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Effect of Organic Nutrient Management on Soil Chemical Properties, Microbial Population and Nutrient Uptake by Plants

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ABSTRACT

A field experiment was conducted at University of Agricultural Sciences, Bangalore, during *kharif,* 2016 to study the effect of organic sources of nutrients on soil chemical properties, microbial population and nutrient uptake by plants. The experiment was laid out in a RCBD with seven treatments replicated thrice. A significant increase in the available NPK status of soil after harvest as compared to initial status was observed. The available nitrogen, phosphorous and potassium were significantly higher with FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray at 30 DAS (381.93, 37.67 and 275.73 kg ha^{-1}, respectively) as compared to other treatments. The same treatment also recorded significantly higher population of bacteria, fungi and actinomycetes (85.37, 13.57 and 14.07 × 10^3 CFU g^{-1} soil, respectively). The nutrient uptake was also higher in the same treatment.

Keywords : Organic, Baby corn, EBDLM, Panchagavya, Vermiwash

MAIZE is the third most important cereal crop globally. A recent trend is growing maize for vegetable purpose, commonly known as 'baby corn'. It is a small young cob or ear or the female inflorescence before pollination or fertilization. The important attributes relevant to baby corn are early maturity, synchronized ear emergence and small palatable yellow kernels. Organic farming is gaining popularity as organic food is being perceived as healthier and of late there is an uptick in demand for organically grown foods. It is also a key to improve the soil health (both physical and biological) and sustainable maintenance of environment.

The greatest challenge facing by the nation in the coming years is to provide safe food for the growing population. In this regard, organic farming is a holistic production management system for promoting and enhancing health of agro-ecosystem. It avoids largely use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives and relies on green manures, crop rotations, crop residues, animals manure, biofertilizers, bio/botanical pesticides, different kinds of cow based liquid organic manure (Ali *et al.*, 2011).

MATERIAL AND METHODS

The field experiment was conducted to study the 'effect of organic nutrient management on soil chemical properties, microbial population and nutrient uptake by plants' during *kharif* 2016 at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi KrishiVigyana Kendra, Bengaluru, Karnataka.

Treatments

T_1: Vermicompost at 75 kg N eq. ha^{-1} + EBDLM at 75 kg N eq. ha^{-1}

T_2: FYM at 75 kg N eq. ha^{-1} + Vermicompost at 75 kg N eq. ha^{-1}

T_3: FYM at 50 kg N eq. ha^{-1} + Vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1}

T_4: Vermicompost at 75 kg N eq. ha^{-1} + EBDLM at 75 kg N eq. ha^{-1} + Panchagavya (3 %) at 15 and 45 DAS + Vermiwash (3 %) at 30 DAS

T_5: FYM at 75 kg N eq. ha^{-1} + Vermicompost at 75 kg N eq. ha^{-1} + Panchagavya (3 %) at 15 and 45 DAS + Vermiwash (3 %) at 30 DAS

T_6: FYM at 50 kg N eq. ha^{-1} + Vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + Panchagavya (3 %) at 15 and 45 DAS + Vermiwash (3 %) at 30 DAS

T_7: FYM at 10t ha^{-1} + 150:75:40 kg NPK ha^{-1}

Note: FYM : Farmyard Manure, EBDLM : Enriched Bio-digested Liquid Manure, DAS: Days After Sowing, eq: Equivalent

The experiment was laid out in a randomized complete block design (RCBD) with seven treatments replicated thrice.

The soil of the experimental site was sandy clay loam. Before start of the experiment, composite soil samples were collected from 0 to 15 cm depth and were analyzed for mechanical and chemical properties. The soil is moderately acidic in nature, low in organic carbon and medium in available nitrogen, phosphorus and potassium. The results of soil analysis and the methods followed for their estimation are presented in Table 1.

Analysis of Microbial Population in Soil

Soil samples were collected from the rhizosphere of the plants from each treatment at harvest. They were placed in a polyethylene bag and stored at 5 ^{0}C in refrigerator and then analyzed.

Enumeration of Soil Microbial Population

Microbial population were enumerated from the soil samples collected at 0-15 cm depth. The samples were mixed thoroughly and were subjected to serial dilution using 1 g of soil in 100 ml of sterile water. The enumeration of micro-organisms was done after culturing these organisms using different media by standard dilution plate technique. The media used were soil extract agar for bacteria, Martins Rose Bengal Agar with streptomycin sulphate for fungi and Kusters agar for actinomycetes. The number of colonies appeared on agar medium in plate were counted and multiplied by the representative dilution factor for each group of micro-organisms and expressed as number of colonies per gram of oven dry soil.

