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Effect of Organic Nutrient Schedule on Soil Nutrient Status Cultivated with Banana cv Jahaji (AAA)

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Abstract An experiment was carried out during 2012-2013, to study the effect of organic manures, biofertilizers and their combination on soil nutrient status cultivated with banana cv Jahaji. The experiment was laid out in randomized block design (RBD) with four replications. The treatments combinations were T_1- FYM 10 kg + Neem cake 1.25 kg +Vermicompost 5 kg + Wood ash 1.75 kg/pl, T_2- FYM 10 kg + Neem cake 1.25 kg + Vermicompost 5 kg + Wood ash 3.75 kg/pl, T_3- FYM 15 kg + Neem cake 1.875 kg + Vermicompost 7.5 kg + Wood ash 0.625 kg/pl, T_4- FYM 15 kg + Neem cake 1.875 kg + Vermicompost 7.5 kg + Wood ash 2.625 kg/pl, T_5- Control, T_6- Triple green manuring with dhaincha + Cowpea + Cowpea as intercrop, T_7- AM (25 g) + *Azospirillum* (50 g) + PSB (50 g) + *T. harzianum* (50 g)/pl, T_8- T_1 + T_6, T_9- T_1 + T_7, T_{10}- T_1 + T_6 + T_7, T_{11}- 300 g N + 100 g P + 300 g K per plant as inorganic. The study revealed that soil analysis after harvest of the crop showed a significant variation among treatments in respect of organic carbon content and available N, P_2O_5 and K_2O in the soil. The highest organic carbon (0.64%), N (219.57 kg/ha), P_2O_5 (46.20 kg/ha) and K_2O (93.39 kg/ha) were recorded in T_{10} while the lowest were recorded in T_5.

Keywords Soil nutrient status, Organic manures, Banana, Biofertilizers.

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Introduction

Banana is the second most important fruit crop next to mango in India and accounts for 32.6% of the total fruit production. Banana is a heavy feeder crop and requires high quantity of nitrogen, phosphorus and potassium [1] to maintain high yields. These nutrients must be replenished every year in the soil to fulfil the plant demand for nutritional attributes, which mostly comes from inorganic chemical sources. The increased use of chemical fertilizers increased the quantity of the food produced but decreased the nutritional quality and soil fertility over the years. It is also associated with increased health hazards to human as well as causing severe environmental problems such as water and air pollution. The continuous use of chemical fertilizers badly affects the texture and structure, reduces organic matter content and decreases microbial activity in soil [2]. On the other hand, use of organic fertilizer helps in improving the

soil physical, chemical and biological properties which are suitable to plant growth in the long run as well as to improve the nutritional quality of fruits. Keeping this in view, a field experiment was conducted to study the effect of organic manures and biofertilizers on nutrient status of soil after harvest of the crop.

Materials and Methods

The present investigation was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2012–1013. The banana cultivar selected for the experimentation was 'Jahaji' (AAA) and were planted in the pits of 45 cm^3 dimension dug at a spacing of 1.5 m × 1.5 m. The experiment was laid out in randomized block design (RBD) with four replications comprising 11 treatments. The treatments combinations were- T_1- FYM 10 kg + Neem cake 1.25 kg + Vermicompost 5 kg + Wood ash 1.75 kg/pl, T_2- FYM 10 kg + Neem cake 1.25 kg + Vermicompost 5 kg + Wood ash 3.75 kg/pl, T_3- FYM 15 kg + Neem cake 1.875 kg + Vermicompost 7.5 kg + Wood ash 0.625 kg/pl, T_4- FYM 15 kg + Neem cake 1.875 kg + Vermicompost 7.5 kg + Wood ash 2.625 kg/pl, T_5- Control, T_6- Triple green manuring with dhaincha + Cowpea + Cowpea as intercrop, T_7- AM (25 g) + *Azospirillum* (50 g) + PSB (50 g) + *T. harzianum* (50 g)/pl, T_8- T_1 + T_6, T_9- T_1 + T_7, T_{10}- T_1 + T_6 + T_7, T_{11}- 300 g N + 100 g P + 300 g K per plant as inorganic. The FYM and neem cake were applied thoroughly as basal and vermicompost and wood ash were applied after 3rd and 5th months of planting respectively. The seeds of green manure crop dhaincha (*Sesbania aculeata*) @ 50 kg/ha (135 g per plot) was grown immediately after planting of suckers for three times and respectively incorporated into the soil at 45, 10 and 30 days after sowing. After that cowpea was grown as intercrop for two times and incorporated into the soil respectively at 10 and 30 days after sowing. Bio-fertilizers and bio-control agents were applied thoroughly and mixed uniformly with the soil at the time of planting following the treatment schedule. The nitrogenous, phosphatic and potassium fertilizers @ 300 g N, 100 g P and 300 g K per plant as urea, single super phosphate (SSP) and muriate of potash (MOP) respectively were applied in 2 split doses. The whole phosphatic fertilizers along with half nitrogenous and potassic fertilizer were applied at third month of planting and remaining half of nitrogenous and potassic fertilizer were applied at fifth month of planting.

