INFLUENCE OF ORGANIC MANURES AND AMENDMENTS ON GROWTH, FLOWERING, YIELD, QUALITY AND POSTHARVEST LIFE OF BANANA CV. GRAND NAINE

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KEYWORDS
Green Manures
Organic manures
Bio-fertilizers
Inorganic fertilizers
Yield
Quality and Shelf life
**ABSTRACT**

Of late growing awareness on health makes consumer more concerned for food quality and safety. In banana Total soluble solids, acidity and sugar content mostly determine the degree of acceptability of fruit. An experiment was conducted during 2010-11 with 12 different treatment combinations of Farmyard manure, Vermicompost, Neem cake, Wood ash and green manures (organic sources) along with and without microbial inoculants (Arbuscular mycorrhizae, Azospirillum, Phosphate solubilising Bacteria and Trichoderma harzianum) comparison with inorganic sources alone on quality attributes and shelf life of banana cv. Grand Naine (AAA). Results revealed that the treatment T9 (Farmyard manure @ 10kg + Neem cake @ 1.25kg + Vermicompost @ 5kg and Wood ash @ 1.75kg/plant + Triple green manuring with sunhemp + Double intercropping of Cow pea + biofertilizers viz., Vesicular Arbuscular Mycorrhizae @ 25g, Azospirillum @ 50g, Phosphate solubilizing bacteria @ 50g and Trichoderma harzianum @ 50g/plant) registered highest growth and yield characters (Pseudostem height and girth – 218 and 69.53cm, number of leaves – 14.56, leaf area index – 3.79, early crop duration - 345.75 days) bunch weight – 27.96kg, fresh and ripened finger weight – 280.25 and 259.40g, the maximum quality attributes (TSS – 23.23 %, Acidity – 0.82 %, Ascorbic acid – 12.92 mg/g), Non-reducing and Total sugars - 6.06 and 100g°, besides enhancing the shelf life of banana (14.03 days) and reduced physiological loss in weight (7.44%).

**INTRODUCTION**

Banana (Musa spp.) is the most important fruit crops of the world. It has nutritional, medicinal, industrial as well as aesthetic value in Hindu religion. Out of the large number of varieties grown in India, Grand Naine is the popular variety grown mostly in all export oriented countries of Asia, South America and Africa. It is a superior selection of Giant Cavendish which was introduced to India in 1990’s. Due to many desirable traits like excellent fruit quality, immunity to fusarium wilt etc, it has proved as a better variety (Singh and Chundawat, 2002). The quality attributes of ripe fruit are mainly influenced by the genotype, the nutritional status of the soil also plays a significant role (Roy and Chakraborty, 1993). Continuous use of inorganic fertilizers as source of nutrient in imbalanced proportion is also a problem, causing inefficiency, damage to the environment and in certain situations, harms the plants themselves and also to human being who consumes them (Sankar et al., 2006). Some studies have suggested that organic manures gave better quality and post-harvest life of fruits when comparing to inorganic sources of nutrients in banana (Patel et al., 2010). Many investigators studied the combined application of organic manures and amendments can enhance the yield, quality and post-harvest attributes of fruit crops Patel et al. (2012) in banana and Akash Sharma et al. (2013) in Guava. Organic or inorganic sources of nutrients alone may not give the expected yield, but when applied in combination to get more yield either in combination of different organic manures with biofertilizers or organic manures with inorganic fertilizers and biofertilizers (Bhalerao et al., 2009). In this experiment we tried and succeeded the maximum yield by the nutrients applied through soil application in combination of organic nutrient sources due to organic manures contain macro and micronutrients, plant growth promoting substances like auxins, gibberellins and cytokinins (Krishnamoorthy and Vairabbiah, 1986). However, information regarding the type of organic manure, optimum dose, and their interaction with biofertilizers on different characters of growth, quality attributes and shelf life of banana is sketchy. With this background the present experiment was carried out with the objective to study the effect of organic manures and amendments on growth, flowering, yield, quality attributes and post-harvest life of banana cv. Grand Naine.

