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Influence of organics, inorganic and biofertilizers on growth, fruit quality, and soil characters of Himsagar mango grown in new alluvial zone of West Bengal, India

P. Dutta (*), K. Das, A. Patel
Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, P.O. Mohanpur, 741252 Dt. Nadia, West Bengal, India.

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Abstract: A field study with organic manures, inorganic manures and biofertilizers alone and in combination was carried out on 11-year-old mango (*Mangifera indica* L.) cv. Himsagar spaced 10 m apart in a randomized block design at the University Research Station, Gayeshpur, BCKV, West Bengal, India. The objective was to determine their effect on growth, soil characters, and fruit quality of mango grown in a new alluvial zone of West Bengal. Respiration, physiological loss in weight (PLW) and shelf life at ambient room temperatures, and soil characters were also assessed. Results revealed that among the eight treatments, biofertiliser (*Azotobacter* + PSM) along with 50% inorganic fertilizer significantly increased the growth characters of mango trees. This treatment also increased the physico-chemical character of fruit while biofertilizers alone improved the fruit quality, viz. total soluble solids, total sugar and β-carotene. Fruits treated with biofertilizers also had increased shelf life with lower PLW and respiration rate. Soil microbial population and other soil characters were improved by application of biofertilizer as well. It is concluded that biofertilizer application in mango gives better growth, fruit quality, and soil health.

1. Introduction

Mango (*Mangifera indica* L.) is the most important tropical fruit and considered king of all the fruits in India. The fruits are a rich source of iron and various anti-oxidants. In addition, mango is a rich source of vitamin A, E and selenium, which help to protect against heart disease and other such related aliments. Nowadays, continuous use of chemical fertilizer without organic manure causes problems of soil health and fruit quality. Fruit qualities are being deteriorated through the use of chemical fertilizers (Huyskens-Keil and Schreiner, 2003). Organic farming is currently gaining gradual momentum worldwide with growing awareness of health and environmental issues in agriculture and consumers demanding the production of organic fruit, thus offering an attractive source of rural income. Organic farming in India has attracted many farmers throughout the country and different fruit crops like banana, papaya, pineapple and sapota have been successfully tested. According to Neuhoff *et al*. (2011) working with oranges and Ilic *et al*. (2013) tomato, organically grown fruits are rich in various minerals such as P, K, Ca and Mg. Soil microbes were found to increase in organic systems compared to the conventional system of planting (Dutta and Kundu, 2011). However, the influence of organic, inorganic, and biofertilizer on growth characters and fruit quality of mango and soil properties are not well documented. Hence, a study was initiated to evaluate their effect on fruit quality and soil properties.

2. Materials and Methods

The study was conducted at the University Research station, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India on 11 years old tree of mango cv. Himsagar with 10×10 m spacing. The following eight treatments were imposed: Vermicompost at 5 kg/plant/year, FYM at 10 kg/plant/year, inorganic fertilizer (NPK at 1000:500:1000 g/plant/year), 50% Vermicompost +

(*) Corresponding author: pallab_bckv@rediffmail.com
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50% inorganic fertilizer, 50% FYM+50% inorganic fertilizer, Biofertilizer (Azotobacter at 150 g/plant) + PSM at 100 g/plant), Biofertilizer + 50% inorganic fertilizer, and control (no treatment). Treatments were applied separately in split doses, once at fruit set and another at harvest The experiment was laid out in a randomized block design with three replications. Mature fruits were harvested and brought to the laboratory for physico-chemical analyses following all standard procedures as described by Ranganna (2000).

