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Research Article

INM method for Sweet Corn Hybrid on Soil Biology

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ABSTRACT

An experiment was conducted during rabi 2014-2015 on clay loam soil at irrigated upland farms of Eastern block, Tamil Nadu Agricultural University, Coimbatore to study the effect of integrated nitrogen management of sweet corn hybrid on certain soil biological properties. The experiment was replicated thrice, with 12 treatments comprising integration of organic manures viz., FYM, vermicompost, poultry manure, goat manure and biogas slurry at 2 levels (25 and 50 percent) with inorganic N at 75 and 50 per cent. The remaining two treatments were 100 per cent N as inorganic fertilizer and 100 per cent N as inorganic fertilizers with 12.5 t ha^{-1} of FYM. The microbial population and Urease, Dehydrogenase and Phosphatase activity in the soil at different growth stages of sweet corn hybrid by adopting standard procedure. The soil micro flora and enzymatic activity were found greater due to application of 50 per cent N as biogas slurry with 50 per cent N as inorganic. However, it was comparable with 50 per cent N as vermicompost + 50 per cent N as inorganic and 50 per cent N as FYM + 50 per cent N as inorganic. The 100 per cent N applied plot as inorganic registered lesser microbial load and soil enzymatic activity.

Keywords: *Soil microbial population, Urease, Dehydrogenase and Phosphatase activity.*

INTRODUCTION

Sweet corn (*Zea mays* L. sub sp. *saccharata*) is consumed as human food in soft dough stage with succulent, sweet, creamy, tender, and crispy kernels, which tastes almost shell-less. The higher content of water soluble polysaccharide in the kernel adds texture and quality to sweetness (Venkatesh et al., 2003). Its demand in amusement parks, theatres, circus and exhibition is increasing with increasing urban population not only in India (Sahoo & Mahapatra, 2007) but in international markets (Kumar, 2008).

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This created an increasing tendency for commercial production. Unlike maize, sweet corn is also an energy rich crop, so its productivity largely depends upon nutrient management practices. Non availability of chemical fertilizers in time and their higher cost are the reasons for creates an imbalance in the soil. To sustain the soil health and provide adequate plant nutrition, it is about the plant nutrient sources other than the chemical fertilizers and their application in integration (Singh et al., 2009). Use of organic manures along with inorganic fertilizers not only reduces the demand of inorganic fertilizers, but also, increases the efficiency of applied nutrients due to favourable effect on physical, chemical and biological properties of soil (Prasad et al., 1992). The effectiveness of integrated nutrient management practice can depend on season, soil type, climate, water management, variety and cropping pattern.

Microbes and enzymes in soil are biologically significant as they are involved in the transformation, cycling of mineral nutrients and influence nutrient availability to plants. The addition of soil enzymes is influenced by the nature, age of crop and addition of manures and fertilizers. The enzyme activity is considered as the index of microbial and physic-chemical conditions of soil in relation to nutrient availability (Aon & Colaneri, 2001). Available NPK and organic carbon content have a positive relationship with all the enzymes and soil microbes. Organic source of NPK fertilization enhanced the activities of the soil enzymes and the effect was more pronounced with organic manures when combined with inorganic chemical fertilizers (Singaram & Kamalakumari, 1996 & Reddy, 2002).

Soil microorganisms and soil enzyme activities, is enhanced by their eco-environment, can sense minute changes. Soil urease showed a close relation with urea hydrolysis and increases the utilization rate of nitrogen. The enzyme dehydrogenase on the other hand is involved in simplification of carbohydrates, proteins and lipids. This study is planned to investigate the effect of integrated nitrogen management on soil microbial load and soil enzymes *viz*., Urease, Dehydrogenase and Phosphatase activity at different stages of sweet corn hybrid.

MATERIALS AND METHODS

The field experiment was carried out during ***rabi*** 2014-15 at irrigated upland farm of Eastern block, Tamil Nadu Agriculture University, Coimbatore which is situated at11^{o} N latitude and 77^{o} E longitude with an altitude of 426.74 meters above mean sea level. The soil of the experimental field was clay loam, alkaline in reaction (pH: 8.6), non saline (EC: 0.28 dSm^{-1}), medium in organic carbon (0.46 %) and low available nitrogen (208 kg ha^{-1}), medium available phosphorus (18 kg ha^{-1}) and high available potassium (415 kg ha^{-1}) in the plough layer. The details of the soil characteristics are furnished in Table 1.