Composite soil samples from the top soil up to a depth of 0—45 cm from random spots were collected and analyzed for organic carbon, available N, P_2O_5 and K_2O before imposing treatments and in each treatment after the harvest of crop. Organic carbon content of the soil sample was estimated by the wet digestion method as described by Walkley and Black [3] and expressed as percentage. Available nitrogen of the soil sample was eatimated by modified Kjeldahl's method and available phosphorus by Bray's method as described by Jackson [4] and the amount present in the sample was expressed as kg ha^{-1}. Available potassium of the soil sample was extracted with neutral ammonium acetate as outlined by Jackson [4]. The potassium content was determined with the help of flame photometer and expressed as available K_2O (kg ha^{-1}). The data were analyzed statistically as described by Panse and Sukhatme [5] and the significance of mean differences amongst treatments was tested with DMRT.

Results and Discussion

The soil of the experimental site is sandy loam in texture belonged to the order inceptisol and derived from the alluvial deposits of the river Brahmaputra. The experimental soil contained 0.52% organic carbon, 216.50 kg/ha of available N, 41.35 kg/ha available P_2O_5 and 86.09 kg/ha of K_2O before imposing treatments. However, after harvest of the crop it was observed that there was significant increase in the content of soil organic carbon, available nitrogen, phosphorus and potassium in some treatments and also the treatments shows a significant difference among them (Table 1). Comparison of data revealed that, soils under the treatment T_{10} (0.64%) exhibited highest organic carbon content which was closely followed by T_9 (0.60%), T_8 (0.59%) and T_2 (0.58%). The highest soil nitrogen was recorded in treatment T_{10} (219.57 kg/ha) while the same treatment also recorded highest soil available phosphorus content (46.20 kg/ha) followed by T_9 (45.80 kg/ha) and T_8 (45.67 kg/ha). The highest soil available potassium content was noticed under T_{10} (93.39 kg/ha) followed by T_9 (92.11 kg/ha),

Table 1. Effect of organic nutrient schedule on soil parameters of banana cv 'Jahaji' (AAA).

Treatments	Organic carbon (%)	Nitrogen (kg)	Phosphorus (kg)	Potassium (kg)
T_1	0.57^{cde}	218.20^{ab}	43.60^{d}	88.73^{d}
T_2	0.58^{bcd}	218.72^{a}	44.93^{c}	90.76^{c}
T_3	0.55^{ef}	215.56^{abc}	41.33^{g}	87.40^{e}
T_4	0.56^{def}	216.17^{abc}	42.60^{f}	91.28^{bc}
T_5	0.48^{g}	213.14^{c}	39.23^{j}	82.10^{h}
T_6	0.55^{ef}	215.20^{abc}	40.67^{h}	86.93^{ef}
T_7	0.54^{f}	217.46^{abc}	43.13^{e}	86.31^{f}
T_8	0.59^{bc}	218.85^{a}	45.67^{b}	91.44^{bc}
T_9	0.60^{b}	218.97^{a}	45.80^{b}	92.11^{b}
T_{10}	0.64^{a}	219.57^{a}	46.20^{a}	93.39^{a}
T_{11}	0.50^{g}	214.14^{bc}	40.21^{i}	84.15^{g}
CD at 5%	0.02	3.87	0.23	1.03

T_8 (91.44 kg/ha) and T_4 (91.28 kg/ha) which were statistically at par with each other and in all cases the lowest was recorded in treatment T_5.

