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Impact of organic manures on different soil chemical indicator improved the soil health under basmati rice in North Zone of Jammu region

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Abstract
Organic manure applications can affect the soil chemical properties. In a rice cultivation there are wide variations in the soil chemical characteristics throughout the crop cycle. The present study was conducted to study the impact of different manures on soil phosphorus, potassium, DTPA Zn and Fe in a rice (basmati) during 2018 and 2019. The treatments were T_1-Control (No application); T_2-Farm Yard Manure (FYM) (100% N); T_3-Vermicompost, VC (100% N); T_4 - FYM (50% N) + VC (50% N); T_5-FYM (50% N) + Poultry manure, PM (50% N); T_6-FYM (50% N) + Neem cake, NC (50% N); T_7-VC (50% N) + PM `(50% N) and T_8-VC (50% N) + NC (50% N). Available phosphorus and potassium were significantly affected by manure application in comparison to control, where no manures were applied during both the years. Treatment VC+PM significantly increased available phosphorus and potassium.

Keywords: organic manures, soil available N, $P_2 0_5$, K_2O, basmati rice

Introduction
Soil degradation is said to be occurring due to the intensification of crop cultivation and the advance of monoculture rice and indiscriminate and imbalance use of synthetic fertilizers has led to soils losing their sustainability, leading to decreased productivity per unit of nutrient used. Organic farming has been touted as the alternative to conventional farming. Organic farming makes use of organic manures as use of source of nutrients replacing synthetic fertilizers completely. Organic manures have been promoted as an alternative to enhance soil fertility and make agriculture production systems more sustainable. Organic matter influences soil physical, chemical and biological properties. The primary goal of organic farming is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Yuda *et al.*, 2016) [22]. Addition of organic matter in the form of manures can positively impact soil chemical properties such as Available nitrogen, phosphorus and potassium, DTPA Zn and iron.

Soil having good physical and biological properties, must also have a good chemical condition to realize its full potential. Organic fertilizer emerged as a feasible option to concerns related to increasing food contamination. The urgency of using organic manure has been gaining ground in the escalating cost of fertilizer with every passing year and besides other inherent limitations with the use of chemical fertilizers. Organic matter in general help to regulate the chemical, biological and physical properties of the soil by acting as a “revolving nutrient fund”; and as an agent to improve soil structure, maintain tilth and minimize erosion. The accumulated organic manure is a store house of plant nutrients. The stable organic fraction (humus) adsorbs and holds nutrients in a plant available form. Organic matter releases nutrients in available form to plants upon decomposition (Alexandra and Jose, 2005) [3].

Organic manures show considerable diversity in physical, chemical, biological properties and their efficiency in crop production depends upon the agro-ecological environment where the crop is grown. Farm yard manure (FYM) is the most commonly used organic manure in most countries of the world. FYM not only supplies a variety of macro and micronutrients to the soil, but also improves the physico-chemical and biological properties of soil. Vermicompost is a rich source of enzymes, antibiotics, immobilized micro flora and growth hormones like gibberellins which regulate the growth of plants and microbes. Poultry manure is an excellent organic manure source as it contains high nitrogen, phosphorus, potassium and other essential nutrients. It was also indicated that poultry manure more readily supplies P to plants than other organic manure sources (Garg and Bahla, 2008) [9]. The dual activity of neem cake as manure and as a bio-pesticide has made it a favored input. It provides macro nutrients essential for all plant growth, helps to increase the yield of plants in the long run, bio-degradable and eco-friendly and excellent soil conditioner. Although the organic manures contain plant nutrients in small quantities as compared to the inorganic fertilizers, the presence of growth promoting principles like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity (Baliah *et al*. 2017) [4].

