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Influence of biofertilizer and inorganic fertilizer in pruned mango orchard cv. Amrapali

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ABSTRACT

An experiment was carried out at Horticultural Research Station of Bidhan Chandra Krishi Viswavidyalaya (Agriculture University), West Bengal, India during 2005-07 to find out the effect of biofertilizer and inorganic fertilizer in Amrapali mango trees of 10 years old which were planted in the year 1995 at 5m × 5m spacing and subsequently pruned during January, 2004 at 2.5 m height. Three levels of inorganic fertilizers (100% NPK, 75% NPK and 50% NPK) were applied alone and also in combinations with different biofertilizers (Azotobacter, Azospirillum and VAM). Among sixteen treatments, all the inorganic and biofertilizer combinations exhibited profound effect on growth, yield and fruit quality and leaf mineral composition than inorganic fertilizer alone. However, the efficiency of inorganic fertilizer at three levels was more when supplemented with both Azotobacter and VAM. Higher fruit yield was obtained when the plants were treated with 100% NPK + Azotobacter + VAM (98.1 kg/plant) or 75% NPK + Azotobacter + VAM (93.5 kg/plant) as compared to much lesser yield (60 Kg/plant) with 100% NPK. It was concluded that the treatments 100% NPK + Azotobacter + VAM and 75% NPK + Azotobacter + VAM were effective and may be adopted to improve the vegetative growth and productivity with quality fruits.

Key words: Fruit quality, growth, leaf mineral composition, yield

Mango (*Mangifera indica* L.), the King of fruits, is the most important fruit in the tropical and subtropical region of the world. The nutritional and economic importance makes mango very popular over the world. Amrapali is a mango hybrid (Dashehari × Neelum) and gaining popularity for its dwarf stature and regular bearing in nature. Amrapali has already occupied a major area in newly planted mango orchard in West Bengal and replacing the traditional cultivars. Nutrition of trees is an important part of mango orchard management practices and fertilizer is one of the major inputs accounting for nearly 35 percent of the cost of cultivation. Indiscriminate use of inorganic chemical fertilizers resulted in high amount of chemical residues in field as well as in the crop produces leading to various environmental and health hazards along with socio-economic problem. Again the increasing cost of fertilizer and global concern of ground water pollution through leaching from the soil are discounting the use of fertilizers. So, it is necessary, to maintain 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 (Chundawat, 2001). Biofertilizers are the living organism which add, conserve and mobilize the plant nutrients in the soil. Biofertilizer based on renewable energy source are cost effective supplement to chemical fertilizers and can help to economize on the high investment needed for fertilizer use (Motsara *et al.*, 1995). The beneficial effect of bio-fertilizers is now well established in fruit crops like papaya (Sukhade *et al.*, 1995) and banana (Gogoi *et al.*, 2004). However, very little work has been done on the use of biofetilizers in mango. With these backgrounds the present experiment was designed with the objective to supplement the use of ever increasing costly chemical fertilizers with the incorporation of biofertilizers that could ensure eco-friendly environment.

MATERIALS AND METHODS

The experiment was carried out at Horticultural Research Station of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during 2005-07 to find out the effect of biofertilizer and inorganic fertilizer on 10 years old Amrapali mango trees which were planted during 1995 at 5m× 5m spacing and subsequently pruned during January, 2004 at 2.5m height. The research station is located at 22 °43' N latitude and 88°34' E longitude, having an altitude of 9.75m above mean sea level. The experiment was laid out with sixteen treatments and three replications with completely randomized design. Three levels of inorganic fertilizers (100% NPK, 75% NPK and 50% NPK) were applied alone and also in combinations with different biofertilizers *viz.*, *Azotobacter*, *Azospirillum* and vesicular arbuscular mycorrhiza (VAM). The plant fertilized with 100% NPK revealed 1000g nitrogen, 500g phosphorous and 1000g potassium. Inorganic or chemical fertilizers were applied to the concerned plants according to their levels of treatments in two splits - once after fruit harvest (August) and another at pea stage of fruit (March). However, full dose of phosphorous and potassium and 50 % of nitrogen were given after harvest and remaining 50% of nitrogen was given at pea stage. Biofertilizers @250g each was incorporated to the concerned plant in the month of October by thoroughly mixing with 10 Kg of FYM. Both inorganic and biofertilizer were applied in a ring 1

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meter away from the trunk and at a depth of 30 cm. which were mixed in soil and covered.