Plant Analysis

Plant samples collected for dry matter estimation at harvest from the respective treatments were oven dried and grinded into fine powder in and used for estimating nitrogen, phosphorus and potassium (Table 2).

Results and Discussion

Soil Chemical Properties

Organic carbon of the soil after the harvest of baby corn did not differ significantly among organic sources of nutrients and with recommended dose of fertilizers (150:75:40 kg NPK ha^{-1}) + FYM at 10 t ha^{-1}. However, the organic carbon ranged from 0.46 to 0.54 per cent. Application of organic sources of nutrients did not significantly influence the pH of the soil. It ranged from 5.64 in T_7 (150:75:40 N:P_2O_5:K_2O per ha^{-1}+10 t FYM ha^{-1}) to 6.11 in T_6 (FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS. The electrical conductivity of soil ranged from 0.176 to 0.215 d Sm^{-1} (Table 3).

Table 1

Chemical properties of soil of the experimental site at ZARS, UAS, GKVK, Bengaluru

Particulars	Methods followed	Values
pH	Glass electrode pH meter (Piper, 1966)	5.95
EC (dSm^{-1})	Conductometry (Jackson, 1967)	0.14
Organic carbon (%)	Walkey and Black wet oxidation method (Subbiah and Asija, 1956)	0.49
Available N (kg ha^{-1})	Alkaline permanganate method (Subbiah and Asija, 1956)	298.5
Available P_2O_5 (kg ha^{-1})	Olsen's method (Jackson, 1967)	27.9
Available K_2O (kg ha^{-1})	Neutral normal ammonium acetate method (Jackson, 1967)	180.8

TABLE 2

Analytical methods employed for plant analysis

Particulars	Methodology
Nitrogen	Micro Kjeldahl's method (Humphries 1956)
Phosphorus	Tri acid digestion and Vanado - molybdate yellow colour method (Jackson, 1967)
Potassium	Tri acid digestion and flame photometric method (Jackson, 1967)

A significant increase in the available NPK status of soil after harvest as compared to initial status was observed. The available nitrogen, phosphorous and potassium were significantly higher with FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS (381.93, 37.67 and 275.73 kg ha^{-1}, respectively) as compared to other treatments.

The soil nutrient status after the harvest of baby corn under different treatments is dependent on the sources of nutrient supply and the crop uptake, besides the losses or transformation into unavailable forms. Addition of organic manures tended to increase the available nitrogen, available phosphorus and potassium status in the soil, as compared to initial soil status. Soil available nutrients increased significantly upon application of different sources of organic manures, indicating their build up in the treated soil. The treatment which comprised of FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS recorded higher available N, P_2O_5 and K_2O (381.93, 37.67 and 275.73 kg ha^{-1}, respectively). The results were in conformity with Manjunatha (2010) in maize crop, Choudharya and Suresh Kumar (2013) in baby corn and Kanu Murmu *et al*. (2013) in case of sweet corn.

The increase in available nutrients may be due to the effect of enrichment of bio-digested liquid manure with neem cake that was more pronounced in increasing the post harvest soil available nutrients. Inhibition of nitrification process by neem cake which slows down the release of nitrogen from organic manures might have reduced the loss of nitrogen from soil since organic carbon in the soil was higher than that from inorganic fertilizer application. Increased solubility of native phosphorus by means of organic acids produced during the course of decomposition of organic sources of nutrients may have lead to increase the available soil phosphorus. The increase in available potassium might be related to release of K from EBDLM and also due to the solubilization of mineral bound K or

TABLE 3

Chemical properties of soil after harvest of baby corn as influenced by the organic nutrient management

Treatments	OC (%)	pH	EC (dSm^{-1})	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T_1	0.51	5.67	0.18	322.13	31.10	241.83
T_2	0.52	5.77	0.19	352.87	32.37	251.13
T_3	0.53	5.83	0.20	360.17	34.10	260.00
T_4	0.53	5.91	0.20	367.47	34.10	267.17
T_5	0.52	5.96	0.21	373.83	36.17	268.87
T_6	0.54	6.11	0.21	381.93	37.67	275.73
T_7	0.46	5.64	0.17	285.43	28.40	186.23
Initial	0.49	5.95	0.14	298.5	27.9	180.8
S.Em.±	0.01	0.01	0.001	10.65	1.13	7.41
C.D. ($p = 0.05$)	NS	NS	NS	32.83	3.47	22.85

OC – Organic carbon, EC – Electrical conductivity

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native K. Further, it may also due to prevention of leaching losses owing to retention of more K by organic colloids as they possess higher cation exchange capacity (CEC) than mineral colloids (Reddy *et al.,* 2011).