Table 1: Soil characteristics of the field at the inception of experiment

Particulars	Values	Method	Author(s)
Textural composition (Moisture free basis)			
Clay (%)	29.15	Robinson's international pipette method	Piper (1966)
Silt (%)	17.42		
Coarse sand (%)	23.10		
Fine sand (%)	30.33		
Texture	Clay loam		
Chemical composition			
Available N (kg ha^{-1})	208 (Low)	Alkaline permanganate method	Subbiah and Asija (1956)
Available P_2O_5 (kg ha^{-1})	18 (Medium)	Olsen method	Olsen *et al.* (1954)
Available K_2O (kg ha^{-1})	415 (High)	Neutral normal ammonium acetate method	Stanford and English (1949)
Organic carbon (%)	0.36	Chromic acid wet digestion method	Walkley and Black (1934)
Microbial population			
Total bacteria (CFU x 10^6 g^{-1} soil)	10	Nutrient agar	Collings and Lyne (1968)
Total fungi (CFU x 10^3 g^{-1} soil)	6	Martin`s rose Bengal agar	Martin(1950)
Total actinomycetes (CFU x 10^4 g^{-1} soil)	12	Ken Knight`s medium	Kenknight and Muncie (1939)
Soil enzymatic activity			
Urease (µg NH_4^+ g^{-1} soil 24 h^{-1})	22.80	Urea hydrolysis in soil	Tabatabai (1982)
Dehydrogenase (µg TPF g^{-1} soil 24 h^{-1})	3.1	Spectrophotometer at 485 nm	Casida *et al.* (1964)
Phosphatase (µg p-nitrophenol g^{-1} soil 24 h^{-1})	18.65	Spectrophotometer at 420 nm	Halstead (1964)

Field experiment was laid out in randomized block design with 12 treatments and replicated thrice. The treatments include, T_1 (25% N as FYM + 75% N as inorganics), T_2 (25% N as vermicompost + 75% N as inorganics), T_3 (25% N as poultry manure + 75% N as inorganics), T_4 (25% N as goat manure + 75% N as inorganics), T_5 (25% N as biogas slurry + 75% N as inorganics), T_6 (50% N as FYM + 50% N as inorganics), T_7 (50% N as vermicompost + 50% N as inorganics), T_8 (50% N as poultry manure + 50% N as inorganics), T_9 (50% N as goat manure + 50% N as inorganics), T_{10} (50% N as biogas slurry + 50% N as inorganics), T_{11} (100% N as inorganic) and T_{12} (100% N as inorganic + FYM @ 12.5 t ha^{-1}) which is the recommended practice and fixed as bench mark.

The recommended dose of fertilizer was applied as N: P_2O_5: K_2O @ 120:60:45 kg ha^{-1}. Based on N equal basis required quantities of organic manures were incorporated in the soil one week before sowing. P and K requirements of the crop were applied separately as fertilizer. All the package of practices was carried out as per recommendation of CPG (2012).

The microbial population in the soil at different growth stages of the crop was determined by serial dilution plate count method. Soil samples from different treatments were collected separately replication wise. Ten gram of soil (treatment wise) was mixed in 90 ml sterilized water blank to give 10^{-1} dilutions. Subsequent dilutions upto 10^{-6} were made by transferring serially one ml of each dilution to nine ml sterilized water blanks. The population of bacteria, fungi and actinomycetes were estimated by serial dilution and plate count technique by plating on appropriate media *viz.*, Nutrient agar, Martins rose Bengal agar media and Kenknights agar media, respectively. The inoculated plates were kept for incubation at $30^oC \pm 1\ ^oC$ and emerged colonies were counted. The incubation time varied based on the microorganisms. Microbial population was expressed as colony forming units (CFU) g^{-1} of the soil. This method was suggested by Jensen (1968).

The enzyme activity was determined at post-harvest stages of sweet corn. The substrates and methods followed for enzyme assays as shown in Table 2.

