91	40.00
T_6	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol	22.91	22.84	0.134	0.129	170.97	177.05	42.32	43.65
T_7	Recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol	22.24	22.84	0.124	0.130	179.35	175.69	42.91	40.87
T_8	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	23.72	23.91	0.120	0.121	191.60	197.76	44.13	45.63
T_9	Biodynamic Compost + recommended NPK	21.86	21.81	0.130	0.134	168.15	162.76	40.37	40.03
T_{10}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol	22.65	22.54	0.131	0.124	172.90	181.77	41.92	43.32
T_{11}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol	22.31	22.32	0.128	0.130	174.30	171.69	41.67	42.51
T_{12}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	23.67	23.87	1.21	1.22	179.96	180.69	43.71	44.41
CD at 5%		2.24	2.24	0.014	0.014	17.28	17.89	4.19	2.25

Y = year

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2. Kulkarni, V. and Hamilton, D. 1994. Flowering and fruting in mango in the top end with paclobutrazol. *Agnote Darwin*, **614**: 2.

3. Manjunatha, Hebbara, Ganiger, V.M., Reddy, B.G.M. and Joshi, V.R. 2006. Integrated nutrient management in sapota (*Manilkara zapota*) using vermicompost to increase yield and quality of fruits. *J. Agric. Sci*. **76**: 587-90.

4. Mahendra, Singh, H.K. and Singh, J.K. 2009. Effect of integrated nutrient management on yield and quality of ber (*Z. mauritiana* Lamk.) cv. Banarasi Karaka. *Asian J. Hort.* **04**: 47-49.

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Treatment		Carotenoids (mg/100 g)		Reducing sugars (%)		Non-reducing sugars (%)		Total sugars (%)	
		1st y	2nd y	1st y	2nd y	1st y	2nd y	1st y	2nd y
T_1	FYM + recommended NPK	15.77	16.71	7.16	7.07	8.33	8.42	15.49	16.00
T_2	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + paclobutrazol	17.31	16.79	7.68	7.70	9.93	9.91	17.61	15.42
T_3	Recommended NPK + FYM + *Azotobacter* + PSB + Fe + paclobutrazol	16.64	17.21	7.44	7.41	8.85	8.88	16.29	17.66
T_4	Recommended NPK + FYM + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	18.00	18.31	7.89	7.86	9.78	9.81	17.67	16.31
T_5	Vermicompost + recommended NPK	16.71	16.83	7.38	7.39	9.16	9.15	16.54	17.67
T_6	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + paclobutrazol	18.51	17.09	7.98	8.00	9.71	9.69	17.69	17.69
T_7	Recommended NPK + vermicompost + *Azotobacter* + PSB + Fe + paclobutrazol	17.71	17.53	7.57	7.60	9.75	9.72	17.32	17.80
T_8	Recommended NPK + vermicompost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	18.91	18.63	8.35	8.39	9.94	9.95	18.29	18.34
T_9	Biodynamic compost + recommended NPK	16.79	16.41	7.39	7.39	8.96	9.96	16.35	17.26
T_{10}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + paclobutrazol	17.89	16.63	7.90	8.10	9.85	9.65	17.75	16.50
T_{11}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Fe + paclobutrazol	17.89	17.98	7.66	7.69	9.48	9.45	17.14	17.80
T_{12}	Recommended NPK + biodynamic compost + *Azotobacter* + PSB + Zn + Fe + paclobutrazol	18.76	18.43	8.34	8.38	9.91	9.93	18.25	18.31
CD at 5%		1.75	1.80	0.73	0.74	0.95	0.97	1.65	1.73

Y = year

5. Ram, R.A. and Rajput, M.S. 2000. Role of biofertilizers and manures in production of guava (*Psidium guajava* L.) Allahabad Safeda. *Haryana J. Hort. Sci*. **29**:193-94.

6. Ranjan, Tarai and Ghosh, S.N. 2006. Integrated nutrient management in sweet orange cv. Mosambi (*Citrus sinensis* Osbeck). *Orissa J. Hort*. **34**: 72-75.

7. Robertse, P.J. and Stassen, P.J.C. 2004. Paclobutrazol suppressed vegetative growth and improved yield as well as fruit quality of Tommy Atkins mango (*Mangifera indica*) in Ethiopia. *New Zealand J. Crop Hort. Sci.* **32**: 281-93.

8. Singh, J.K., Prasad, J. and Singh, H.K. 2007. Effect of micro-nutrients and plant growth regulators on yield and physico-chemical characteristics

of *aonla* fruits (*Emblica officinalis* Gaertn) cv. Narendra *aonla* -10. *Indian J. Hort*. **64**: 216-18.

9. Singh, J.K., Singh, D.K., Prasad, J. and Singh, H.K. 2009. Studies on integrated nutrient management in flowering behaviour of *bael* (*Aegle marmelos* Correa) cv. Narendra Bael-9. *National Symposium on Emerging Trends in Plant Science and Herbal Medicines*, held at N.D. University of Agric. & Tech., Kumarganj, Faizabad (U.P.) on March 17th & 18th, pp. 78-80.

10. Singh, H.K., Srivastava, A.K., Dwivedi, R. and Kumar, P. 2001. Effect of foliar feeding of micronutrients on plant growth, fruit quality, yield and internal fruit necrosis of *aonla* (*Emblica officinalis* Gaertn.) cv. Francis. *Prog. Hort*. **33**: 80-83.

11. Verma, R.S. 2010. Studies on effect of intregrated nutrient management in phalsa (*Grewia subinaequalis* D.C.). Ph.D. thesis, N.D. Univ. Agric. & Technology, Kumarganj, Faizabad (U.P).

12. Voon, C.H., Pitakpaivan, C. and Tan, S.J. 1991. Mango cropping manipulation with Cultar. *Acta Hort*. **291**: 219-28.

13. Yadav, Rajesh., Baksh, Hari, Singh, H.K. and Yadav, A.L. 2007. Effect of integrated nutrient management on productivity and quality of *aonla* (*Emblica officinalis* Gaertn.) cv. Narendra Aonla - 7. *Plant Arch.* **7**: 881-83.

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