The increase in tree height, girth and spread were measured at an interval of six months and averages of these parameters were presented. Data on fruit yield, weight, fruit quality were recorded at maturity. Bio-chemical constituents like TSS, total sugar, acidity and ascorbic acid were estimated by following the standard method (Boland, 1990). Leaf mineral content was estimated by standard methods for nitrogen (Black, 1965), phosphorus (Jackson, 1960) and potassium (Piper, 1956). For leaf analysis third pair of leaves from apex of the shoot was collected in the month of January. The data were analyzed to compare sixteen treatment means for all parameters by following completely randomized design technique and Duncan test at 5 % level of significance using SPSS (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Among sixteen treatments, the combinations of inorganic fertilizers and biofertilizers treatments exhibited profound effect on growth, yield, fruit quality and leaf mineral composition than inorganic fertilizers alone. Results indicated that the efficiency of inorganic fertilizer at three levels was more when supplemented with VAM, *Azotobacter* or *Azospirillum*. Maximum increase in height (17.01%), girth (15.77%) and tree spread in east-west (12.73%) and north-south (11.53%) directions were recorded when plants were treated with NPK (100%) + VAM + *Azotobacter*. Treatment with NPK (75%) + VAM + *Azotobacter* also increased the tree height (16.20%) promisingly (Table 1). The improved growth resulted by the supplementation of biofertilizer might be due to better absorption and mobilization of nutrients by the action of microbes. In the present studies, when fertilizers are supplemented with single biofertilizer, the growth was more with VAM. Silva and Siqueira (1991) also found better growth response in mango seedlings when inoculated with *Glomus margarita* (VAM fungi) only. Higher fruit yield was obtained when the plants were treated with NPK (100%) + VAM + *Azotobacter* (98.1 kg plant^{-1}) or NPK (75%) + VAM + *Azotobacter* (93.5 kg plant^{-1}) as compared to much lesser yield (60 kg plant^{-1}and 57.3 kg plant^{-1}) with NPK (100%) and NPK (75%) respectively. The increased tree yield of present studies was also supported by the findings of Ahmad *et al.* (2003) who obtained optimum yield when nitrogen was applied in combination with *A. chroococcum* CBD-15 in mango cv. Amrapali under high-density planting. The use of both biofertilizers at a time (VAM + *Azotobacter*) in combination with NPK (100%) responded maximum increase in fruit weight (318.3 g). However single biofertilizer when used with different levels of inorganic fertilizer, *Azotobacter* showed best response in increasing fruit weight than VAM or *Azospirillum* (Table 2). The application of biofertilizers along with inorganic fertilizer might have increased the total chlorophyll content which in turn increased the photosynthesis and ultimately improved fruit yield.

Table 1: Effect of biofertilizer and inorganic fertilizer on annual growth of mango

Treatments	Height (% increase)	Basal girth (% increase)	Spread (% increase)	
			East-West	North-South
NPK_{100} + VAM	14.85^{c}	14.73^{b}	11.35^{b}	9.89^{b}
NPK_{100} + *Azotobacter*	14.07^{e}	12.63^{f}	10.72^{c}	9.44^{c}
NPK_{100} + *Azospirillum*	12.75^{h}	12.02^{g}	10.9^{c}	8.94^{d}
NPK_{100} +VAM + *Azotobacter*	17.01^{a}	15.77^{a}	12.73^{a}	11.53^{a}
NPK_{75} + VAM	14.51^{d}	14.45^{c}	9.66^{d}	8.11^{f}
NPK_{75} + *Azotobacter*	13.79^{f}	13.18^{e}	8.55^{e}	7.28^{g}
NPK_{75} + *Azospirillum*	13.22^{g}	12.60^{f}	8.64^{e}	6.85^{i}
NPK_{75} + VAM + *Azotobacter*	16.20^{b}	14.22^{d}	9.44^{d}	8.66^{e}
NPK_{50} + VAM	12.57^{i}	12.47^{f}	7.11^{g}	6.70^{i}
NPK_{50} + *Azotobacter*	12.10^{j}	11.30^{i}	7.09^{g}	6.09^{j}
NPK_{50} + *Azospirillum*	11.86^{k}	10.73^{j}	6.89^{h}	5.82^{k}
NPK_{50} + VAM+ *Azotobacter*	12.89^{h}	11.82^{h}	7.68^{f}	7.03^{h}
NPK_{100}	11.01^{e}	9.76^{k}	6.56^{h}	5.07^{m}
NPK_{75}	10.49^{m}	9.28^{i}	5.24^{i}	4.61^{n}
NPK_{50}	10.33^{n}	9.13^{i}	4.45^{j}	5.58^{i}
Control	10.08^{o}	8.22^{m}	4.17^{j}	4.27^{o}
SEm (±)	**0.07**	**0.09**	**0.24**	**0.08**
LSD (0.05)	**0.19**	**0.26**	**0.78**	**0.25**