**MATERIAL AND METHODS**

The present investigation was carried out at Horticultural College and Research Institute, TNAU, Coimbatore, during the year 2010-11 with banana (Musa spp.)cv. Grand Naine (AAA). The experiment was laid out in a Randomized Block Design with twelve treatments and four replications. The treatments comprised of organic manures, amendments and green manures viz., FYM @ 10kg/plant + Neem Cake @ 1.25kg/plant + Vermicompost @ 5 kg/plant and Wood ash @ 1.75 kg/plant (T1), FYM @ 10kg/plant + Neem Cake @ 1.25kg/plant + Vermicompost @ 5 kg/plant and Wood ash @ 3.75 kg/plant (T2), FYM @ 15kg/plant + Neem Cake @ 1.875kg/plant + Vermicompost @ 7.5 kg/plant and Wood ash @ 625 g/plant (T3), FYM @ 15kg/plant + Neem Cake @ 1.875kg/plant + Vermicompost @ 7.5 kg/plant and Wood ash @ 625 g/plant (T4), FYM @ 15kg/plant + Neem Cake @ 1.875kg/plant + Vermicompost @ 7.5 kg/plant and Wood ash @ 625 g/plant (T5), FYM @ 15kg/plant + Neem Cake @ 1.875kg/plant + Vermicompost @ 5 kg/plant and

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Wood ash @ 2.625 kg/plant (T3), Control - absence of organic and inorganic sources (T5), Triple green manuring with sunhemp + Cow pea + Cow pea as inter - crop (T7), Arbuscular Mycorrhizae @ 25g/plant + Azospirillum @ 50g/plant + PSB @ 50g and Trichoderma harzianum @ 50g/plant (T9), T5 + T6 (T10), T5 + T9 + T10 (T11), T5 + T6 + T9 (T12) and the absolute control treatments (inorganic) 300 : 100 : 300g NPK/plant (T1), 110 : 35 : 330g NPK /plant (T13).

The recommended spacing of 1.8m x 1.8m was adopted for planting of banana cv. Grand Naine obtained from organic field. Among the twelve treatments, ten treatments were organic treatments (Nutrients equal to the recommended dose of inorganic fertilizers) supplied through organic manures and amendments (FYM and Neem Cake were applied as basal dose, Vermicompost, Vesicular arbuscular mycorrhizae, Azospirillum, Phosphate solubilizing bacteria and Trichoderma harzianum were applied after three month of planting and Wood ash was applied after five month of planting) and rest of them were inorganic treatments with three levels of inorganic fertilizers were applied at 3rd, 5th and 7th month after planting of suckers. Drip irrigation was provided to the experimental plots depending on soil moisture availability. Recommended cultural practices (except nutrient management) and plant protection measures were carried out regularly.

Recording growth and yield parameters of banana.
Four uniform plants were selected randomly in each treatment for recording the following observations on morphological characters of banana at vegetative and reproductive stage of plants. Height of pseudostem was measured from the base of the trunk to the axis of the youngest leaf and girth was measured at 30cm height from the ground level expressed in centimeters (cm). The leaf area index was calculated using the formula suggested by Watson (1952). Number of days taken from planting to shooting and also till harvest was recorded for calculating crop duration. Yield of banana (bunch weight) was recorded including the peduncle measuring 20cm above the first hand and expressed in kilograms (kg). The following yield attributing characters were recorded from the middle finger of the second hand except number of hands per bunch. Five middle fingers in the top and bottom rows of the second hand were selected as representative fingers (Gottreich et al., 1964) to record the average weight of fingers.

Estimation of important quality traits
Fully matured representative fingers were allowed for natural and uniform ripening. These fruits were subjected for determining the quality biochemical parameters. The total soluble solids were determined by using Carl-Zeiss hand refractometer and expressed in per cent. Titrable acidity was estimated by adopting the method of A.O.A.C. (1960) by titrating against N/10 KOH using phenolphthalein indicator and expressed in terms of percentage of citric acid. Ascorbic acid content was estimated using 2,6-dichlorophenol indophenol dye and expressed as milligrams of ascorbic acid 100 g⁻¹ (Freed, 1966). Total, reducing and non-reducing sugars were estimated as per the method suggested by Somogyi (1952).

Estimation of post-harvest characteristics
Shelf life of the fruit was estimated by days taken for the fruits to lose their edible quality as evident by over softening and onset of decay was taken and expressed in number of days. Physiological loss in weight (PLW) was assessed by taken initial weight of the fruits in different treatments were recorded and the final weight was taken as and when the fruits reached the stage of yellow flecked with brown, in each treatment. Physiological loss in weight of fruits was computed at the end of full ripening stage by weight/weight basis by adopting the following formula and the value expressed in percentage.