Total soluble solids were determined using a hand refractometer (0-32°brix). Total soluble sugar content was analysed using Fehlings' A and B solution, according to the method described by Ranganna (2000) and expressed as percentage. In this method, for inversion of room temperature an aliquot of claried and diluted solution was transferred for a flask. 10 ml of HCl (1:1) was added and allowed to stand at room temperature for 24 hrs. The solution was then neutralized with concentrated NaOH solution and made to volume. An aliquot was taken and the total soluble sugars were determined as invert sugars using Fehling's A and B solution. Titratable acidity (% malic acid) was estimated by titrating fruit juice (5 ml) to pH 8 against 0.1 M NaoH using phenolphthalene as indicator. Total carotenoids were estimated by the method described by Ranganna (2000). Five grams of fresh sample were taken, a few crystals of anhydrous sodium sulphate were added, and then crushed in 10 ml acetone with the help of a mortar and pestle. The supernatant was decanted into a beaker. The process was repeated twice or thrice and the combined supernatant was transferred to a separating funnel out on standing. Petroleum ether (10 to 15 ml) was added in the separating funnel and rinsed, the pigment was then transferred to the petroleum ether phase by diluting the acetone with water or water containing 5% sodium sulphate. The extraction of the acetone phase with a small volume of petroleum ether was repeated, if necessary, until no more colour was extracted. The lower layer was discarded and the upper layer was collected in a 100 ml volumetric flask. The petroleum ether extract was filtered through anhydrous Na_2SO_4 and the volume was made up to 100 ml with petroleum ether. The optical density was recorded at 452 nm using petroleum ether as blank containing 3 ml acetone per 100 ml and expressed as µg 100 g^{-1} pulp. As carotenoids are light sensitive, all steps were performed under subdued light. Shelf life was determined at ambient room temperature (34±1°C). The CO_2 evolution of fruits was determined by titration of residual $Ba(OH)_2$ in the solution with standardized N/10 HCl as described by Mitra *et al*. (1971). Growth characters such as plant height, plant spread, and trunk girth were measured after fruit harvest. Soil properties were recorded as per the standard procedure given by Black (1965). Soil microbial population was counted using the method described by Collin and Lyne (1985). Statistical analysis was carried out according to the standard procedures.

3. Results and Discussion

Growth parameters

Table 1 reveals that different nutrient treatments significantly increased plant height, canopy, spread, and trunk girth. Biofertilizer + half inorganic fertilizer gave maximum (6.72 m) plant height, canopy spread (6.37×6.92 m), and trunk girth (79.32 cm), followed by Vermicompost (2.5 kg/plant/year) + half chemical fertilizer (RDF-NPK at 1000:500:1000 g/plant/year);

Table 1 - Growth characters of mango cv. Himsagar as influenced by inorganic and organic manures

Treatments	Plant height (m)	Canopy spread (m)		Trunk girth (cm)
		E-W	N-S	
1. Vermicompost (5 kg/plant)	5.99	5.49	5.12	69.72
2. FYM (10 kg/plant)	6.10	5.97	6.14	72.11
3. Inorganic fertilizer (NPK- 1000:500:1000 g/plant/yr.)	6.00	5.97	6.11	73.72
4. 50% Vermicompost + 50% Inorganic fertilizer	6.24	6.12	6.31	70.47
5. 50% FYM + 50% Inorganic fertilizer	6.11	6.00	6.09	73.15
6. Biofertilizer (*Azotobacter* @ 150g/plant + PSM @ 100 g/plant)	5.99	5.84	5.91	70.37
7. Biofertilizer + 50% Inorganic fertilizer	6.72	6.37	6.92	79.32
8. Control	5.97	5.82	5.90	71.41
SEM±	1.01	0.72	1.11	2.40
CD (P=0.05)	3.11	1.92	3.31	3.14

the lowest measurements for these three parameters were found in untreated control plants. Korwar *et al*. (2006) in Aonla and Shukla *et al*. (2009) in guava obtained similar results. These findings may be due to a better nutritional environment: application of organic matter improves soil health by improving the physico-chemical and biological activities (Schnitizer, 1991) and biofertilizer was found to enhance the rate of mineralization and availability of the nutrients, further enhancing plant growth (Sahoo and Singh, 2005).

