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Influence of bio-fertilizer and liquid organic manures on growth, fruit quality and leaf mineral content of mango cv. Himsagar

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ABSTRACT

A field trail was conducted at Regional Research Station, Gayespur, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during two successive seasons of 2014-2015 to investigate the influence of different fertilization sources (chemical, organic and biofertilizer) on growth, yield, fruit quality of mango trees cv. Himsagar, as well as to asses leaf mineral nutrient status of respective tree and soil health condition of the orchard. Results revealed that different treatments of biofertilizer along with Panchagavya significantly increased the canopy spread, fruit weight, yield and bio-chemial qualities while minimum results recorded from trees treated with chemical fertilizers and control plant. Among the different treatments of biofertilizer, [Azotobacter chorococcum + Azospirillum brasilense + AM (Glomus musseae) + Panchagavya 3%] showed maximum fruit weight (237.12 g), yield (42.14 kg plant^{-1}) and fruit biochemical qualities like TSS (19.70° Brix) and total sugars (13.41%) along with prolonged shelf life of 10 days. The same treatment also exhibited maximum content for soil bacterial population and available N, P and K both in soil and leaf while minimum results obtained from control plants followed by chemical fertilizer. So, for getting higher yield and quality produce from mango by maintaining soil health condition, biofertilizer along with liquid organic manure (Azotobacter chorococcum + Azospirillum brasilense + AM + Panchagavya 3%) may be a good alternative for the mango-growers.

Keywords : Biofertilizers, fruit quality, leaf nutrients, mango, panchagavya and soil health

Mango (*Mangifera indica* L.) the king of fruits, native to the Indian subcontinent, belonging to family Anacardiaceae, is a premier tropical fruit of the world (Rymbai *et al*., 2015). Mangoes are grown in over 90 countries in the world and Asia accounts for 77 per cent of global mango production and the America and Africa account for 13 and 19 per cent, respectively (Yadav *et al.*, 2014). The fruit is nutritionally very rich, unique in flavour and smell thus account for approximately half of all tropical fruits produced globally (Annes *et al.*, 2011). In addition, mango is a rich source of vitamin A, E and selenium, which help to protect against heart disease and other such related ailments (Datta, 2016). Till today, chemical fertilizers are mostly in use for mango cultivation leads to the deterioration of soil characteristics and fertility and might lead to the accumulation of heavy metals in plant tissues, affecting the fruit nutritional value and edibility. The cost of inorganic fertilizers is increasing enormously to an extent that they are out of reach from small and marginal farmers. 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 (Kundu *et al.,* 2011). Panchagavya is an organic product blended from five different cow products, commonly applied to crop plants as growth promoter and immunity booster through foliar spray, soil application and seed treatment in organic farming (Vallimayil and Sekar, 2012). The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable fruit production. Therefore, it has become imperative to turn towards eco-friendly methods for sustainable fruit production. In this context, biofertilizers and liquid organic manures, which are of biological origin, offer themselves as alternative. Keeping these in view, the present investigation was undertaken with the objective to produce residue free organic mango fruit.

MATERIALS AND METHODS

The experiment was carried out at Regional Research Station, Gayespur, BCKV, West Bengal during two successive seasons of 2014-2015. Healthy mango trees cv. Himsagar of about 12 years old spaced at 10 × 10m were selected for study. The experiment was conducted in randomized block design having ten treatments replicated thrice. Ten treatments with treatment abbreviation are as follows: T_1-*Azotobacter chorococcum* + Panchagavya 3%, T_2- *Azospirillum brasilense* + Panchagavya 3%, T_3 - AM (*Glomus musseae*) + Panchagavya 3%, T_4- *Azotobacter chorococcum* + *Azospirillum brasilense* + Panchagavya 3%, T_5 –*Azotobacter chorococcum* + AM + Panchagavya 3%, T_6 – *Azospirillum brasilense* + AM + Panchagavya 3%, T_7 - *Azotobacter chorococcum* + *Azospirillum brasilense* + AM + Panchagavya 3%, T_8 - Panchagavya 3%, T_9- N:P:K (1000:500:1000 g plant^{-1} year^{-1}), T_{10} – Control.

Biofertilizers @ 250g each was incorporated to the concerned plant in the month of October by thoroughly