It was apparent from the data presented in Table 1 that the incorporation of various organic sources caused a significant increase in organic carbon content of the post harvest soil. This could be attributed to the fact that presence of organic sources led to stabilized C: N ratio increasing the organic carbon content of the soil [6]. An increase in organic carbon in the treatments receiving *Azospirillum* was perhaps due to microbial metabolism and constitution of microbial cell added after death of the organism [7]. The highest organic carbon content (0.64%) was recorded under treatment having combination of $T_1+T_6+T_7$ (T_{10}) followed by T_1+T_7 (T_9). The increase in soil organic carbon content with the addition of organic manures might be attributed to higher carbon content in the organic manure. This could also be due to addition of higher rate of organic matter to the soil which ultimately increases the soil organic carbon content. This result is consistent with the findings of Wu et al. [8], who found an increase in the final soil organic carbon content after application of organic matter. The application of organics increased the soil organic carbon content after harvest of the banana crop cvs Rasthali and Karpuravalli were also observed by Mustaffa et al. [9].

From the findings, it was revealed that different organic and biological supplements except control (T_5) and inorganic fertilizer sources (T_{11}) significantly increased the available nitrogen content of post-harvest soil. The highest available nitrogen content was recorded under the treatment T_{10}. Such a build up to available soil nitrogen could be attributed to the ability of *Azospirillum* to fix atmospheric nitrogen in the rhizosphere throughout the cropping period. Similar results had been reported by Tiwary et al. [10] in banana due to application of biofertilizer. It may also be due to higher *Azospirillum* population, which apart from N fixation also function N mineralization and nitrification process [10]. This might be also due to organic acids and other microbial products of decomposition from organic sources solubilise the insoluble compounds by interacting with their specific binding cations and clay mineral. However, application of different organic sources along with inorganic fertilizer increases the available N in soil after harvest of the crop. This is in the agreement with finding of Gogoi et al. [11] and Bhalerao et al. [12].

The available phosphorus status was increased in the treatment having combinations of biofertilizers and organic manures as compared to the treatments receiving inorganic fertilizers and sole organic manures (Table 1). The highest available soil phosphorus in the treatment T_{10} might be due to production of organic acids by phosphate solubilizing bacteria or may be due to released of organic acids during the decomposition of organic manures. These acids act as a chelating agent and form stable complexes with Fe and Al abundantly available in the acid soils and thereby release phosphorus from clutches of Fe and Al to the soil solution. This might also be due to higher amount of nitrogen fixed by *Azospirillum* as the increase of nitrogen increases the soil phosphorus. The positive influence of *Azospirillum* on the available phosphorus, as observed in the present study, was earlier reported by Tiwary et al. [10] in banana. It was also reported that vermicompost as a bioinoculant increased nitrogen and phosphorus availability by enhancing biological nitrogen fixation and phosphorus solubilization [13]. The significant decrease in available soil phosphorus in the treatment T_5 might be due to lower rate of fixation of phosphorus during initial stage and also due to non availability of actively solubilizing microbes.

A significant increase in available K_2O content of soil was noticed under different treatment combinations as compared to inorganic fertilizers and control. Higher K_2O content of soil receiving both organic and biofertilizers might be due to mineralization of insoluble compounds through the action of organic acids released during the decomposition of organic manures or produced by biofertilizers. This may also be due to release of potassium from these organic amendments and also due to solubilization of mineral based potassium or native potassium by these organic components. The positive influence of organic manure on the available soil potassium was earlier reported by Karwar et al. [14].

The result of present investigation revealed that application of organic manures, biofertilizers and their combination significantly increased the soil organic carbon and available N, P_2O_5 and K_2O in soil after harvest of crop over control and inorganic fertilizer treatments. The treatment T_{10} would be the most effective practices in banana plantation under the prevailing condition of Jorhat.

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