Rice-berseem system is commonly practiced in the plains of Jammu region of Jammu and Kashmir. Rice based cropping systems undergo wide changes in its physical conditions due to special conditions required for rice cultivation. Application of different organic sources tend to significantly influence the physical properties of soil over the inorganic fertilizers (Kannan *et al*., 2005) [11]. Different organic manures behave differently in soil and outcomes on their impact on soil properties may vary. However, the inclusion of green manure source such as berseem may reduce this variation among manures. The work on influence of organic manures on soil chemical properties under rice-berseem system is scarce, especially on soils where there is long-term exclusion of inorganic fertilization. Therefore, this study was evaluated entitled on "Impact of organic manures on different soil chemical indicator improved the soil health under basmati rice in North Zone of Jammu region.

Material and Methods

The experiment was conducted in the experimental farm of the Organic Farming Research Centre (OFRC) of SKUAST-Jammu, Chatha, Jammu. The experiment consisted of 8 treatments wherein various nutrient sources such as FYM, Vermicompost, Poultry Manure, Neem Cake and their combinations were utilized. These treatments were T_1-Control (No application); T_2-Farm Yard Manure (FYM) (100% N); T_3-Vermicompost, VC (100% N); T_4-FYM (50% N) + VC (50% N); T_5-FYM (50% N) + Poultry manure, PM (50% N); T_6-FYM (50% N) + Neem cake, NC (50% N); T_7-VC (50% N) + PM `(50% N) and T_8-VC (50% N) + NC (50% N). The experiment was laid out under randomized block design with three replications. The land was fallow for over 6 years and then brought under organic cultivation since 2016. During the first-year organic cultivation rice-wheat system was followed, and from subsequent year rice was adopted.

Soil samples were collected from 0-15 cm soil depths after the harvesting of rice for both the years. Soil samples were air dried, ground in wooden pestle and mortar and then passed through 2 mm sieve and preserved in polythene bags for the subsequent analysis of different properties. Olsen's approach for determining available phosphorus mentioned by Jackson (1973) [10] was used. The method provided by Merwin and Peech (1950) [15] for determining the available potassium content of soil was used to extract it using a neutral 1 N ammonium acetate solution. Availability of DTPA-extractable micronutrient cations (Zn and Fe) was assessed by extracting 10gm of soil sample with 20 ml of diethylenetriamine penta acetic acid (DTPA) extractant as described by Lindsay and Norvell (1978). The extract was fed to Atomic Absorption Spectrophotometer (Thermo). The data obtained with respect to these chemical properties was subjected to ANOVA as per the randomized block design and CD was calculated to differentiate between the treatment means.

Available phosphorous

The available phosphorus after harvesting rice crops varied between 10.68 and 14.93 kg ha^{-1} during 2018 and 11.57 to 15.08 in the year 2019 (Table 2). In the year 2018 and 2019 the phosphorus values were found to be non-significant between the treatments. The maximum phosphorus observed was 14.93 kg ha^{-1} and 15.08 kg ha^{-1} in T_7 during 2018 and 2019, respectively after the harvest of the rice crop. Two-year pooled data showed significantly higher available higher in T_7 (15.01 kg ha^{-1}) and it was at per with T_3, T_5 and T_2 with a value of 13.25, 12.77 and 12.54 kg ha^{-1}, respectively.

Available potassium

Application of organic manures significantly increased available K over control. Application of VC+NC (T_7) recorded maximum available potassium (197.42 kg ha^{-1} and 194.88 kg ha^{-1} during 2018 and 2019, respectively) after harvest of rice crop (Table 3). T_7 was at par with T_4 (194.54 kg ha^{-1}), T_6 (193.16 kg ha^{-1}), T_5 (192.01 kg ha^{-1}) and T_3 (189.35 kg ha^{-1}) during 2018 while it was significantly higher than T_8 (181.03 kg ha^{-1}), T_2 (179.27 kg ha^{-1}) and T_1 (control= 165.95 kg ha^{-1}). In the year 2019, T_7 was significantly higher compared to control but it was at par with all organic manure treatments as T_6 (194.28 kg ha^{-1}), T_4 (194.13 kg ha^{-1}), T_5 (192.27 kg ha^{-1}), T_3 (190.77 kg ha^{-1}), T_8 (189.43 kg ha^{-1}) and T_2 (180.17 kg ha^{-1}). The pooled data showed that T_7 was (196.15 kg ha^{-1}) significantly higher compared to T_1 (163.03 kg ha^{-1}) (control), T_2 (179.72 kg ha^{-1}), and T_8 (184.23 kg ha^{-1}) but it was at per rest of the organic manure treatments.