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mixing with 10 kg of FYM. Inorganic or chemical fertilizers were applied to the concerned plants in two splits - once after fruit harvest (August) and another at pea stage of fruit (March).Both inorganic and biofertilizer were applied in a ring 1meter away from the trunk and at a depth of 30 cm. Panchagavya @ 3 per cent were sprayed immediately after fruit set (mid. of Feb.). Panchagavya used in this experiment made following the norms stated by Vijayakumari *et al.* (2012) and biofertilizers used (packed only 40 days before application) are purchased from authentic distributor. The tree height and spread were measured at an interval of six months and averages of these parameters were presented. The total fruits harvested (in 2-3 intervals) from each tree was measured with weighing balance to obtain the fruit yield per tree and expressed in kilograms. The mature fruits were harvested and brought to the laboratory for chemical analysis following all standard methods. The Total Soluble Solid (TSS) content was estimated using digital refractometer (ATAGO, RX 5000, Tokyo, Japan) and was expressed as Brix. Total sugars were determined according to the method explained by Khan *et al.* (2009) and were expressed as %. Leaf mineral content was estimated following standard methods for nitrogen (Black, 1965), phosphorus (Jackson, 1960) and potassium (Piper, 1956). Air - dried soils sieved through 2 mm mesh were analyzed for pH (Soil: H_2O), Available N (kg ha^{-1}), P (kg ha^{-1}) and K (kg ha^{-1}) following standard norms according to standard protocols (McLean, 1982). Soil bacterial population were enumerated by serial dilution plate method (Johnson and Curl, 1972) using nutrient agar (NA) media where inoculated petri plates were incubated in a sterile culture room at 25° ± 1° C and colony forming units (CFU) were estimated by counting the number of colonies under a digital counter after two days. Number of bacteria in 1 gm of soil was calculated using the following formulae:

$$\text{No of bactoria}\left(\frac{\text{CPU}}{\text{g of soil}}\right)=\frac{\text{No. of colonies}}{\text{Volume plated (ml)}}\times \text{Dilution factor.}$$

Statistical assessment was performed by the analysis of variance (ANOVA) for randomized block design based on the guidelines given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

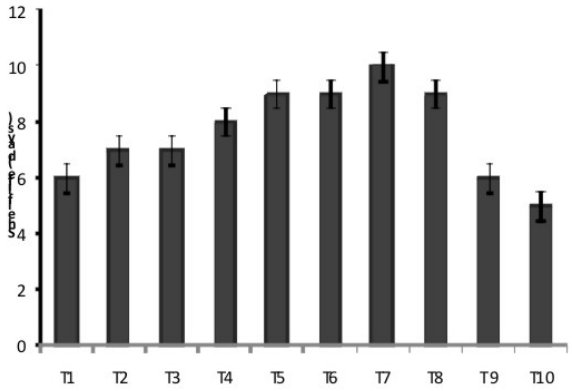
Perusal data presented in table 1 revealed that different treatments of biofertilizer along with Panchagavya @ 3 per cent significantly increased the plant height, canopy spread, fruit weight and yield of mango fruit while fruits from trees treated with chemical fertilizers and control plant recorded minimum results. Among different treatments under the study, T_7 (*Azotobacter* + *Azospirillum* + AM + Panchagavya 3%) showed maximum plant height (11.12 m), Canopy spread (11.11 m), fruit weight (237.12 g) and fruit yield (42.14 kg $plant^{-1}$) followed by T_6 and T_5. Biofertilizers are known to increase the nitrogen fixation and nutrient content of soil (Babita *et al.,* 2015), produce growth stimulants for plants, improve soil stability, provide biological control, biodegrade substances, recycle nutrients, promote mycorrhiza symbiosis (Rivera-Cruz *et al.,* 2008) that sequentially improved plant growth and yield attributing factors. Additionally, the use of bio-fertilizers can improve productivity per unit area in a relatively short time with improving soil fertility as they release more amount of N, P and K (Corpoica, 2007). Improved plant growth with Panchagavya application may be due to their role in providing macro nutrients, essential micro nutrients, many vitamins, required aminoacids, growth promoting substances and beneficial microorganisms (Sivakumar, 2014). Similar results of growth promotion with biofertilizer also reported by Dwevedi *et al.* (2012) in red flehed guava; Al-Ashkar *et al.* (2007) in banana ; and with application of panchagavya by Gore and Sreenivas (2011) in tomato. Maximum peak for important biochemical parameters like total soluble solids (19.70º Brix) and total sugar (13.41%) with prolonged shelf life (10 days) also observed in fruits that obtained from trees treated with T_7 while minimum results showed by T_{10} (control) followed by trees applied with T_9 (chemical fertilizers only) (Table 1 and Fig. 1a). Increased fruit physico-chemical parameters upon application of different treatments of biofertilizer may be due to account of their role in nitrogen fixation, production of phyto-hormone like substances and increased uptake of nutrients, particularly micronutrients which are normally not available to the tree (Babita *et al.,* 2015). Natarajan (2007) opined that liquid organic product like panchagavya proved effective in improving fruit qualities as these products are enriched with mineral nutrients, vitamins, essential amino acids, growth promoting substances like IAA, GA and some beneficial organism. These observations are also in line with the results obtained by Dutta and Kundu (2012) in Mango and Devi *et al.* (2014) in litchi. It is evident from table 2 that soil properties were increased over the control for the application of bio-fertilizer and panchagavya. Maximum results for soil properties like pH (6.91), available N (184.35 kg ha^{-1}), P (99.17 kg ha^{-1}), K (311.23 kg ha^{-1}) and soil bacterial population (3.11×10^6 cfu g^{-1} of soil) were recorded from trees treated with T_7 (*Azotobacter* + *Azospirillum* + AM + Panchagavya 3%) while minimum results obtained from treatment of chemical fertilizers (T_9) and control (T_{10}). Like soil nutrients, the same treatment (T_7) also exhibited maximum leaf N (1.97%), leaf P (0.99%) and leaf K