Note: Similar alphabets denotes homogeneous means (Duncan's multiple range test at 5% level of significance)

NPK (100%) treated plants resulted more quality fruits when used with biofertilizer/(s). However, NPK (75%) was also effective particularly when used with both VAM + *Azotobacter*. Among sixteen treatments, NPK (100%) + VAM + *Azotobacter* treated plants exhibited maximum contents of TSS (19.55 ^{0}brix), total sugar (12.77 %), ascorbic acid (68.3 mg g^{-100} pulp), TSS: acid ratio (102.4) and minimum content of acidity (0.32 %) in the fruits (Table 2).

Table 2: Effect of biofertilizer and inorganic fertilizer on yield and quality of fruits

Treatments	Yield (kg plant^{-1})	Fruit wt. (g)	TSS (^{0} brix)	Total sugar (%)	Acidity (%)	Ascorbic acid (mg g^{-100} pulp)
NPK_{100} + VAM	89.0 ^{c}	313.6 ^{a}	18.65 ^{abc}	11.38 ^{d}	0.45 ^{h}	66.7 ^{b}
NPK_{100} + *Azotobacter*	91.4 ^{bc}	313.8 ^{a}	18.93 ^{ab}	12.03 ^{b}	0.47 ^{h}	65.0 ^{c}
NPK_{100} + *Azospirillum*	83.5 ^{d}	306.2 ^{b}	18.50 ^{abc}	11.40 ^{d}	0.50 ^{h}	62.0 ^{d}
NPK_{100} +VAM + *Azotobacter*	98.1 ^{a}	318.3 ^{a}	19.55 ^{a}	12.77 ^{a}	0.32 ^{i}	68.3 ^{a}
NPK_{75} + VAM	85.5 ^{cd}	298.3 ^{cd}	16.65 ^{d}	10.47 ^{f}	0.65 ^{j}	61.2 ^{d}
NPK_{75} + *Azotobacter*	82.0 ^{de}	305.7 ^{b}	18.35 ^{abc}	10.50 ^{f}	0.77 ^{f}	60.2 ^{ef}
NPK_{75} + *Azospirillum*	78.0 ^{e}	293.5 ^{de}	18.23 ^{abcd}	11.07 ^{e}	0.75 ^{f}	60.9 ^{de}
NPK_{75} + VAM + *Azotobacter*	93.5 ^{b}	303.2 ^{bc}	18.87 ^{ab}	11.73 ^{c}	0.62 ^{f}	62.4 ^{d}
NPK_{50} + VAM	81.7 ^{de}	290.2 ^{ef}	18.12 ^{abcd}	10.67 ^{f}	1.00 ^{e}	60.2 ^{ef}
NPK_{50} + *Azotobacter*	66.7 ^{f}	290.3 ^{ef}	17.70 ^{abcd}	9.72 ^{gh}	1.10 ^{d}	59.3 ^{fg}
NPK_{50} + *Azospirillum*	66.6 ^{f}	289.3 ^{ef}	17.75 ^{abcd}	9.40 ^{i}	1.15 ^{d}	58.6 ^{gh}
NPK_{50} + VAM+ *Azotobacter*	64.5 ^{g}	293.3 ^{de}	17.85 ^{abcd}	9.62 ^{i}	0.09 ^{e}	61.0 ^{de}
NPK_{100}	60.0 ^{gh}	284.5 ^{fg}	17.53 ^{bcd}	10.47 ^{f}	1.50 ^{a}	57.6 ^{h}
NPK_{75}	57.3 ^{h}	287.5 ^{efg}	17.17 ^{abcd}	9.90 ^{g}	1.40 ^{a}	56.0 ^{i}
NPK_{50}	50.5 ^{i}	282.0 ^{g}	17.72 ^{d}	9.95 ^{g}	1.20 ^{c}	55.8 ^{i}
Control	42.5 ^{j}	273.2 ^{h}	16.20 ^{e}	9.00 ^{j}	1.30 ^{b}	55.2 ^{i}
SEm(±)	**2.24**	**2.36**	**0.13**	**0.09**	**0.51**	**0.47**
LSD(0.05)	**5.61**	**5.95**	**0.34**	**0.22**	**1.28**	**1.18**

Table 3: Effect of biofertilizer and inorganic fertilizer on leaf mineral composition of mango