Table 2: Standard methods followed for soil enzyme analysis

S.No.	Enzyme	Substrate	Reference
1	Urease	Urea solution (10%)	Tabatabai (1982)
2.	Dehydrogenase	2,3,5-Triphenyl tetrazolium chloride	Casida et al. (1964)
3.	Phosphatase	p-nitrophenol phosphate	Halstead (1964)

The data recorded on various parameters recorded during the course of investigation was statistically analysed as per the procedures suggested by Gomez and Gomez (1984) for randomized block design. Wherever the treatmental difference were found significant ('F' test), critical difference was worked out at 0.05 probability level. Treatmental differences that were non-significant were denoted by 'NS'.

RESULTS AND DISCUSSION

Microbial load

The influence of organic and inorganic sources of nutrients on the soil biological properties is studied through the assessment of soil microbial population. Application of different organic and inorganic sources of nutrients significantly energized the soil microbial load during the crop growth period (Figure 1, 2 & 3). The fluctuation in the microbial load in the soil is based on the availability of carbon source in the soil and enhanced microbial activity stimulated by organic manures (Hoflich et al., 2000). Higher population of soil microbes under organic added treatments acted as an index of soil fertility because it serves as temporary sink of nutrients flux.

Among the integrated treatments, application of 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) had higher

influence on the population of bacteria, fungi and actinomycetes which is closely related to of 50 per cent N as FYM + 50 per cent N as inorganic (T_6). This is due to higher organic carbon content of the soil, so this helped to increase the soil microflora. Biogas slurry used as organic manure enhanced the soil microbial population at half substitution with inorganic fertilizer (Sankaran et al., 1981).

The soil microbes continue to increase with the advancement of crop growth due to enhanced organic carbon content of the soil as a result of organic manure addition as compared to sole inorganic fertilizers application (Krishnakumar et al., 2007).

The lower soil microbial load was found in 100 per cent N through inorganic fertilizer applied plots which might be due to inhibitory nature of chemical fertilizers on the growth and development of microbes (Singh, 1998; & Yadav & Lourduraj, 2007). Higher concentration of exchangeable and soluble Al^{3+} ion, under the chemical fertilizer treatment might have created a deleterious impact on soil acidity on microorganisms, which in turn reduced the microbial population (Swain et al., 2013).

Enzymatic activity

Urease activity:

Changes in the soil enzyme activities at different crop growth stages is presents in Table: 3. Soil urease activity ascended gradually with sweet corn growth and reached highest value during 60 DAS then after it decreased. The soil fertilized with the recommended level released 47.2 µg NH_4^+ g^{-1} soil 24 h^{-1} at 60 DAS. Among the integrated treatments application of 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) reported 42.9, 46.5 and 40.2 µg NH_4^+ g^{-1} soil 24 h^{-1} at 30, 60 DAS and at harvest respectively, this is on par with T_6, T_7 and T_9. Balanced nutrition of crop, responsible for better proliferation of root (rhizosphere) was responsible the maximum activity of enzymes. These results are in conformity with trends reported by various workers (Srilatha et al., 2013; Vilasitha et al., 2013 & Rai & Yadav, 2011).

Dehydrogenase activity:

The dehydrogenase activity of the soil showed that it released 3.1 µg of TPF released g^{-1} soil 24 h^{-1} of soil before the commencement of the experiment. The dehydrogenase activity accelerated substantially by the integrated nutrient management treatments. Application of 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) reported 3.8, 6.1 and 2.9 1 µg of TPF released g^{-1} soil 24 h^{-1} of soil at 30, 60 DAS and at harvest respectively, which is in par with T_6, T_7 and T_9. A sharp increase in dehydrogenase activity found to coincide with 60 DAS, so it enhanced root growth and the relase of cellular enzyme like dehydrogenase activity to the soil solution. These results are in consonance with the finding of Srilatha et al. (2013) and Reddy and Reddy (2012).

