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Improvement in productivities and profitability in high density orchard of mango (*Mangifera indica* L) cv. Amrapali through integrated nutrient

Rajnee Sharma, P.K. Jain and T.R. Sharma

Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, MP, India

ABSTRACT

A field investigation was conducted to study the effect of organic and inorganic sources of nutrients on productivity and profitability in high density orchard of mango (*Mangifera indica* L) cv. Amrapali through integrated nutrient at Horticulture Complex, Maharajpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during 2012-13 and 2013-14. A total of twenty four treatment combinations of inorganic and organic sources on nutrient were tested in factorial randomized block design with three replications. The results of study revealed that higher level of nutrient either in the form of chemical fertilizer or organic sources enhanced the plant growth. Application 520: 160: 450 NPK g plant^{-1} alongwith vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + TV + PSB (100g each) registered maximum crown height (78.3cm), crown length (197.4cm), crown width E-W (248.4cm), crown width N-S (251.7cm), shoot length (16.1cm), number of panicle (40.0) and length of panicle (39.7cm). Whereas, higher fruit set pea stage (24.7), fruit retention (17.8%), number of fruit plant^{-1} (75.5), gross return (₹ 4.14 plant^{-1}) with B: C ratio (1.94) was noted when plant nourished with 100% RDF of chemical fertilizer (415: 130: 360 NPK g plant^{-1}) incombination with organic sources of nutrient viz. vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + TV + PSB (100g each).

Keywords: High density, productivity, profitability, integrated nutrient

India is still behind in yield per unit area than the major mango producing countries of the world. Though Soil and climate conditions are highly suitable for mango production and grown an area of 2.52 million hectares with a total production of 18.431 million tonnes, which works out to a low average productivity of 7.3 metric tonnes per hectare (Anonymous 2014). In recent year's, high density planting system of mango is getting popularity. Fruit plant removes large amount of essential nutrient reserves in the soil. Over the time,

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Address for correspondence

Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, MP, India

E-mail: trsharmajbp@rediffmail.com

continues depletion of nutrients decreases fruit yield and soil fertility and lead to soil degradation. On the other hand, excess or continuous use of inorganic fertilizers as source of nutrient in imbalance proportion creates problems, causing economic inefficiency, threaten the environment and human beings. The use of bio-fertilizers and on farm organics as a sources of nutrient is gaining popularities in recent years because of higher cost and hazardous effect of chemical fertilizers. Appropriate measure to ensure optimum nutrient status of soil will go to long way in maintaining mango tree in various stages which will ensure optimum level of productivity in sustainable manner. Therefore, present investigation was carried out to know the effect of organic sources of nutrients on growth, yield and economics of mango Cv. Amrapali, planted under high density.

Materials and Methods

A field experiment was conducted at Horticulture Complex, Maharajpur, JNKVV during 2012-13 and 2013-14. The soil of experimental filed was clay in texture (58.4% clay, 21.5 silt and 20.1% sand) natural in reaction (pH 7.4) and having 0.25 dS m^{-1} electric conductivity, medium available N (230.7 kg ha^{-1}), low P (12.6 kg ha^{-1}), medium K (340.2kg ha^{-1}) and low range of organic carbon (0.47%). The experiment consisted of four levels of NPK fertilizer (F_1: Without fertilizer, F_2: 75% of RDF (310: 100: 270 NPK g $plant^{-1}$), F_3: (100% of RDF (415: 130: 360 NPK g $plant^{-1}$) and F_4: 125% of RDF (520: 160: 450 NPK g $plant^{-1}$) and six organic sources O_1: Oil cake 2.5 kg $plant^{-1}$, O_2: Azotobacter + VAM + *Trichoderma viridi* + PSB (100g of each $plant^{-1}$), O_3: Vermicompost (25 kg $plant^{-1}$), O_4: Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$), O_5: Vermicompost (25 kg $plant^{-1}$) + Azotobacter + VAM + *Trichoderma viridi* + PSB (100g of each $plant^{-1}$), O_6: Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$) +Azotobacter + VAM + *Trichoderma viridi* + PSB (100g of each $plant^{-1}$) were fertilized. Seventy two plants of mango var. Amrapali planted (2.5 × 2.5 m) under high density were randomly selected for study and replicated thrice. The observations pertaining growth, yield and economics of treatments were computed and statistically analyzed.

