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ANALYZING THE IMPACT OF ORGANIC MANURES ON SOIL MICROBIAL PARAMETERS FOLLOWING OKRA-BROCCOLI CROPPING PATTERN

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ABSTRACT

A study was conducted at OFR Centre of SKUAST -Jammu to find out the impact of organic manures on soil microbial and enzymatic health following Okra-Broccoli cropping pattern. Significant results in microbial biomass carbon were obtained with highest Microbial Biomass Carbon (MBC) value 45.65 μg g^{-1} was observed in T8 in okra and 47.49 μg g^{-1} in broccoli. Highest to lowest value observed was 2.80 μg g-1 (T_8) to 2.63 μg g^{-1} (T_1) in okra and 3.20 μg g^{-1}(T_8) to 2.89 μg g^{-1} (T_1) in broccoli. Highest Dehydrogenase (DHG) value 122.55 μg TPF g^{-1} soil day-1 was observed in T8 in okra and 123.41 μg TPF g^{-1} soil day-1 in broccoli. Highest to lowest value observed was 12.86 μg PNP g^{-1} soil day-1 (T_8) to 12.04 μg PNP g^{-1} soil day-1 (T_1) in okra and 13.10 μg PNP g^{-1} soil day-1(T_8) to 12.26 μg PNP g^{-1} soil day-1 (T_1) in broccoli. Microbial Biomass Nitrogen (MBN) and Acid Phosphatase (ACP) values were found to be non-significant as minor variations in treatments were observed as compared to control. In the experiment, the most effective treatment was found to be T8 comprising of Vermicompost + Poultry Manure @ 5.00 + 1.45 t ha^{-1}.

INTRODUCTION

Soil enzymatic and microbial activities have been used as indicators of soil fertility because they are a reflection of the effects of cultivation, soil properties and soil amendments (Pokharel *et al*., 2015). Several studies have reported that organic manure applications in irrigated systems resulted in improved soil structure and microbial communities including direct impact on soil microbial carbon and nitrogen (Bhattacharyya *et al*., 2007). Since organic manures help in enhancing the activity of microorganisms in soil which further increase solubility of nutrients and their consequent availability to plants which is known to be altered by microorganism by altering soil properties at microsites, chelating action of organic acids produced by them and intraphyl mobility in the case of fungal growth (Parthasarathi *et al*., 2008). Rodriguez Vila *et al*. (2016) found that organic amendments sustain soil properties by increasing OM, nutrient content, microbial activity and thus increase crop growth and yield. Lower greenhouse gas emissions for crop production and enhanced carbon sequestration, coupled with additional benefits of biodiversity and other environmental services; make organic agriculture a farming method with many advantages and considerable potential for mitigating and adapting to climate change (Das and Singh 2014). Also, Indian soils are poor to medium status within; therefore organic manures can have a direct impact on soil organic matter content, soil fertility, soil physical characteristics and augment microbial activities (Padbhushan R. *et al*., 2015; Vanilarasu and Balakrishnamurthy 2014). So, in the present era, where sustainability concept is lacking in crop cultivations and nutrient deficiencies in soil are on rise, there is need to implicate organic measures in cropping plans and practices. Despite dependency on cereals is more for calorie consumption but vegetables cropping pattern need to have at par view in relation to soil health, sustainability and productivity aspects. Therefore, the objectives of this study were to assess the effect organic manures and combinations on soil microbial parameters in okra- broccoli sequence.

MATERIALS AND METHODS

The present investigation entitled "Studies on impact of organic manures on soil quality in Okra-Dhaincha-Broccoli sequence" was conducted at Organic Farming Research Centre of SKUAST –Jammu. The treatment details with input applied on the basis of Nitrogen requirement T_1: No application, T_2: Farm Yard Manure: 10.00 tonne ha^{-1}, T3: Vermicompost: 6.60 tonne ha^{-1}, T4: Poultry Manure: 2.91 tonne ha^{-1}, T_5: Neem Cake: 2.00 tonne ha^{-1}, T_6: Farm Yard Manure + Poultry Manure: 5.00 + 1.45, T7 Farm Yard Manure + Neem Cake 5.00 + 1.00, T_8 Vermicompost + Poultry Manure 3.30 + 1.45, T_9 Vermicompost + Neem Cake: 3.30 + 1.00 tonne ha^{-1}, T10: Neem Cake + Poultry Manure: 1.00 + 1.45 tonne ha^{-1}.