Phosphotase activity:

The phosphatase activity showed that the initial sample released 18.65 µg p-nitrophenol g^{-1} soil 24 h^{-1}. The soil fertilized with recommended level released 42.60 µg p-nitrophenol g^{-1} soil 24 h^{-1}at 60 DAS. Among the integrated treatments application of 50 per cent N as biogas slurry + 50 per cent N as inorganic (T_{10}) reported 38.20, 41.8 and 35.20 µg p-nitrophenol g^{-1} soil 24 h^{-1} at 30, 60 DAS and at harvest stage respectively which is in par with T_6, T_7 and T_9. Increasing level of phosphatase known to improve growth and development of roots which in turn release the enzymes in larger quantities (Pallab et al., 1990). The additional advantage of INM in improvement in biological activity was probably due to addition of organic manures in the integrated nutrient management treatments that serve as a source of increased microbial activity which exude the enzyme and through better soil aggregation and other process (Singaram & Kamalakumar, 1995 & Vilasitha et al., 2013).

Table 3: Effect of integrated nutrient management practices on soil enzyme activity

Treatments	Urease activity (µg NH_4^+ g^{-1} soil 24 h^{-1})			Dehydrogenase activity (µg of TPF released g^{-1} soil 24 h^{-1})			Phosphatase activity (µg of p-nitrophenol released g^{-1} soil 24 h^{-1})		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1 – 25% N as FYM + 75% N as inorganic	39.5	43.1	36.8	3.5	5.8	2.6	34.7	38.3	31.3
T_2 – 25% N as vermicompost + 75% N as inorganic	37.6	41.2	34.9	3.1	5.4	2.2	32.4	36.0	28.9
T_3 – 25% N as poultry manure + 75% N as inorganic	38.5	42.1	35.8	3.3	5.6	2.4	34.4	38.0	29.8
T_4 – 25% N as goat manure + 75% N as inorganic	37.9	41.5	35.2	3.1	5.4	2.2	34.2	37.8	30.0
T_5 – 25% N as biogas slurry + 75% N as inorganic	39.0	42.6	36.3	3.4	5.7	2.5	34.5	38.1	30.2
T_6 – 50% N as FYM + 50% N as inorganic	42.6	46.2	36.3	3.8	6.1	2.9	36.4	40.0	32.8
T_7 – 50% N as vermicompost + 50% N as inorganic	41.7	45.3	39.0	3.7	6.0	2.8	35.6	39.2	31.2
T_8 – 50% N as poultry manure + 50% N as inorganic	40.3	43.9	37.6	3.5	5.8	2.6	34.9	38.5	30.9
T_9 – 50% N as goat manure + 50% N as inorganic	41.1	44.7	38.4	3.6	5.9	2.7	35.2	38.8	31.4
T_{10} – 50% N as biogas slurry + 50% N as inorganic	42.9	46.5	40.2	3.8	6.1	2.9	38.2	41.8	35.2
T_{11} – 100% N as inorganic	35.0	38.6	32.2	2.0	4.3	1.1	24.0	27.6	21.3
T_{12} – 100% N as inorganic + 12.5 t ha^{-1} FYM	43.6	47.2	40.9	4.0	6.3	3.1	39.0	42.6	35.3
SEd	**0.2**	**1.2**	**0.8**	**0.2**	**0.3**	**0.1**	**1.2**	**1.8**	**0.5**
CD (P=0.05)	**0.4**	**2.6**	**1.7**	**0.4**	**0.5**	**0.3**	**2.5**	**3.8**	**1.1**