Soil Microbial Population

The data (Table 4) indicates significantly higher population of bacteria,fungal colonies and actinomycetes (86.13, 13.57 and 14.07 × 10^3 CFU g^{-1} of soil, respectively) with FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS as compared to other treatments. It was highly beneficial in improving bacteria, fungi and actinomycetes. Similarly, Pradeep Gopakkali *et al*. (2011) also found increase in soil microflora with the application of FYM and cattle urine in rice. Enriched bio-digested liquid manure might have improved the activity of beneficial micro-organisms due to increase in the fast decomposing organic matter fraction as a consequence there was higher availability of NPK in soil. While, the lower microbial activity with inorganic fertilizer use was attributed to the lower availability of organic matter and unfavourable conditions in the soil.

TABLE 4

Bacteria, fungi and actinomycetes population after harvest of baby corn as influenced by the organic nutrient management

Treatments	Bacteria (10^3 CFU g^{-1} soil)	Fungi (10^3 g^{-1} soil)	Actinomycetes (10^3 g^{-1} soil)
T_1	70.40	5.27	9.83
T_2	71.10	6.93	10.77
T_3	74.07	8.23	10.73
T_4	77.10	10.70	11.53
T_5	86.13	12.97	13.63
T_6	85.37	13.57	14.07
T_7	64.60	3.70	7.77
S.Em.±	3.17	0.44	0.64
C.D. (p = 0.05)	9.77	1.37	1.98

CFU – colony forming units

Influence of Organic Nutrient Management on Nutrient uptake by Baby Corn

Total nitrogen uptake (dehusked baby corn + stover), total phosphorous and total potassiumuptake (Table 5) was significantly higher with recommended dose of fertilizers (150:75:40 kg N: P_2O_5: K ha^{-1}) + 10 t FYM ha^{-1} (190.85 kg N ha-^{1}, 34.60 kg P ha^{-1} and 232.35 kg K ha^{-1} respectively) and was on par with the application of FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS(183.17 kg N ha^{-1}, 32.85 kg P ha^{-1} and 223.39 kg K ha^{-1}, respectively).

TABLE 5

Total nitrogen uptake (baby corn and stover) as influenced by the organic nutrient management

Treatments	Uptake of nitrogen		
	Total N uptake (kg N ha-1)	Total P uptake (kg P ha-1)	Total K uptake (kg K ha-1)
T1	133.90	15.57	161.48
T2	143.52	17.75	175.14
T3	152.93	21.53	187.82
T4	165.25	25.46	204.26
T5	176.61	28.52	215.53
T6	183.17	32.85	223.39
T7	190.85	34.60	232.35
S.Em.±	5.78	1.21	9.23
C.D. (p = 0.05)	17.82	3.73	28.44

Significant increase in total N, P and K uptake was due to increased baby corn and stover yield (Thavaprakash *et al.,* 2007 and Hossain *et al*., 2012). As a result of enhanced nutrient availability and increased microbial activity which is in turn responsible for quick release of nutrients resulting in more uptake of nutrients.

Foliar application of panchagavya and vermiwash was found to colonize ammonia and nitrite oxidizers in the leaves and increased the uptake of total N and the indole acetic acid (IAA) and gibberelic acid (GA) present in panchagavya could have created stimuli in

the plant system and increased the production of growth regulator in cell system and the action of growth regulators in plant system stimulated the necessary growth and development. These results are in agreement with the findings of Somasundaram *et al.* (2007) and Lourduraj (2005). Indole acetic acid stimulated the growth of adventitious roots and activated the functioning of root tips which may be the possible reason for higher uptake of nutrients available in the soil. These results are in agreement with the findings of Beaulah (2002) in drumstick. Higher phosphorus uptake could be attributed to higher concentration of phosphorus in vermicompost and conversion of fixed phosphorus into readily available form by the organic acids released during the decomposition of compost and EBDLM and consequent improvement in the available P in the soil. These results are in accordance with the findings of Praveen Kumar (2010). Highest potassium uptake due to application of EBDLM along with panchagavya and vermiwash sprays was attributed to the increase in the concentration of potassium.

It can be concluded that the use of organic nutrient sources may have a positive influence on the productivity and soil health. Application of FYM at 50 kg N eq. ha^{-1} + vermicompost at 50 kg N eq. ha^{-1} + EBDLM at 50 kg N eq. ha^{-1} + panchagavya spray (3 %) at 15 and 45 DAS + vermiwash spray (3 %) at 30 DAS can result in higher as well as sustainable productivity of crops without deteriorating the soil.

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