

ECO FRIENDLY NUTRIENT MANAGEMENT PRACTICES FOR YIELD AND SOIL ORGANIC CARBON, IN BANANA

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ABSTRACT

To study the productivity of banana by the effect of nutrient management practices, field investigations was conducted from 2010-2012 at Northern Block Farm of Agricultural Research Station, Bhavanisagar (TNAU) of Tamil Nadu. Study results revealed that, when 100% recommended dose of fertilizer (RDF) is applied, along with 40% Wellgro soil, maximum number of hands (10.2 and 10.3) were recorded, along with the maximum number of fingers (136.3 and 145.2), total yield (72.8 and 77.1 t/ha) and bunch weight (23.9 and 25.3 kg/plant) during 2010-11 and 2011-12, respectively. By the integrated nutrient management practices, there was an influence of the quality parameter of the study in banana during both the years. With regard to organic carbon, when either 75 or 100 % of RDF is applied along with FYM @ 10 kg plant⁻¹ or WG organic manures, maximum accumulation of carbon was found to be recorded in soil. When nutrient management practices are done, i.e., when there was a combined application of 40% Wellgro soil or Cow based Farm Yard Manure @ 10kg plant⁻¹ with recommended dose of fertilizers to banana has been observed to be a good option that helps to increase soil nutrient status and yield parameters under climate and soil condition in Tamil Nadu, India.

KEYWORDS: Wellgro Soil, Wellgro Grains, Fertilizers, Farm Yard Manure, Yield, Quality

INTRODUCTION

Banana requires large amounts of nutrients owing to its rapid growth rate and large size for good quality and higher yield. It has been observed that when there is an increase in the application of inorganic fertilizers, there will be an increase in the yield but could not sustain the fertility status of the soil. It is necessary to opt for an integrated nutrient management (INM), including numerous sources of organic fertilizers, considering the current condition of the soil quality and environmental security. Many commercial organic fertilizers are being used in today's cultivation because of their application in less quantity and their enrichment with nutrients. One of the commercial organic fertilizers used for the research is Wellgro. Wellgro organic manure is exclusive manure with a mixture of non-timber forest produce and neem, which is a rich source of nutrients. Therefore, this research was conducted to find out the yield and quality parameters of banana by the influence of nutrient management practices that are ecofriendly. The test is conducted under irrigated conditions.

MATERIAL AND METHODS

The research was conducted at Northern Block Farm, Agricultural Research Station (Tamil Nadu Agricultural University), Bhavanisagar, Erode district of Tamil Nadu. Geographically, the farm is located at 77°08' E longitude and 11°29' N latitude at an altitude of 256 m above MSL.

The experiments were performed under irrigated conditions. The mean annual rainfall was 742.8 in 43 rainy days and 538.8 mm in 38 rainy days during the second year and first year, respectively throughout the experiment. The recorded mean maximum and minimum temperature were 33.8°C and 21.9°C in 2010-2011 and 34°C and 21.1°C in 2011-2012. The relative humidity was recorded - 87.8 (mean, maximum) and 50.2% (mean minimum) during 2010-11 and 86.2 (mean, maximum) and 56.3% (mean minimum) during 2011-12. The mean value of bright sunshine hours per day, with a mean solar radiation of 453 Cal cm² day⁻¹, was 4.67. The soil texture used for this experiment was sandy loam. The soils were neutral (pH 7.06 and 7.18), medium and low in organic carbon content (0.51 and 0.46%), with low soluble salts (EC 0.263 and 0.254 dSm⁻¹), medium in available phosphorus (14.7 and 15.3 kg/ha), low in available nitrogen (208 and 232 kg/ha), and high in potassium (611 and 649 kg/ha) for 2010-2011 and 2011-2012, respectively. In the similar way, particle density was 2.27 and 2.31g/cc, soil bulk density was 1.35 and 1.28 g/cc and porosity was 40.3 and 44.6% during 2010-11 and 2011-12, respectively.