Physico-chemical composition of fruit

Different nutrient treatments significantly improved the physico-chemical composition of fruits (Table 2). Biofertilizer + half of inorganic fertilizer produced maximum fruit weight (285.15 g), yield (57.20 kg/plant), fruit length/breath (9.14/8.19 cm), followed by biofertlizer alone. Also with regard to fruits, control trees gave minimum results. Unlike the physical characters, the bio-chemical composition of fruits was more effected by biofertilizer alone.

Biofertilizer (*Azotobacter* @ 150 g/plant + PSM @ 100 g/plant/year) gave maximum total soluble solids (19.80°brix, total sugar (16.00%) and β-carotene (6123 μg/100 g) with minimum (0.16%) acidity. Fruits treated with inorganic fertilizers showed minimum total solids (18.20°brix) and β-carotene (4792 μg/100 g) with maximum (0.31%) acidity. Results revealed that fruits grown under organic manure/biofertilizer had better fruit quality. The increase in physico-chemical parameters in fruits due to bio-fertilizer might be because of their role in nitrogen fixation, production of phytohormone-like substances and increased uptake of nitrogen as reported by Dutta and Kundu (2012). Furthermore, micro-organisms are an important component of soil environment (Arshad and Frankemberger, 1992). Thus, utilization of biofertilizer could be a better preposition for improving biological attributes of soil, which in turn may increase quality and productivity potential of various crops as reported by Allen *et al*. (2002).

Soil nutrient status and soil bacterial population

Different nutrient treatments significantly increased the soil pH and soil organic carbon (Table 3). Biofertilizer alone gave maximum (6.70) soil pH while inorganic fertilizer-treated soil the minimum

Table 2 - Fruit quality of Himsagar mango as influenced by inorganic and organic manures

Treatments	Fruit weight (g)	Yield (kg/plant)	Fruit length/breadth (cm)	TSS (°Brix)	Total Sugar (%)	Acidity (%)	β Carotene (μg/100g)
1. Vermicompost (5 kg/plant)	250.00	50.95	8.40/7.29	18.70	16.12	0.14	5720
2. FYM (10 kg/plant)	151.42	50.35	8.31/7.31	18.90	15.91	0.17	5824
3. Inorganic fertilizer (NPK- 1000:500:1000 g/plant/yr)	248.43	51.75	8.00/7.44	18.20	15.33	0.31	4792
4. 50% Vermicompost + 50% Inorganic fertilizer	265.14	53.92	9.11/8.12	19.00	15.11	0.25	5012
5. 50% FYM + 50% Inorganic fertilizer	270.00	54.98	9.00/8.15	19.10	15.23	0.26	5170
6. Biofertilizer (*Azotobacter* @ 150 g/plant + PSM @ 100 g/plant)	270.40	54.12	8.99/85.16	19.80	16.00	0.16	6123
7. Biofertilizer + 50% Inorganic fertilizer	285.15	57.20	9.14/8.19	19.60	15.92	0.18	5814
8. Control	240.40	48.00	8.10/7.60	18.00	14.94	0.19	4914
SEM±	1.15	0.70	1.01/0.72	0.51	0.07	0.01	4.31
CD (P=0.05)	3.72	2.10	3.11/1.97	1.37	0.21	0.03	12.39