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\text{PLW (\%)} = \frac{\text{Initial weight-Weight after storage}}{\text{Initial weight}} \times 100
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RESULT AND DISCUSSION

Effect of organic manures and amendments on growth characters of banana
Plants with more height and girth are positively related to bunch yield, besides giving better anchorage (Krishna and Shanmugavelu, 1978). Presence of carbonic acid produced during the degradation process of FYM has favored the mineralization of many needy nutrients and FYM with narrow CN ratio might enhances the productivity of more humic acid and the substances along with phosphorus in chelated form has been reported to be more soluble in water and its easy availability of nutrients are leads to increased pseudostem height (218.0cm) and girth (69.53cm) of banana cv. Grand Naine. Inoculation of biofertilizers like Azospirillum, phosphate solubilizing bacteria and VAM is a good strategy to increase the nutrient levels of NPK especially nitrogen released from biofertilizers viz., Azospirillum, AMF for promoting the growth of banana plantations by improved water and nutrient absorption. FYM, vermicompost, neem cake, green manures and biofertilizers along with optimum soil moisture retention facilitated by them might have favored the microbial population to solubilise the available nutrients in soil and uptake of by plants. Leaf production in banana is related to increased rate of plant growth (Sathyanarayana, 1985). Apart from the number of leaves, total leaf area at any stage of growth is very critical in banana as it has a close bearing on photosynthetic efficiency reflecting on biomass production. The association of VAM to host plants is usually considered to be mutualistic symbiosis because of high interdependent relationship established between them, as the host plant receives mineral nutrients via fungal mycotropism, and heterotrophic fungus gets carbon compounds from the host synthesis (Harley and Smith, 1983). It is also reported that auxins, cytokinins, gibberellins and vitamins are produced by VAM fungi in pure culture (Slankis, 1975). More number of leaves (13.79) and leaf area index (3.79) in the present investigation may also be attributed to the beneficial synthesis of these hormones and growth factors by VAM fungi through increasing cell multiplication and cell division, leading to the overall increase in vegetative parameters (Table 1).

The shortest crop duration of 345 days was observed in the treatment T3 might be due to the higher net assimilation rate on account of better growth leading to the production of endogenous metabolites earlier in optimum level enabling early flower bud initiation and there by early shooting (Table 1).
The earliness in flowering is observed in the treatment T10 (235.75 days) followed by T12 (221.75 days) which was earlier than T1 (246.25 days) followed by T9 (235.75 days). The increase in yield by the application of organic manures with biofertilizers and green manuring as recorded in the present study could also be attributed to the availability of rich source of macronutrients, micronutrients, vital plant promoting substances, N – fixer’s humus forming substances and other beneficial organisms which are known to increase the vigour and yield of plants (Venkatesh et al., 1998). The increased weight of bunch with organic nutrient application might have first improved the internal nutritive condition of plant leading to increased growth and vigour associated with photosynthesis and finally translocation of assimilates into the fruits and application of organic manures could be ascribed to high rate of microbial transformation due to better availability of organic carbon and nitrogen for heterotrophic organisms, resulting in, buffering effect, improved soil aggregation, aeration, release of organic acids etc. which might have acted as stimulant for supply of crop nutrients during the course of microbial decomposition and enabled the crop to utilize nutrient and water more efficiently (Ajeet Singh et al., 2013).

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the treatment $T_{12}$ (11.50) whereas minimum number of hands were observed in $T_5$ (8.0). The highest number of fingers were recorded in the treatment $T_{11}$ (158.63) followed by $T_{12}$ (153.45) and $T_{10}$ (144.33) higher the dose of nutrients resulted in more number of fingers per bunch due to the effect of nutrients especially N & K fed at an appropriate stages of growth of crop namely vegetative, flower initiation and differentiation phases favoring the development of more number of fingers per bunch.

The highest fruit fresh and ripened finger weight (280.25 and 259.40 g) in the treatment $(T_{10})$ which received organic amendments along with organic manures, bioferlilizers and green manures (Fig. 2). This might be due to the availability of more friable and porous soil having more nutrients obtained from organic manures, amendments and green manures applied to the plant and hence improvement in quality characters of fruit. Similar results were also documented by Anonymus (2000) in papaya, Abd El- Naby & Sanbaty (2005) and Kamel (2002) in banana.

Effect of different organic manures and amendments on yield of banana

Substitution of organic manures and amendments (biofertilizers and biocontrol agents) and green manures combination significantly enhanced the growth, flowering, yield, important quality attributes and post-harvest life of banana compared to either organic manure alone or inorganic sources alone.

CONCLUSION

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