During 2010-2011 and 2011-2012, the banana cv. Grand Naine (AAA) was used as a test crop. The experiments included 13 treatments like four treatments consisted of Wellgro soil @ 20 and 40% in combination of 100 and 75% RDF, Control (100% Recommended dose of fertilizer), four treatments including Wellgro grains @ 20 and 40% combined with 100 and 75% RDF, two treatments including 2% Wellgro liquid organic manure spray on bunches with 100 and 75% RDF, and the last two treatments consisted of Cow based Farm Yard Manure (FYM) @ 10kg plant⁻¹ to 100 and 75% RDF combinations. For the experiments, Randomized complete block design was adapted and was replicated thrice. For each treatment, the net plot size of 78 M² was selected, which accommodated 24 banana trees distributed at 1.8 M X 1.8 M. A product of Indian Tobacco Company (ITC) has produced the product, Wellgro organic manures and it was developed for foliar spray and for soil application. These were prepared from non-timber forest produce and have good quantities of phosphorus (0.41%), nitrogen (1.6%) and potash (2.10%). It also includes micronutrients like boron, zinc, copper, etc. The results recorded yield attributes like number of hands bunch⁻¹, bunch weight, total number of fingers bunch⁻¹, and yield and finger weight in both the seasons. The results also showed the records of quality parameters like acidity, Total Soluble Solids, reducing sugars, ascorbic acid, sugar, acid ratio and non-reducing sugars in the banana during both the years of study.

To calculate the quantity of *Wellgro soil* and *Wellgro grains @ 20 and 40%* w/w of chemical fertilizers, the following formula was used.

$$\text{Wellgro soil/grains (g plant}^{-1}\text{ split}^{-1}\text{)} = \frac{\text{Urea+ super phosphate+ muriate of potash (g plant}^{-1}\text{ split}^{-1}\text{)}}{100} \times 20 \text{ or } 40\%$$

The 100 (165-52.5-495) and 75% (123.7-39.4-371.3g N-P-K/plant) recommended dose of fertilizers respectively, were applied through single super phosphate (SSP), urea, and muriate of potash (MOP). During 2nd month, entire dose of FYM and phosphorus were applied after planting to schedule treatments. At two month interval, remaining potash and nitrogen were applied along with *Wellgro* organic manures at 2nd, 4th, 6th and 8th MAP. Organic manures and fertilizers were applied around the plant's base in a circular band. @ 2% liquid organic manure was sprayed twice at 15 and 30 days after the last hand opening uniformly on the developing bunches and on the foliage. Other cultural practices, irrigation, weeding, disease and pest management, and operations like denavelling, desuckering, earthing up, pruning of leaves and propping were uniformly followed for crop raising as per the Crop Production Techniques of Horticultural crops (2004).

RESULTS AND DISCUSSIONS

Yield Parameters

As per the experimental results, the yield and quality parameters were noticeably higher in the combinations of organic manure as compared to control fertilizers alone. The results recorded maximum number of hands, bunch weight, and fingers/bunch and total yield with application of 100% RDF along with either 40% Wellgro soil or FYM @ 10kg/plant (Table 1).

With the application of 100% RDF along with 40% Wellgro soil, there were results of highest bunch weight (23.9 and 25.3kg), finger weight (175.0 and 184.2 g) and maximum yield (72.8 and 77.1 t ha⁻¹), number of hands (10.2 and 10.3) and fingers (136.3 and 145.2/bunch) respectively during 2010-11 and 2011-12. Bunch weight was compared with T₉ (23.3 kg), T₁₂ (23.77 kg) and T₂ (23.0 kg) during 2010-11 and with T₁₂ (25.3 kg) and T₉ (24.9 kg), T₂ (24.5 kg) and T₈ (23.7 kg) during 2011-2012. Similarly, total yield was on par with T₁₂ (72.5 t ha⁻¹), T₉ (71.0 t ha⁻¹), T₂ (70.1 t ha⁻¹) and T₈ (69.3 t ha⁻¹) during the 1st year and T₁₂ (77.1 t ha⁻¹), T₉ (75.9 t ha⁻¹), T₂ (74.7 t ha⁻¹) and T₈ (72.1 t ha⁻¹) during 2nd year. It was observed that the increment in yield was higher as compared to control due to the INM treatments. There were records of 11.2 and 14.7% increased yield over control with the application of 100 per cent RDF along with 40 per cent *WG organic soils* (T₃) during 2010-11 and 2011-12, respectively. Compare yield increment was also observed @ 10 kg plant⁻¹ (10.8 and 14.6 %), or 40 per cent *WG organic grains* (8.9 and 13.3%) or 20 per cent *WG organic soil* (7.7 and 11.9%) or 20 per cent *WG organic grains* (6.8 and 8.8%) with the application of 100 per cent RDF during 2010-11 and 2011-12, respectively compared to control. Owing to the application of organics, higher yield was found to improve the chemical, physical and biological properties of soil. This resulted in better supply of nutrients of plants, which resulted in good yield and crop growth. The reserved food materials could have been mobilized by the humus substance present in organic product to sink through increased activity of oxidizing enzymes and hydrolyzing enzymes.