Treatments	Nitrogen (% dry wt.)		Phosphorus (% dry wt.)		Potassium (% dry wt.)	
	Before flowering	After harvest	Before flowering	After harvest	Before flowering	After harvest
NPK_{100} + VAM	1.83 ^{ab}	1.50 ^{b}	0.15 ^{a}	0.13 ^{ab}	1.20 ^{ab}	1.16 ^{a}
NPK_{100} + *Azt*	1.83 ^{ab}	1.47 ^{b}	0.15 ^{ab}	0.12 ^{bc}	1.19 ^{ab}	1.14 ^{a}
NPK_{100} + *Azs*	1.80 ^{ab}	1.49 ^{b}	0.15 ^{ab}	0.13 ^{ab}	1.18 ^{b}	1.10 ^{bc}
NPK_{100} + VAM + *Azt*	1.88 ^{a}	1.56 ^{a}	0.15 ^{a}	0.14 ^{a}	1.21 ^{a}	1.11 ^{b}
NPK_{75} + VAM	1.76 ^{bc}	1.49 ^{b}	0.14 ^{bc}	0.13 ^{ab}	1.08 ^{d}	1.06 ^{d}
NPK_{75} + *Azt*	1.80 ^{ab}	1.44 ^{c}	0.13 ^{cd}	0.15 ^{a}	1.06 ^{efg}	1.03 ^{e}
NPK_{75} + *Azs*	1.70 ^{cd}	1.40 ^{d}	0.13 ^{cd}	0.12 ^{ab}	1.04 ^{gh}	1.00 ^{fg}
NPK_{75} + VAM + *Azt*	1.79 ^{b}	1.50 ^{b}	0.15 ^{ab}	0.13 ^{ab}	1.10 ^{c}	1.09 ^{c}
NPK_{50} + VAM	1.48 ^{g}	1.40 ^{d}	0.12 ^{ef}	0.10 ^{cde}	1.04 ^{def}	0.99 ^{g}
NPK_{50} + *Azt*	1.60 ^{ef}	1.37 ^{de}	0.11 ^{f}	0.09 ^{de}	1.05 ^{fgh}	0.98 ^{gh}
NPK_{50} + *Azs*	1.55 ^{fg}	1.30 ^{f}	0.10 ^{g}	0.08 ^{def}	1.03 ^{hi}	0.96 ^{hi}
NPK_{50} + VAM + *Azt*	1.64 ^{de}	1.40 ^{d}	0.12 ^{de}	0.10 ^{cd}	1.07 ^{de}	1.01 ^{ef}
NPK_{100}	1.50 ^{g}	1.38 ^{de}	0.10 ^{g}	0.09 ^{de}	1.02 ^{i}	0.95 ^{i}
NPK_{75}	1.41 ^{h}	1.36 ^{e}	0.09 ^{g}	0.09 ^{de}	0.99 ^{j}	0.90 ^{j}
NPK_{50}	1.32 ^{i}	1.31 ^{f}	0.08 ^{h}	0.08 ^{ef}	0.97 ^{k}	0.87 ^{k}
Control	1.30 ^{j}	1.23 ^{g}	0.05 ^{i}	0.06 ^{f}	0.94 ^{l}	0.85 ^{k}
SEm(±)	**0.03**	**0.01**	**0.004**	**0.07**	**0.01**	**0.01**
LSD(0.05)	**0.07**	**0.03**	**0.01**	**0.17**	**0.03**	**0.03**

Note: Similar alphabets denotes homogeneous means (Duncan's multiple range test at 5% level of significance)
Azt- Azotobacter; Azs- Azospirillum

Higher fruit acidity was recorded with inorganic fertilizer treated plants and with control plants. However maximum content of fruit acidity was noted when plants were treated with NPK (100%). Patel *et al.* (2005) also noted higher yield and quality fruits with combined application of biofertilizers in Amrapali mango. The mineral composition of leaves in terms of nitrogen, phosphorus and potassium was higher when collected before flowering than collected after fruit harvest. The treatment NPK (100%) + VAM + *Azotobacter* resulted higher nitrogen (1.56-1.88%), phosphorus (0.14-0.15%) and potassium (1.11-1.21%) content in leaves (Table 3). However, all the single biofertilizers were also effective when used with NPK (100%). This is in agreement with the findings of Ram *et al.* (2007) who obtained increased leaf mineral content with the application of bio-fertilizer and organic manures.

It was concluded from the present findings that the treatments NPK (100%) + *Azotobacter* + VAM and NPK (75%) + *Azotobacter* + VAM were effective and can be applied to improve the vegetative growth and productivity with quality fruits in Amrapali mango.

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