Okra

Spacing: - 45cms (Row) X 30cms (Plant), Variety:- Seli Special, Seed rate:- 20-25 kg ha^{-1} , N:P:K requirement:- 100:60:60

Broccoli

Spacing: - 60cms (Row) X 45cms (Plant), Variety:- Early Green, Seed rate:- 300-400g ha^{-1}, N:P:K requirement:- 120:60:60

The sources of nitrogen, phosphorus and potassium were organic fertilizers, respectively. The data recorded in respect of physico-chemical properties of the soil of the experimental site revealed that the soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction, medium in organic carbon, low in Available N, medium in Available P and Available K, low in Available S, Available Zn and high in Available Cu, Mn and Fe.

Soil microbial carbon (MBC) and soil microbial nitrogen (MBN) were determined by 24 h chloroform fumigation followed by extraction with 0.5 M potassium sulfate (K2SO4). (Jenkinson and Powlson 1976).

The enzyme dehydrogenase was analyzed through Triphenyl formazin method suggested by Thalmann (1968). The acid phosphatase enzyme activity was assayed by p-nitrophenyl Phosphate Method by adopting the standard procedure of Tabatabai (1982).

The data on various characters studied during the course of investigation were statistically analyzed by using Tukey's test with an aim to figure out which groups in our sample differ by using "Honest Significant Difference," a number that represents the distance between groups, to compare every mean with every other mean.

RESULTS AND DISCUSSION

The values of MBC and MBN are presented in Table 1 and 2. As per tukey's post-hoc Analysis, MBC was found to be significant in both 2016 and 2017 as compared to control. Significant results were obtained with highest value 43.02 μg g^{-1} observed in T8 in okra and 44.75 μg g^{-1} in broccoli as compared to control T1. In 2017, MBC showed significant results as values followed the same pattern of major variations as in 2016 in both crops. The MBC mean values showed the similar increasing pattern as above. In year 2016, MBN values were found to be non-significant as minor variations in treatments were observed as compared to control. The maximum MBN observed was 2.28 μg g^{-1} in okra and 2.61 μg g^{-1} in broccoli in T8. Due to the additive effects of organic manures the MBN trend was continuously observed in increasing pattern as compared to time. The individual and combined applications showed better response as compared to control. In 2017, also the MBN was found to be non-significant among the treatments as values followed the same pattern with minor variations. The mean values of two years showed the similar increasing pattern in comparison to time. MBC serves as an important reservoir of plant nutrients (Okur *et al*., 2009). In the experiment, microbial biomass carbon was found significantly highly with Vermicompost + Poultry manure application, however microbial biomass nitrogen was found non-significant with some partial increase as compared to control. Furthermore, higher soil microbial biomass carbon in organic farming is mainly due to the regular application of organic manures and large carbon inputs in the form of organic amendment (Naik *et al*., 2014. Additionally, farmyard manure, vermicompost, poultry manure supplies readily available N, resulting higher plant biomass. Consequently, more crop residues are incorporated in soil and thereby higher organic matter levels are maintained (Roldan *et al*., 2005). This also provides a favorable environment for microorganisms, contributing to a highly diverse and stable microbial community structure in organic farming systems (Wada and Toyota 2007). A positive effect of organic fertilizers on microbial biomass nitrogen and carbon content in soil was observed and reported by Cerny *et al*. (2008). Stimulation of microbial biomass Carbon and Nitrogen and activities by organic carbon inputs have been well documented also in various organic substrates. (Goyal *et al*., 1999; Chowdhary *et al*., 2000; Gracia-Gil *et al*., 2000; Peacock *et al*., 2001; Tu *et al*., 2005).