Table 1: **Effect of biofertilizers and panchgavya on growth, yield and fruit-chemical attributes of mango cv. Himsagar**

Treatments	Plant height	Canopy	Fruit weight	Fruit yield (Kg	TSS (°Brix)	Total sugar
T_1	10.35	10.31	211.72	37.47	18.10	11.98
T_2	10.37	10.25	212.34	38.12	18.20	11.94
T_3	10.31	10.47	200.07	37.12	18.00	11.42
T_4	10.77	10.79	220.12	39.42	18.90	12.98
T_5	10.92	10.98	231.79	40.11	19.00	13.00
T_6	10.97	10.99	232.11	40.72	19.10	13.11
T_7	11.12	11.11	237.12	42.14	19.70	13.41
T_8	10.35	10.72	231.11	40.11	18.40	11.92
T_9	10.25	10.21	219.12	38.11	17.00	11.63
T_{10}	10.11	10.10	200.00	36.4	17.20	11.11
LSD(0.05)	**0.03**	**0.01**	**1.01**	**1.97**	**1.73**	**2.11**

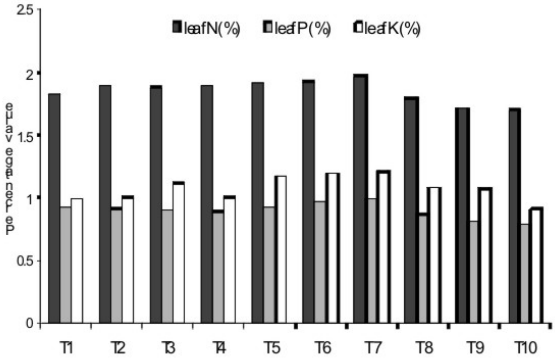
Table 2: **Effect of biofertilizers and panchgavya on soil properties of mango orchard (cv. Himsagar)**

Treatments	Soil pH	Available N	Available P	Available K	Soil bacterial population (cfu g^{-1} soil)
T_1	6.61	182.11	96.19	299.14	2.6×10^6
T_2	6.62	181.37	96.21	299.72	2.7×10^6
T_3	6.60	182.92	96.11	290.12	2.3×10^6
T_4	6.59	182.72	96.23	299.77	2.9×10^6
T_5	6.69	183.00	96.72	300.00	2.9×10^6
T_6	6.84	183.11	96.91	301.00	3.0×10^6
T_7	6.91	184.35	99.17	311.23	3.1×10^6
T_8	6.61	183.42	99.00	299.00	2.6×10^6
T_9	6.52	183.92	94.11	291.00	2.0×10^6
T_{10}	6.50	181.00	93.12	272.00	2.1×10^6
LSD(0.05)	**0.17**	**1.11**	**0.09**	**1.34**	**1410.25**



[a]

Fig. 1: Effect of biofertilizers and panchgavya on life of mango cv. Himsagar



[b]

Fig. 1: Leaf N, P and K content of mango cv. Himsagar

(1.09%) content whereas minimum results were recorded from chemical fertilizer and control plants (Fig 1b). Zahir *et al.* (2003) opined that micro-organisms are important component of soil environment and their large number is indicative for better soil health which improves more nutrient availability from source to sink. Thus, utilization of organic fertilizer could be better contrivance for improving biological attributes of soil which in turn may increase productivity and quality (Allen *et al*., 2012) of different fruit crops. Increased leaf mineral nutrient content upon application of biofertilizer and panchagavya, might be due to greater solubilisation, increased root surface to volume and permeation of hyphal-pads beyond the explore zone of root hairs. Application of bio-fertilizers substantially increased the soil microbial population which improve the soil health, thereby the growth and productivity of the crop. Similar result was obtained by Dutta and Kundu (2012) in mango and Mitra *et al.* (2012) in guava.

From the study, it is confirmed that biofertilizers and liquid organic product (Panchagavya) is an efficient and sustainable alternative to standard NPK fertilization as they revealed a positive influence on vegetative growth and yielding of fruits with desired quality in mango production. In respect of soil heath condition, the biofertilizer and panchagavya application make it more fertile in a sustainable manner for getting prolonged benefit from such treated land. So, the treatment of combined application of biofertilizer along with liquid organic manure i.e. (*Azotobacter chorococcum* + *Azospirillum brasilense* + AM + Panchagavya 3%) is recommended to the farmers of new alluvial zone of West Bengal to obtain higher mango production with quality fruit.

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