Results and Discussion

Canopy development

Growth parameters pertaining to height, length and spread of crown and shoot length, are presented in Table 1. It inferred that significantly increased the crown height (68.8 cm), crown length (193.7 cm), spread in direction of east-west (229.3 cm) and south – north (225.0 cm) and shoot length (15.3 cm) due to application of 520:160:450g NPK $plant^{-1}$. The increase in the area of canopy consisted of height, length and spread might be due to induction of more shoot and their spread with the use of 125% recommended dose of NPK. These results are in accordance with the findings of Pathak and Ram (2005) who observed the improvement in vegetative growth parameter in guava with application of fertilizers. Syamlal and Mishra (1989) who reported that higher dose of NPK resulted in more height and length of crown.

On an average increasing crown height (71.3cm), length (192.3 cm), canopy spread in direction of east-west (239.0 cm) and south – north (233.3 cm) and shoot length (15.3 cm) were recorded when plant were nourished with a combination of Vermicompost (25kg $plant^{-1}$) + Oil cake (2.5 kg $plant^{-1}$) + Azotobacter + VAM + Trichoderma viridi + PSB (100g $plant^{-1}$ each) over inoculation of bio-inoculants alone. The increase in plant height, spread, volume, shoot length, could be attributed to the stimulative activity of microflora in the rhizosphere leads to availability of nutrients, plant vigorous growth (Singh *et al.* 2000 and Aseri *et al.* 2008).

The positive improvement in crown height (75.5 cm), length (201.0 cm), spread in direction of east-west (251.7 cm) and south – north (248.3 cm) and shoot length (16.1 cm) were recorded with the use of chemical fertilizer 520:160:450g NPK $plant^{-1}$ (125% of RDF) in combination with Vermicompost (25 kg $plant^{-1}$) + Oil cake (2.5 kg

Table 1: Effect of inorganic and organic sources of nutrients on growth under high density orchard of mango

Treatments	Crown height (cm)	Crown length (cm)	Crown width (E-W)	Crown width (N-S)	Shoot length (cm)	No. of panicle	Length of Panicle (cm)
Without fertilizer + O C (2.5kg)	53.5	176.7	190.4	175.0	12.5	28.0	29.9
Without fertilizer + Azt + VAM + *TV*	49.0	174.7	185.8	171.7	12.4	29.0	29.1
Without fertilizer + VC (25 kg)	61.7	178.7	203.4	196.3	12.7	29.0	30.4
Without fertilizer + VC (25 kg) + OC(2.5 kg)	62.7	179.7	204.2	201.2	12.9	30.5	31.2
Without fertilizer + VC (25 kg) + Azt + VAM + *TV*	66.7	181.0	214.2	205.0	13.9	30.5	31.7
Without fertilizer + VC (25 kg) + OC(2.5 kg)+ Azt + VAM + *TV* (100g each)	68.0	182.7	215.8	232.5	15.0	31.5	32.5
75% RDF + OC(2.5kg)	63.0	181.7	196.3	181.7	13.2	29.0	31.7
75% RDF + Azt + VAM + *TV*, (100g each)	56.3	181.4	195.0	175.0	12.9	31.0	30.4
75% RDF + VC (25 kg)	63.6	183.2	202.5	201.7	13.8	31.5	32.4
75%RDF + VC (25 kg) + OC (2.5 kg)	65.0	184.1	208.4	203.3	14.0	33.0	33.6
75% RDF + VC (25 kg) + Azt + VAM + *TV*	66.0	184.9	221.7	210.0	14.1	32.0	33.4
75% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	67.7	188.7	232.5	230.0	15.1	33.5	34.8
100% RDF + OC (2.5kg)	63.2	185.7	201.7	211.7	13.8	32.5	33.9
100% RDF + Azt + VAM + *TV*	60.3	184.1	200.0	205.0	13.3	33.5	32.6
100% RDF + VC (25 kg)	66.4	187.4	203.4	215.0	14.0	33.5	33.5
100% RDF + VC(25 kg) + OC (2.5 kg)	67.7	188.7	220.0	221.7	14.2	35.0	35.2
100% RDF + VC (25 kg) + Azt + VAM + *TV*	68.1	189.2	226.7	238.4	14.6	34.5	34.6
100% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	69.6	193.8	236.7	241.7	15.0	36.0	36.1
125% RDF + OC(2.5kg)	65.4	190.7	216.5	218.4	13.9	35.0	36.7
125% RDF + Azt + VAM + *TV*	58.4	188.9	206.7	213.3	13.3	37.0	34.9
125% RDF + VC (25 kg)	70.0	192.7	216.7	222.5	14.2	36.5	36.2
125%RDF + VC(25 kg) + Oil cake (2.5 kg)	71.7	193.8	227.5	225.0	14.5	38.0	38.0
125% RDF + VC (25 kg) + Azt + VAM + *TV*	76.7	196.4	234.2	245.0	15.7	38.0	37.9
125% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	78.3	197.4	248.4	251.7	16.1	40.0	39.7
CD at 5%							
Fertilizer	**1.92**	**1.31**	**2.32**	**1.77**	**0.50**	**0.23**	**0.26**
Organic Sources	**2.36**	**1.60**	**2.85**	**2.16**	**0.61**	**0.28**	**0.32**
Interaction (F × O)	**4.71**	**3.20**	**5.69**	**4.32**	**NS**	**0.56**	**0.64**

plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). The use of bio fertilizers attributed to improve nutrient use efficiency under balance use of organic and inorganic sources of nutrient. The increase in plant height, spread might be due to improvement of physical properties of soil, higher nutrient uptake due to increase in proliferation and activities of microorganisms which manifested in the form of enhanced growth and carbohydrates production as explained by Kumar *et al.* (2008) and Hassan *et al.* (2001).

Yield attributes

The fruit yield of the crop significantly increased with application of fertilizers. The application of chemical fertilizer 415:130:360 g NPK plant^{-1} (RDF) maximize the number of fruit set (21.8), fruit retention (15.6%), total number of fruit harvested (70 plant^{-1}) and yield (12.53 kg plant^{-1}). Moreover, it also minimize fruit drop (84.5%) and registered 61.26 % higher yield over control. The application of 125% recommended dose of fertilizer (520:160:450g NPK plant^{-1}) produced 11.24 kg and 65 fruit plant^{-1}. The response of crop to applied NPK is quite obvious as it increased flower, fruit setting and fruit retention. Fruits size and weight are the major component of mango production. These parameters are highly affected due to nutrient management. The increase in yield was mainly attributed to relative increase in the availability of nutrients and better solute uptake by the plant. These findings are in accordance with the results of Korwar *et al.* (2006) and Pathak *et al.* (2005) in aonla.

Among the organic sources, the combination of manures and biofertilizers exhibited profound effect on fruit set, fruit retention, fruit drop, number of fruit per plant and fruit weight. Data indicated that the higher efficiency of organic manures was noted when supplemented with bio-inoculants. The organic sources of nutrients maximized the number of fruit at pea stage (21.8), fruit retention (15.0 %), total number of fruit harvested (68 plant^{-1}) and yield (12.03 kg plant^{-1}) as well as minimum fruit drop (85.0%) was recorded with the application of Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). Enriched treatments are able to produce more fruits set, retention of fruit at maturity, bearing of fruit per plant as well as yield. The increase in the yield of mango with the use of enriched organic manures in the form of vermicompost and oil cake. The increase in yield was due to optimum supply of plant nutrient and growth hormones at desired amount during entire period of growth, ultimately resulted in accumulation of more photosynthats in panicle and fruit, resulted into more induction and retention in panicle with biomass. These results are in corroborating with the finding of Yadav *et al.* (2011) and Verma (2010).

The integration of inorganic and organic sources of nutrient maximized the number of fruit at pea stage (24.9), fruit retention (17.8%), total number of fruit harvested (76 plant^{-1}) and yield (15.00 kg plant^{-1}) as well as minimum fruit drop (82.2%) was recorded with the application of 415:130:360 g NPK plant^{-1} (recommended dose of fertilizer) in combination with Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). The increase in both number and weight might be attributed to the fact that there was increasing levels of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. The above results are in conformity with the findings of Dalal *et al.* (2004) and Lal and Dayal (2014).

Economics of treatments

Net profit obtained under various treatments is presented in Table 2. Data reveal that net return as well as benefit cost ratio are significantly influenced due to different sources of nutrients. The higher net return and benefit cost ratio of ₹ 196 plant^{-1} and 2.52 were recorded with recommended dose of fertilizer (415:130:360 g NPK plant^{-1}). The increase in yield gave higher net profit and per rupee investment in terms of benefit cost ratio.