The values of DHG are presented in Table 3. As per tukey's post-hoc Analysis, DHG was found to be significant in both 2016 and 2017 as compared to control. Significant results were obtained with highest value 121.73 μg TPF g^{-1} soil day-1 observed in T8 in okra and 122.12 μg TPF g^{-1} soil day-1 in broccoli as compared to control T1 In 2017, DHG showed significant results as values followed the same pattern of major variations as in 2016 in both crops. The DHG mean values showed the similar increasing pattern as above. The highest value of DHG 121.91 μg TPF g^{-1} soil day-1 was noticed in okra and 122.76 μg TPF g^{-1} soil day-1 in broccoli in T8. Enzymes have also been suggested as indicators of soil quality, since they show a rapid response to changes in soil management practices such as fertilizer application, or pesticides use (Albiach *et al*., 1999). The dehydrogenase enzyme activity was found highly significant in treatment containing vermicompost + poultry manure in soil as compared to control. Singaram and Kumari (2000) found that the enzyme activity was found to be maximum in organic manure treated plots as dehydrogenase activity was found significantly increased in all treatments. Liang *et al*. (2005)

Table 1: Effect of organic manures on Microbial Biomass Carbon (μg g^{-1} soil)

MBC		Okra			Broccoli	
Treatment	2016	2017	Mean	2016	2017	Mean
T_1: Control	40.35a	42.82a	41.59a	41.98a	44.56a	43.27a
T_2: FYM	41.38ab	43.91ab	42.65ab	43.05ab	45.69ab	44.37ab
T_3: VC	41.86bc	44.43bc	43.15bc	43.55bc	46.22bc	44.89bc
T_4: PM	42.50bc	45.11bc	43.80bc	44.20bc	46.93bc	45.57bc
T_5: NC	41.76bc	44.31bc	43.03bc	43.44bc	46.10bc	44.73bc
T_6: FYM + PM	42.54bc	45.15bc	43.85bc	44.33bc	47.00bc	45.62bc
T_7: FYM + NC	42.59bc	45.20bc	43.89bc	44.31bc	47.02bc	45.67bc
T_8: VC + PM	43.02c	45.65c	44.33c	44.75c	47.49c	46.13c
T_9: VC + NC	42.10bc	44.68bc	43.39bc	43.80bc	46.48bc	45.14bc
T_{10}: NC + PM	42.90bc	45.53bc	44.21bc	44.63bc	47.37bc	46.00bc

*Mean values with similar alphabet in a subset are statistically at par.

Table 2: Effect of organic manures on Microbial Biomass Nitrogen (μg g^{-1} soil)

MBN		Okra			Broccoli	
Treatment	2016	2017	Mean	2016	2017	Mean
T_1: Control	2.15	2.63	2.39	2.46	2.89	2.68
T_2: FYM	2.18	2.67	2.43	2.5	3.06	2.78
T_3: VC	2.19	2.68	2.43	2.51	3.07	2.79
T_4: PM	2.2	2.68	2.44	2.52	3.08	2.8
T_5: NC	2.21	2.72	2.46	2.53	3.1	2.82
T_6: FYM + PM	2.22	2.72	2.47	2.54	3.11	2.83
T_7: FYM + NC	2.24	2.75	2.49	2.57	3.14	2.86
T_8: VC + PM	2.28	2.8	2.53	2.61	3.2	2.91
T_9: VC + NC	2.25	2.76	2.51	2.59	3.16	2.88
T_{10}: NC + PM	2.27	2.78	2.52	2.6	3.19	2.9

*As per Tukey's Post-hoc analysis, the values are non-significant.