These help, the better utilization and availability of nutrients. Quick mobilization and availability of nutrients is facilitated by the positive effect of all these, which aid in increased number of leaves, increased plant height, leaf area index, leaf area and photosynthetic rate. This results in the increased banana yield, which is on par with the findings of Aba et al. (2011) and Patel et al. (2010a&b) and Aba et al. (2011). Other possibilities are humus substances would have been retained in the soil and chelated metal ions in an exchangeable form, which is available for plant growth. This has also contributed to increase in number and weight of the fingers. This is supported by Panwar et al. (2010). The increase in the yield may also be contributed to the organic manure application owing to the availability of phosphorus and micronutrients to the plants and greater movement.

Table 1: Effect of Nutrient Management Practices on Yield Parameters during 2010-11 & 2011-12

Treatments	2010-11					2011-12				
	Bunch Weight (kg)	Number of Hands/Bunch	Total no. of Fingers/Bunch	Finger Weight (g)	Yield (t/ha)	Bunch Weight (kg)	Number of Hands/Bunch	Total no. of Fingers/Bunch	Finger Weight (g)	Yield (t/ha)
T ₁ - 100% RDF (Control)	21.2	8.6	125.2	167.3	64.6	21.6	9.6	131.3	173.3	65.8
T ₂ - 100% RDF + 20% WS	23.0	9.5	132.0	172.7	70.0	24.5	10.3	139.0	182.3	74.7
T ₃ - 100% RDF + 40% WS	23.9	10.2	136.3	175.0	72.8	25.3	10.3	145.2	184.2	77.1
T ₄ - 75% RDF + 20% WS	21.0	8.6	123.3	169.3	64.0	21.6	9.5	124.1	178.0	65.7
T ₅ - 75% RDF + 40% WS	22.5	9.2	126.4	171.0	68.5	22.5	10.0	128.7	180.3	68.6
T ₆ - 100% RDF + WC spray	21.9	8.7	126.5	172.3	66.9	22.3	9.6	130.7	178.0	68.0
T ₇ - 75% RDF + WC spray	20.5	8.5	118.6	170.0	62.5	21.0	9.1	124.0	176.3	64.1
T ₈ - 100% RDF + 20% WG	22.5	9.8	130.7	173.7	69.3	23.7	10.0	136.1	181.0	72.1
T ₉ - 100% RDF + 40% WG	23.3	9.5	133.4	178.7	71.0	24.9	10.2	139.8	184.7	75.9
T ₁₀ - 75% RDF + 20% WG	21.2	8.9	122.2	172.8	64.6	21.8	10.0	127.3	179.0	66.5
T ₁₁ - 75% RDF + 40% WG	21.4	9.3	123.1	171.7	65.2	21.7	9.9	129.0	178.3	66.1
T ₁₂ - 100% RDF + FYM	23.8	10.0	135.4	174.3	72.5	25.3	10.4	141.5	186.3	77.1
T ₁₃ - 75% RDF + FYM	21.3	9.7	126.3	170.4	65.0	21.9	9.6	130.9	179.0	66.9
S.Ed	0.6	0.5	3.1	5.3	2.1	0.8	0.5	3.4	5.4	2.4
CD(P=0.05)	1.2	1.0	6.3	10.1	4.2	1.6	1.1	7.0	11.2	5.0

Increase in soil tilth, water holding capacity, physical condition of soil, permeability of soil to water and aeration was found to be in the presence of humic substances, which contributed to the high yield of banana. In addition, the organic manures make the nitrogen available to plants. Increased levels of Nitrogen contributed to the increased yield parameters and the yield. This has been supported by Bhalariao et al. (2010), Kohli et al. (1984) and Mustaffa (1988). The results also showed that the increased yield with Nitrogen is found to be with the accumulation of more of carbohydrates and other metabolites.