Higher net return of ₹ 182 plant^{-1} with cost benefit ratio of 3.50 was recorded under application of Oil cake @ 2.5 kg plant^{-1} whereas, the lowest net return of ₹ 110 plant^{-1} with benefit cost ratio of 1.53 was noted with the application of Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + Trichoderma viridi + PSB (100g plant^{-1} each). Integration of various

Table 2: Effect of integrated on fruit yield and economic of mango under high density orchard

Treatments	Fruit set (pea stage)	Fruit retention (%)	No of Fruit (plant^{-1})	Yield (kg plant^{-1})	Gross return ₹ plant^{-1})	Net return (₹ plant^{-1})	B: C ratio
Without fertilizer + O C (2.5kg)	14.7	11.7	51.0	7.30	202.0	144.0	3.50
Without fertilizer + Azt + VAM + *TV*	13.2	11.3	43.0	6.33	175.0	114.0	2.90
Without fertilizer + VC (25 kg)	15.6	12.5	52.0	8.00	220.0	144.0	2.93
Without fertilizer + VC (25 kg) + OC(2.5 kg)	16.4	12.3	52.5	7.97	219.0	86.0	1.65
Without fertilizer+ VC (25 kg) + Azt + VAM + *TV*	17.9	12.9	53.0	8.33	229.5	94.0	1.70
Without fertilizer + VC (25 kg) + OC(2.5 kg) + Azt + VAM + *TV* (100g each)	18.7	13.2	55.0	8.67	239.0	46.0	1.24
75% RDF + OC(2.5kg)	15.7	12.7	52.0	8.03	221.0	148.0	3.03
75% RDF + Azt + VAM + *TV*, (100g each)	13.5	12.9	46.5	7.20	199.5	123.0	2.64
75% RDF + VC (25 kg)	16.4	13.7	59.5	9.63	264.5	174.0	2.92
75%RDF + VC (25 kg) + OC (2.5 kg)	17.7	13.4	60.5	9.87	272.0	124.0	1.84
75% RDF + VC (25 kg) + Azt + VAM + *TV*	19.9	13.8	67.0	10.90	301.0	150.0	2.00
75% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	20.6	13.9	69.5	11.87	326.5	118.0	1.57
100% RDF + OC (2.5kg)	19.7	15.0	66.5	9.93	273.0	195.0	3.51
100% RDF+ Azt + VAM + *TV*	19.6	14.3	61.5	10.07	278.5	197.0	3.45
100% RDF + VC (25 kg)	20.5	15.5	68.0	13.20	363.5	267.0	3.80
100% RDF + VC(25 kg) + OC (2.5 kg)	22.7	14.7	71.0	13.27	366.0	213.0	2.39
100% RDF + VC (25 kg) + Azt + VAM + *TV*	22.9	16.2	75.0	13.73	378.0	222.0	2.43
100% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	24.7	17.8	75.5	15.00	414.0	201.0	1.94
125% RDF + OC(2.5kg)	19.0	14.0	62.5	10.37	286.0	202.0	3.45
125% RDF + Azt + VAM + *TV*	16.9	13.2	59.0	10.03	276.5	190.0	3.23
125% RDF + VC (25 kg)	20.5	14.1	62.5	11.40	314.0	214.0	3.13
125%RDF + VC(25 kg) + Oil cake (2.5 kg)	21.1	14.0	64.5	11.20	308.0	150.0	1.95
125% RDF + VC (25 kg) + Azt + VAM + *TV*	23.2	14.2	67.0	11.87	327.0	166.0	2.04
125% RDF + VC (25 kg) + OC (2.5 kg) + Azt + VAM + *TV*	23.4	15.0	71.0	12.60	348.0	129.0	1.59
CD at 5%							
Fertilizer	**0.24**	**0.23**	**0.75**	**0.54**	—	—	—
Organic Sources	**0.30**	**0.28**	**0.86**	**0.64**	—	—	—
Interaction (F × O)	**0.60**	**0.57**	**1.75**	**1.60**	—	—	—

Mango market sale price @ ₹ 25 per kg and ₹ 30 per kg for the year 2012-13 and 2013-14, respectively.

components of organic sources add the cost of input which increase the total cost of production hence, reduce the net profit as well as the benefit cost ratio.

The combined application of 415:130:360g NPK plant^{-1} (RDF) with oil cake (2.5 kg plant^{-1}) registered higher net return of ₹ 226 with benefit cost ratio of 3.90. Whereas, oil cake, bio-inoculants and vermicompost showed superiority in combination with chemical fertilizer either applied 100% recommended dose or 125% of RDF. Further, it was also noted that inclusion of different sources of nutrient increase the production cost and reduced the net profit as well as the benefit cost ratio. The similar findings were also reported by Shukla *et al.* (2009) and Dwivedi (2013).

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