Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 210-213
Received: 28-11-2019
Accepted: 30-12-2019

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Effect of different fertility levels and organic manures on biological properties of soil in Pearl millet

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Abstract
A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture Jobner (Rajasthan) during *kharif* season 2018 on loamy sand soil. The experiment was laid out in factorial randomized block design with three replications. The experiment comprised of four treatments of fertility levels (Control, 50 per cent RDF, 75 per cent RDF and 100 per cent RDF) and five treatments of organic manures (Control, vermicompost @ 2.5 t ha^{-1}, vermicompost @ 5 t ha^{-1}, FYM @ 5 t ha^{-1} and FYM @ 10 t ha^{-1}) were applied to the pearl millet var. RHB-173. Results showed that dehydrogenase activity, alkaline phosphatase activity and soil microbial biomass C, N and P in soil after harvest were observed significantly higher with application of 100 per cent RDF. The application of vermicompost @ 5 t ha $^{-1}$ significantly increased dehydrogenase activity, alkaline phosphatase activity and soil microbial biomass C, N and P.

Keywords: Fertility level, microbial biomass, alkaline phosphatase, dehydrogenase

Introduction
Increased uses of chemical fertilizers without adequate organic recycling had not only aggravated multi-nutrient deficiencies in soil plant system but also deteriorated soil health and created environment pollution. Moreover, chemical fertilizers are becoming costlier input in Agriculture. Therefore, it is right time to evaluate the feasibility and efficiency of organic waste not only for improving and building up of soil fertility but also increasing efficiency of chemical fertilizers. Integration of chemical fertilizer with organic manures has been found quite promising not only in sustaining the soil health and productivity but also in stabilizing the crop production in comparison to the use of each component, separately (Nambiar and Abrol, 1992) [1]. The application of chemical fertilizer generally improves crop production. However, concerns have been raised not only about the severe environmental problems posed by such practices but also about the long term sustainability of such systems (Mader *et.al*, 2002) [2]. Organic application increased nutrient status, microbial activity and productive potential of soil while the use of chemical fertilizers in the cropping system resulted in a poor microbial activity and productive potential of soil. The use of chemical fertilizer alone was not effective in improving the nutrient status of soil (Kang *et al*., 2005) [3]. Soil microorganism play a very important role in soil fertility not only because of their ability to carry out biochemical transformation but due to their importance as a source and sink of mineral nutrients (Jenkinson and Ladd, 1981) [4]. Soil microbes, the living part of soil organic matter, function as a transient nutrient sink and responsible for releasing nutrients from organic matter for use by plants (e.g. N, P and S). An understanding of microbial processes is important for management of farming systems, particularly those that rely on organic inputs of nutrients (Smith and Paul, 1990) [5]. The present investigation was carried out with an aim to assess the Effect of different fertility levels and organic manures on biological properties of soil in Pearl millet.

Material and Methods
The experiment was laid out at Agronomy farm, SKN College of Agriculture, Jobner during "*kharif*", 2018 to find out the **"**Effect of different fertility levels and organic manures on biological properties of soil in Pearl millet". Agronomy farm is situated at 75^0 28' East longitude and 26^0 05' North latitude at an altitude of 427 m above mean sea level (MSL) in Jaipur district of Rajasthan. This region falls under agro-climatic zone- III A (Semi-Arid Eastern Plain) of the state. The experiment comprising four level of RDF (control, 50%, 75% and 100%) and five treatments of organic manure (Vermicompost @ 2.5 t ha^{-1}, Vermicompost @ 5.0 t ha^{-1}, FYM @ 5.0 t ha^{-1} and FYM @ 10.0 t ha^{-1}). +

by the method given by Casida *et al.* (1964) [6]. The assay of alkaline phosphatase was carried out according to the method of Tabatabai and Bremner (1969) [7]. To determine microbial biomass carbon the preconditioned soil samples were fumigated by saturating with liquid ethanol free chloroform ($CHCl_3$) in dessicators and stored in the dark room for 24 hr (Srivastava and Singh, 1988) [8]. Organic carbon in the soil extract was measured using the acid dichromate method (Vance et al., 1987) [9]. Microbial biomass nitrogen and phosphorus was estimated by method given by (Brookes et al.1982) [10] using the same K_2SO_4 extract, which was used for soil microbial carbon.