Soil Organic Carbon

Different integrated nutrient management practices, barring 3 and 5 MAP increased the soil organic carbon considerably during 2010-11. Higher organic carbon (0.96 and 0.97%) at shooting and harvest stages respectively was resulted when a banana was applied with 75 percent RDF + FYM @10kg plant⁻¹ (T₁₃). Statistically, it was statistically on par with T₁₂, T₉, T₁₀, T₃, T₄ and T₅ at harvest stage and T₁₂, T₉, T₃, T₁₁, T₂, T₅ and T₁₀ at the shooting stage. With the application of 100% RDF (T₁) at shooting and with 100% RDF + 2%, liquid organic manures *i.e.* T₆ (0.58%) at harvest stage, the lowest organic carbon content (0.67%) was recorded. Combined application of 100 % RDF + 40 % WG organic soil (T₃) recorded the maximum organic carbon content in soil (0.75%) during 2011-12, at 5 MAP and it was analogous with T₁₃, T₁₂, T₉, T₂, T₁₁, T₅ and T₄. Application of 100 % RDF along with 40 % WG organic grains (T₉) at the shooting stage, registered the highest carbon content (0.85%). This is statistically on par with all other treatments except T₇, T₆ and T₁. The organic carbon content was increased (0.95%) at the harvest stage with application of 75 % RDF along with FYM @ 10kg plant⁻¹ (T₁₃) compared to control (0.50%) and this was statistically on par with T₁₂, T₉, T₃ and T₁₁.

For micro-organisms, organic carbon is the source of food. This helps to increase the stability of the soil by binding soil particles together into aggregates or 'peds'. Better soil structure is also obtained with the help of root exudates,

bacterial excretions, plant roots and fungal hyphae. When the soil organic matter is decomposed, there was a release of nitrogen, phosphorus and other nutrients that helped plant growth. As per Pluske *et al.* (2011), the organic carbon influences the characteristics of the soil like nutrient holding capacity, color, cation and anion exchange capacity, nutrient turnover and stability, which results in influencing aeration, water relations and workability. Maximum organic carbon accumulation in soil (Figure 1 & 2) was recorded with the application of either 75 or 100 per cent RDF along with FYM @ 10 kg plant⁻¹ or WG organic manures. It is because of the increased soil organic matter, decreased soil bulk density, water infiltration into soil and total porosity as observed with the results of Obi and Ebo (1995). The organic carbon content of the soil was enhanced with the application of FYM along with neem cake (Kumar *et al.*, 2007 and Ramesh *et al.*, 2009). With the application of organic manure along with NPK fertilizers increases the organic carbon content of soil. This is due to the better growth of crops with association of higher roots biomass generation and increased return of leftover surface plant residues. The organic carbon status could be increased in banana grown soil with the production of more roots and their subsequent decomposition (Narwal and Antil, 2005).

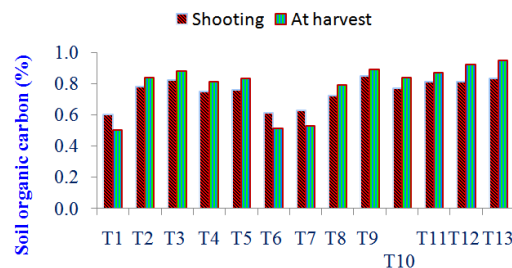


Figure 1: Effect of Integrated Nutrient Management on Soil Organic Carbon (%) at Different Stages During 2010-11

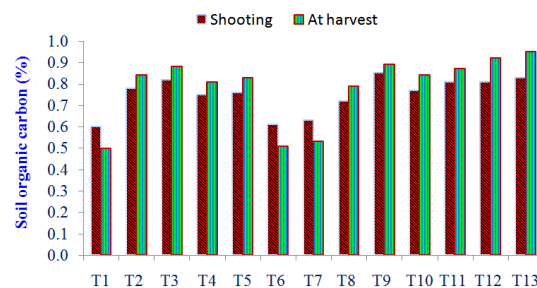


Figure 2: Effect of Integrated Nutrient Management on Soil Organic Carbon (%) at Different Stages During 2011-12

CONCLUSIONS

From the experiments conducted in two years, it is found that the banana favorably responded to WG organic manure and FYM in combination with 100% recommended dose of chemical fertilizers.

Therefore, the integrated nutrient management practice with 100% recommended dose of fertilizer combined with 40 % WG organic soil in banana crop has been found to be the best option for crop productivity and to sustain soil fertility. It is also competitive economically and productive under climatic and soil conditions of the Western zone of Tamil Nadu.

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