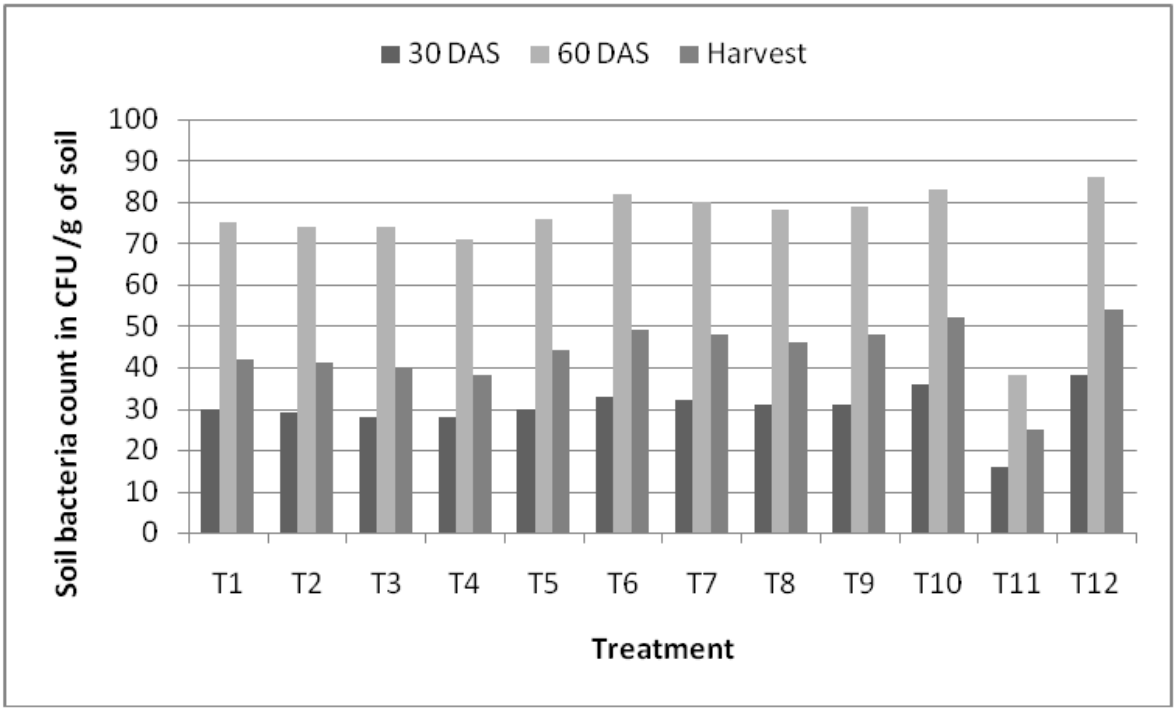

Fig. 1: Effect of INM practices on soil bacteria x 10^6 CFU g^{-1} of soil at different growth stages of sweet corn hybrid