Results and Disscusion

Effect of fertility level

Soil microbial C, N and P

A perusal of data (Table 1) indicated that increasing fertility level had a significant effect on microbial biomass C, N and P in soil. Application of 100% RDF (F_3) showed the highest microbial biomass C, N and P and got about a significant improvement over 75% RDF(F_2), 50% RDF(F_1) and control. The microbial biomass carbon increased with increase in dose of inorganic fertilizers, may be due firstly to increase in microbial population (Hasebe *et al.* 1985) [11] and secondly to the formation of fruit exudates, mucigel soughed of cells and underground roots of previous cut crops which also play an important role in increasing biomass carbon (Goyal *et al*., 1992) [12]. The fertilizers in present study apparently provided supply of nutrients in balance proportion which was reflected in terms of increased amount of microbial biomass nitrogen. Increase in biomass nitrogen has also been reported by Wangscuping *et al*. (2003) [13].

Enzymatic activity

A study of the data (Table 2) revealed that the application of different fertility levels significantly increased the activity of dehydrogenase enzyme and alkaline phosphatase activity over control (F_0). Application of 100% RDF (F_3) enhanced the dehydrogenase enzyme by 28.78; 38.29, 12.24; 15.65 and 4.28; 4.89 per cent respectively over 75% RDF (F_2), 50% RDF (F_1) and control (F_0). All biological reactions in soil are catalyzed by enzymes. Soil enzymes activities are believed to indicate the extent of specific processes in soil and in some cases act as indicators of soil fertility. The increase in dose of inorganic fertilizers increase the activity of dehydrogenase and phosphatase as recorded in 100% RDF. It may be attributed to the fact that inorganic sources of nutrients stimulated the activity of microorganisms to utilise the native pool of organic carbon as a source of carbon. Results are in close findings with Mandal *et al*. (2007) [14] and Abdalla and Langer (2009) [15].

Effect of organic manures

Soil microbial C, N and P

Data presented in table 1 reveal that crop fertilised with vermicompost @ 5 t ha^{-1} (M_2) represented significantly higher microbial biomass C, N and P over other treatments. The application of 5 t vermicompost ha^{-1}showed a significant increase over control (M_0), vermicompost @ 2.5 t ha^{-1} (M_1), FYM @ 5 t ha^{-1} (M_3) and FYM @ 10 t ha^{-1} (M_4), respectively. In general, there was an increase in microbial growth and activities of enzymes with the addition of carbon substrate end declined as the available carbon exhausted (Manna *et al*., 1996) [16]. Build –up of microbial biomass is mainly due to the microbial biomass contained in the organic manures and addition of substrate carbon which stimulate the indigenous soil microbiota (Verma and Mathur, 2009[17] and Nath *et al*., 2012 [18]). The availability of carbonaceous material and substrates such as sugar, amino acids and organic acids in the soil from the decomposing organic material and decay of roots under the plant canopy are important for supplying energy for microbial population (Bowen and Rovira , 1991) [19]. These results are in accordance with the findings of Ros *et al*., (2003) [20].

Enzymatic activity

Perusal of data in table 2 further revealed that the crop manured with vermicompost applied @ 5 t ha^{-1}(M_2) gave significantly higher dehydrogenase and alkaline phosphatase activity over other treatments. On addition of organic material, the content of humic substances which are conventionally known to provide adsorption sites are increased. Thus, the amount of adsorbed enzymes is also increased. Often the level of soil enzyme activity increased with increasing soil organic matter content in the soil (Speir, 1977) [21]. Soil enzyme activities increased by incorporation of organic manure was also reported by Nannipieri *et al*, (1983) [22]. Increase in activity may be due to protection to enzymes fraction upon increase in the soil humus content was also reported by Martens *et al*.(1992)[23], Pareek and Yadav (2011)[24] and Nath *et al*.(2012) [18].

Table 1: Effect of different fertility level and organic manures on microbial biomass of C, N and P (µg g^{-1}) soil at harvest

Treatments	Microbial Biomass C	Microbial Biomass N	Microbial Biomass P
Fertility Levels			
F_0 (Control)	77.40	16.91	7.45
F_1 (50% RDF)	98.90	21.41	9.19
F_2 (75% RDF)	109.52	24.21	10.14
F_3 (100% RDF)	115.90	25.86	10.59
SEm±	1.43	0.31	0.13
CD (P=0.05)	4.10	0.90	0.38
Organic manures			
M_0 (Control)	74.85	16.30	7.04
M_1 (Vermicompost @ 2.5 t ha^{-1})	101.09	21.72	9.37
M_2 (Vermicompost @ 5 t ha^{-1})	119.82	27.12	11.15
M_3 (FYM @ 5 t ha^{-1})	94.50	20.18	8.76
M_4 (FYM @ 10 t ha^{-1})	111.89	25.14	10.40
SEm±	1.60	0.35	0.15
CD (P=0.05)	4.58	1.00	0.43