DTPA extractable zinc

After harvesting of rice crop DTPA zinc was between 0.97 to 1.10 mg kg^{-1} and 1.16 to 1.43 mg kg^{-1} during 2018 and 2019, respectively (Table 4). There was a no significant effect between the treatments. In pooled data highest DTPA zinc (1.23 mg kg^{-1}) was recorded in T_4 followed by T_7, however, all treatments were at par.

DTPA extractable iron

DTPA extractable iron varied between recorded 25.39 to 37.81 mg kg^{-1} and 26.14 to 31.85 mg kg^{-1} during 2018 and 2019, respectively after paddy harvest (Table 5). Application of organic manures did not significantly affect DTPA extractable iron compared to control treatment but organic manure treatments increased the DTPA extractable iron values compared to control treatments during the years 2018 and 2019. Similarly, no significant effect on two years pooled values was observed but overall organic manure treatments increased the DTPA extractable iron from 27.61 to 32.97 mg kg^{-1}. The lowest value (25.90 mg kg^{-1}) was noticed in the control treatment.

Discussion

Available phosphorus

The organic manures in combination with PM treatments showed significant impact on available phosphorus over control. Similar results have also been observed by Adhikary *et al.* (2013) [1], who cited that release of more available P from the decomposition of poultry manure which tend to have higher value in soils treated with organic manure. Meanwhile, Meena *et al.* (2020) [13] also suggested the low molecular organic acids viz., citric acid, oxalic acid, maleic acid which were released by microbial metabolic process which enhanced the Olsen's P through organic P solubilization in organic treatments. The significant improvement towards available phosphorus status might have observed because of added effect of green manure and organic manure, which could have attributed to solubilization of Fe-P, Al-P and reductant soluble P (Kumari *et al*., 2013 [12] and Alamgir *et al.*, (2012) [2]. Similar findings were also observed by several other workers (Pathak *et al.* 1992, Singh *et al.* 2004, Melero *et al.* 2008, Sharma and Singh, 2004, Surekha *et al*., 2010) [16, 19, 14, 17, 20], and they reported that combined application of organic and inorganic fertilizers is considered a good option to enhance nutrient recovery, plant growth and ultimate yield otherwise higher N and P application rates are required to attain better yield.

Available potassium

Organic manure treatments increased the available potassium in comparison to control. Similar results were reported by Adhikary *et al.*, (2013) [1] who reported that the highest exchangeable K content was observed in soils treated with organic manures than treated with synthetic fertilizer. Meanwhile, Choudhary and Suri (2009) [6] reported that FYM application at 10 t ha^{-1} resulted in significantly higher build-up of available K content in soil during both the years which might be due to slow release of these nutrients from organics, and repeated application of organics over the year. These findings conform with those of Thakur *et al.* (1999) [21], Singh and Chauhan (2002) [18], Du *et al.* (2020) [8], Choudhary *et al.* (2018) [7] and Cai *et al.* (2019) [5] and they observed that manure application significantly increased available potassium in soils.

DTPA extractable zinc

There were no significant differences between the treatments but organic manure treatments increased zinc content in soil compared to control. Similar results have been reported by Meena *et al.* (2020) [13] who cited that addition of easily decomposable and mineralizable low C: N ratio organic matter through FYM not only released a high quantity of available zinc but also induced the chemical and biological reactions that resulted in the dissolution and release of adsorbed zinc to the soil solution. Our results have also been corroborated by the findings of Sidhu and Sharma (2010), Chaudhary and Narwal (2005) and Moharana *et al.* (2017).