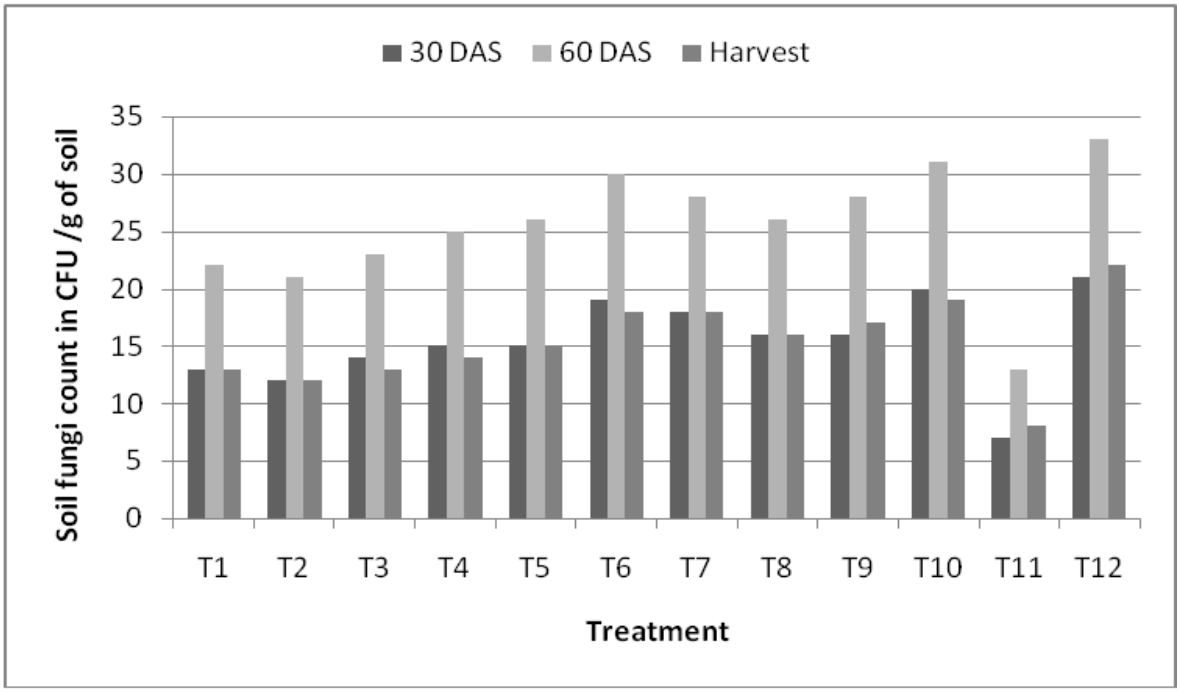

Fig. 2: Effect of integrated nutrient management practices on soil fungi x 10^4 CFU g^{-1} of soil at different growth stages of sweet corn hybrid

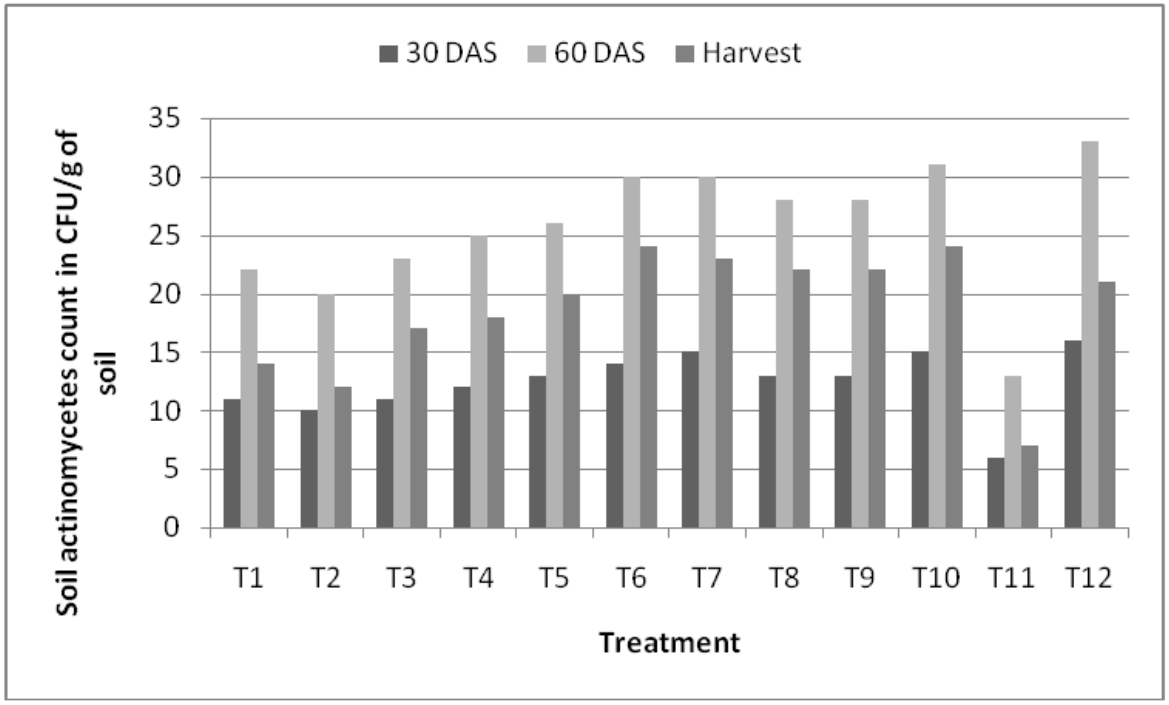

Fig. 3: Effect of integrated nutrient management practices on soil actinomycetes x 10^3 CFU g^{-1} of soil at different growth stages of sweet corn hybrid

CONCLUSION

Microbial population (bacteria, fungi and actinomycetes) and enzymatic (urease, dehydrogenase and phosphatase) activity of the soil were positively influenced due to application of 50 per cent N as biogas slurry in combination with 50 per cent N as inorganic fertilizers. Among the different INM treatments, higher biological property was recorded with half substitution of organic manures with inorganic fertilizer which resulted in buildup of soil organic carbon content at the end of cropping period.

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