Table 2: Effect of different fertility level and organic manures on dehydrogenase activity and alkaline phosphatase activity at harvest

Treatments	Dehydrogenase activity (p Kat kg^{-1} soil)	Alkaline phosphatase activity (µ ml PNP sec^{-1})
Fertility Levels		
F_0 (Control)	13.24	8.07
F_1 (50% RDF)	15.19	9.65
F_2 (75% RDF)	16.35	10.64
F_3 (100% RDF)	17.05	11.16
SEm±	0.19	0.14
CD (P=0.05)	0.54	0.40
Organic manures		
M_0 (Control)	12.96	7.95
M_1 (Vermicompost @ 2.5 t ha^{-1})	15.50	9.91
M_2 (Vermicompost @ 5 t ha^{-1})	17.35	11.39
M_3 (FYM @ 5 t ha^{-1})	14.86	9.40
M_4 (FYM @ 10 t ha^{-1})	16.63	10.77
SEm±	0.21	0.16
CD (P=0.05)	0.61	0.45

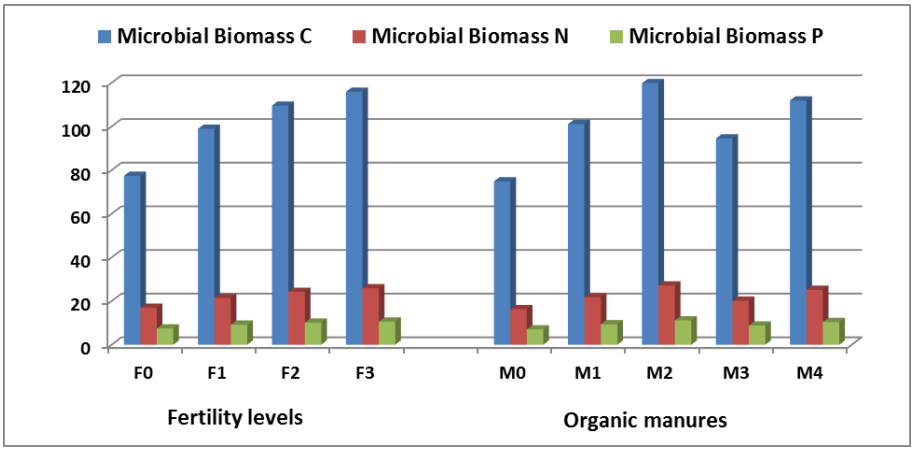

Fig 1: Effect of different fertility level and organic manures on microbial biomass of C, N and P (µg g^{-1}) soil at harvest

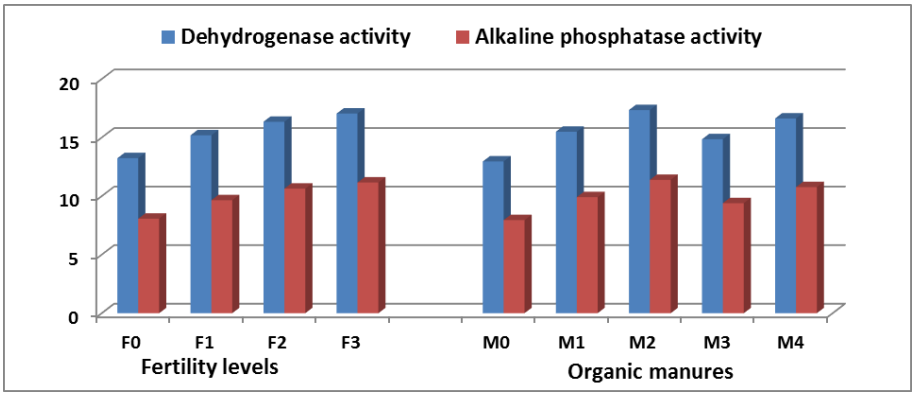

Fig 2: Effect of different fertility level and organic manures on dehydrogenase activity (µg TPF g^{-1} h^{-1} soil) and alkaline phosphatase activity (µg PNP g^{-1} h^{-1} soil) activity at harvest

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