Table 3: Effect of organic manures on Dehydrogenase activity (μg TPF g^{-1} soil day-1)

Dehydrogenase		Okra			Broccoli	
Treatment	2016	2017	Mean	2016	2017	Mean
T_1: Control	110.67a	111.84a	111.26a	111.45a	112.62a	112.04a
T_2: FYM	115.96b	117.18b	116.57b	116.77b	118.00b	117.39b
T_3: VC	115.56b	116.78b	116.17b	116.37b	117.60b	116.98b
T_4: PM	118.63c	119.88a	119.26c	119.46c	120.73c	120.10c
T_5: NC	115.45b	116.62b	116.06b	116.26b	117.49b	116.88b
T_6: FYM + PM	120.09c	121.36c	120.73c	120.95c	122.21c	121.57c
T_7: FYM + NC	119.75c	121.01c	120.68c	120.59c	121.86c	121.76c
T8: VC + PM	121.73a	122.55c	121.91c	122.12c	123.41c	122.76c
T_9: VC + NC	119.78c	121.05c	120.41c	120.62c	121.89c	121.25c
T_{10}: NC + PM	120.42c	121.69c	121.05c	121.26c	122.54c	121.91c

*Mean values with similar alphabet in a subset are statistically at par.

Table 4: Effect of organic manures on Acid Phosphatase activity (μg PNP g^{-1} soil day-1)

Acid Phosphatase		Okra			Broccoli	
Treatment	2016	2017	Mean	2016	2017	Mean
T_1: Control	11.38	12.04	11.71	11.59	12.26	11.92
T_2: FYM	11.42	12.08	11.75	11.73	12.05	12.07
T_3: VC	11.72	12.41	12.05	11.94	12.64	12.3
T_4: PM	11.83	12.52	12.18	12.06	12.77	12.41
T_5: NC	11.51	12.17	11.85	11.63	12.31	11.97
T_6: FYM + PM	12.06	12.75	12.41	12.29	13.02	12.46
T_7: FYM + NC	11.95	12.64	12.3	12.17	12.88	12.53
T_8: VC + PM	12.15	12.86	12.51	12.39	13.1	12.74
T_9: VC + NC	11.92	12.62	12.27	12.12	12.83	12.47
T_{10}: NC + PM	11.9	12.58	12.24	12.16	12.85	12.51

*As per Tukey's Post-hoc analysis, the values are non-significant.

reported that the incorporation of organic amendments to soil stimulated dehydrogenase activity because the added material may stimulate microbial activity in the soil. Jagadeesh (2000) reported that application of FYM along with recommended fertilizers recorded highest activities of dehydrogenase activity than all other treatments. Generally, the enzyme activities in the soil are closely related to organic matter content. Application of manures improves the MBC status of soils which corresponds to higher enzyme activity (Mandal *et al*., 2002). Furthermore, enzymatic activities increased with increasing soil organic C along the plantation chronosequence due to the dependence of microbial activity on the supply of substrate C. (Ferreiro *et al*., 2007). The higher soil organic C can provide enough substrate to support higher microbial biomass, hence higher enzyme production

The ACP values are presented in Table 4. In year 2016, ACP values were found to be non-significant as minor variations in treatments were observed as compared to control. Due to the additive effects of organic manures the ACP trend was continuously observed in increasing pattern as compared to time. The individual and combined applications showed better response as compared to control. In 2017, also the ACP was found to be non-significant among the treatments as values followed the same pattern with minor variations. The mean values of two years showed the similar increasing pattern in comparison to time. Large proportion of the phosphorus in soil exists in organic form (50-80 % of total P). In order to become available to plants, P compounds must be hydrolyzed by phosphatase, which are of plant and microbial origin. Phosphatase produced by microorganism and plant roots has a major role in the hydrolysis of soil organic P thereby releasing inorganic P for plant uptake. In current experiment, acid phosphatase activity was not significantly affected by different treatments. However, there was a slight increase over control (Goldstein 1998). Phosphatase activity is directly related to the level of organic phosphorus in the soil. Further, it can also be extended that the plant roots can hydrolyze organic and insoluble phosphate in soil by the production of the phosphatase, which is also produced by large number of soil microbes (Bandick and Dick, 1999). Jagadeesh (2000) reported that application of organic manures along with recommended fertilizers recorded highest activities of acid phosphatase activity than all other treatments and with positive significant relation with certain soil properties. Denila (2015) reported that higher acid phosphatase activity was found in organic farms and comparatively less in conventional farms.

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