Table 3 - Soil characters as influenced by inorganic and organic manures

Treatments	pH	EC (1:2.5) (dSm-1)	Bulk density (g/cc)	OC (%)	Soil microbial population (Bacteria) (cfug-1 soil)
1. Vermicompost (5 kg/plant)	6.57	0.263	1.21	0.90	1.6×10^6
2. FYM (10 kg/plant)	6.59	0.137	1.29	0.84	5.9×10^6
3. Inorganic fertilizer (NPK- 1000:500:1000 g/plant/yr.)	6.00	0.171	1.49	0.61	4.3×10^5
4. 50% Vermicompost + 50% Inorganic fertilizer	6.45	0.214	1.12	0.72	5.1×10^6
5. 50% FYM + 50% Inorganic fertilizer	6.42	0.219	1.41	0.74	5.4×10^6
6. Biofertilizer (Azotobacter @ 50 g/plant + PSM @ 100 g/plant)	6.70	0.198	1.31	0.78	8.3×10^6
7. Biofertilizer + 50% Inorganic fertilizer	6.42	0.197	1.27	0.74	6.0×10^6
8. Control	6.10	0.111	1.69	0.60	6.9×10^5
SEM±	0.13	0.70	0.03	0.02	4.72
CD (P=0.05)	0.39	2.10	0.09	0.07	14.43

(6.00). Organic carbon content of soil also varied significantly. Vermicompost or FYM-treated soil gave maximum (0.90/0.84%) content of organic carbon, followed by biofertilizer-treated soil (0.78%). Soil organic carbon was at the lowest level in untreated control. The increase in organic carbon of soil may be due to the addition of organic matter through organic manure or microbes and recycling of organic materials in the form of crop residue, which brings the soil pH nearer to neutral and increases the nutrient availability. Our results are in close conformity with earlier findings (Dutta and Kundu, 2012). The effective conductivity (EC) of soil solution depends on the presence of soluble salts. The concentrations of these salts affect the growth and absorption of water. Different treatments significantly influenced the EC of soil. Application of Vermicompost led to the highest EC (0.263 dSm^{-1}) in this study, whereas the control plot gave the lowest. This could be due to the fact that Vermicompost contains salts, mostly Cl and SO_4, but not at toxic levels (Masciandaro *et al*., 1998). Bulk density varied due to different treatments, with the untreated control giving maximum bulk density (1.69 g/cc) of soil. The soil microbial population varied with the different treatments: the maximum ($8.3x10^6$ $cfug^{-1}$ soil) was found with Biofertilizer (*Azotobacter* at 50 g/plant + PSM at 100 g/plant). Soil applied with biofertilizer showed more soil bacteria, whereas least was formed by Vermicompost (Table 3). Similar results were obtained by Dutta *et al*. (2010) in litchi.

PLW, shelf life and respiration of fruit

Physiological loss in weight (PLW) of fruit varied significantly among the different treatments (Table 4). Untreated fruit had the highest (18.95%) PLW while the lowest was found with fruit grown in biofertilizer (11.31%). Fruits grown in biofertilizer showed maximum (10 days) shelf life with minimum respiration rate (109.72 mg/hr/kg fruit) during storage. Untreated control fruit recorded maximum respiration and PLW with minimum shelf life (5 days). Improvement of shelf life due to application of biofertilizer was previously reported in mango (Dutta and Kundu, 2012).

4. Conclusions

The present study reveals that application of organic and biofertilizer are more beneficial for quality mango production and increase soil health. Therefore, this approach can be spread among growers to improve the quality in mango orchards.

References

ALLEN M.F., JASPER D.A., ZAK J.C., 2002 - *Microorganism*, pp. 257-278. - In: PERROW M.R., and A.J. DAVY (eds.) *Handbook of ecological restoration. Volume I. Principles of Restoration. Part 4. Manupulation of the biota*. Cambridge University Press, Cambridge, UK, pp. 445.

ARSHAD M., FRANKEMBERGER JR. W.T., 1992 - *Microbial production of plant growth regulators*, pp. 307-348. - In: MEETING F.B. Jr. (ed.) *Soil microbial ecology. Application in agricultural and environmental management.* Marcel Dekker, Inc. New York, USA.

BLACK C.A., 1965 - *Method of soil analysis.* - Amer. Soc. of Agron. Inc. Publisher, Madison, Wisconsin, USA, Vol. 9, Parts 1 & 2, pp. 1572.

COLLIN C.H., LYNE P.M., 1985 - *Microbiological methods*. - Butterworth Co., London, UK, pp. 450.

DUTTA P., KUNDU S., 2011 - *Effect of organic manure and biofertilizers on organic production of mango*. -

Table 4 - PLW, shelf life and respiration of fruit at the end of storage life as affected by inorganic and organic manures

Treatment	PLW (%)	Shelf life (days)	Respiration CO_2 evolution (mg/hr/kg fruit)
1. Vermicompost (5 kg/plant)	12.62	8	120.41
2. FYM (10 kg/plant)	12.44	9	118.32
3. Inorganic fertilizer (NPK- 1000:500:1000 g/plant/yr.)	17.92	6	170.41
4. 50% Vermicompost + 50 % Inorganic fertilizer	14.31	7	150.37
5. 50 % FYM + 50 % Inorganic fertilizer	14.45	2	159.37
6. Biofertilizer (Azotobacter @ 150 g/plant + PSM @ 100 g/plant)	11.31	10	109.72
7. Biofertilizer + 50% Inorganic fertilizer	13.00	8	122.14
8. Control	18.95	5	163.14
SEM±	1.10	0.61	4.11
CD (P=0.05)	3.42	1.82	12.12

Proceedings of the third scientific conference of ISOFAR, 1: 475-478.

DUTTA P., KUNDU S., 2012 - *Effect of biofertilizers on nutrient status and fruit quality of Himsagar mango grown in new alluvial zones of West Bengal*. - J. Crop Weed Sci., 8(1): 72-74.

DUTTA P., KUNDU S., BISWAS S., 2010 - *Integrated nutrient management in litchi cv. Bombai in new alluvgial zone of West Bengal*. - Indian J. Hort., 67: 181-184.

HUYSKENS-KEIL S., SCHREINER M., 2003 - *Quality of fruit and vegetable*. - J. Appl. Bot., 77: 147-151.

ILIC Z.S., KAPOULAS N., MILENKOVIC L., 2013 - *Micronutrient composition and quality characteristics of tomato (*Lycopersicon esculentum*) from conventional and organic production*. - Indian J. Agric. Sci., 83: 651-655.

KORWAR G.R., PRATIBHA G., RAVI V., PALANIKUMAR D., 2006 - *Influence of organics and inorganics on growth, yield of aonla (*Emblica officinalis*) and soil quality in semi-arid tropics*. - Indian J. Agric. Sci., 76: 457-461.

MASCIANDARO G., CECCANTI B., GARCIA C., 1998 - *Changes in soil biochemical and cracting properties induced by living much system*. - Canadian J. Soil Sci., 77: 579-589.

MITRA D., GUHA J., CHAUDHURI S.K., 1971 - *Studies in Botany.* - Vol, II, Moulik library, Kolkata, India.

NEUHOFF D., VLATSCHKOV V., RAIGON D., 2011 - *Comparison of the quality of conventionally and organically grown oranges in Spain*. - Proceedings of the third scientific conference of ISOFAR, pp. 487-490.

RANGANNA S., 2000 - *Manual of analysis of fruits and vegetables Products*. - Tata McGrow Hill Publishing Co. Ltd. 3rd Ed. New Delhi, India.

SAHOO S.K., SINGH D.B., 2005 - *Effect of different level of biofertilizers on growth, yield and quality of strawberry (*Fragania ananassa *Duch) cv. Sweet Charley.* - The Orissa J. Hort., 33: 82-85.

SCHNITIZER M., 1991 - *Soil organic matter in the next 75 years*. - Soil Sci., 151: 41-59.

SHUKLA A.K., SAROLIA D.K., BHAVANA K., KAUSHIK R.A., MAHAWER L.N., BAIRWA H.L., 2009 - *Evaluation of Substrate dynamics for integrated nutrient management under high density planting of guava cv. Sardar*. - Indian J. Hort., 66: 461-464.