DTPA extractable iron

Iron content in soil was significantly increased by organic manures than control. T_4 (FYM 50% N+VC 50% N) and T_5 (FYM 50% N+PM 50% N) significantly increased iron content after harvest of rice crop during 2018 and 2019, respectively but were statistically at par with all the other organic manure treatments. These results have clearly indicated that addition of a high concentration of organic matter through FYM, VC and crop residues enhanced the microbial degradation of added organic matter and thus resulted in high organic carbon which ultimately resulted in high Fe content in these treatments (Meena *et al.* 2020) [13].

Conclusions

The significantly high phosphorus accumulation was noted in PM treatments when we compared pooled means. The pooled data for available K showed that T_7 was (196.15 kg ha^{-1}) significantly higher compared to T_1 (163.03 kg ha^{-1}) (control), T_2 (179.72 kg ha^{-1}) and T_8 (184.23 kg ha^{-1}) but it was at par rest of the organic manure treatments. The pooled data of DTPA Zn was between 1.07 to 1.23 after harvest of rice crop. However, after harvest of rice it was observed that DTPA Zn in soils increased but no significant difference between the treatments was noted. The pooled data for DTPA Fe showed that T_5 (FYM+VC) had highest DTPA extractable iron (32.97 mg kg^{-1}) and the lowest was T_1 control (25.90 mg kg^{-1}) but it was no significantly difference between the treatments. The study concludes that application of organic manures improved chemical properties when compared with no application of manures. However, all manures may not behave similarly in soil. The results indicated that combinations of VC with PM significant increased available phosphorus and potassium. DTPA Fe was highest in FYM with VC after harvest of rice.

Table 1: Initial soil physico-chemical properties of experimental site

Sand (%)	62.67
Silt (%)	5.31
Clay (%)	32.02
Textural class	Sandy clay loam
Available N (kg ha^{-1})	196.2
Available P (kg ha^{-1})	11.01
Available K (kg ha^{-1})	168.12
Available Zn (mg kg^{-1})	0.99
Available Fe (mg kg^{-1})	28.23

Table 2: Effect of organic nutrient management on available phosphorus (kg ha^{-1})

Treatment	Rice		
	2018	**2019**	**Pooled**
T_1 Control	10.68	11.57	11.13
T_2 FYM (100% N)	12.25	12.84	12.54
T_3 VC (100% N)	12.92	13.59	13.25
T_4 FYM (50% N)+VC (50% N)	11.20	12.02	11.61
T_5 FYM (50% N)+PM (50% N)	11.95	13.59	12.77
T_6 FYM (50% N)+NC (50% N)	11.20	11.65	11.42
T_7 VC (50% N)+PM (50% N)	14.93	15.08	15.01
T_8 VC (50% N)+NC (50% N)	11.20	13.29	12.25
SE (m) ±	1.14	1.19	1.37
CD at 5%	NS	NS	2.74

Table 2: Effect of organic nutrient management on available potassium (kg ha^{-1})

Treatment	Rice		
	2018	**2019**	**Pooled**
T_1 Control	165.95	160.12	163.03
T_2 FYM (100% N)	179.27	180.17	179.72
T_3 VC (100% N)	189.35	190.77	190.06
T_4 FYM (50% N)+VC (50% N)	194.54	194.13	194.34
T_5 FYM (50% N)+PM (50% N)	192.01	192.27	192.14
T_6 FYM (50% N)+NC (50% N)	193.16	194.28	193.72
T_7 VC (50% N)+PM (50% N)	197.42	194.88	196.15
T_8 VC (50% N)+NC (50% N)	181.03	189.43	184.23
SE (m) ±	3.57	5.25	4.66
CD at 5%	10.83	15.91	9.34

Table 4: Effect of organic nutrient management on DTPA extractable zinc (mg kg^{-1}) content

Treatment	Rice		
	2018	2019	Pooled
T_1 Control	0.97	1.16	1.07
T_2 FYM (100% N)	1.01	1.37	1.19
T_3 VC (100% N)	0.91	1.31	1.11
T_4 FYM (50% N)+VC (50% N)	1.09	1.37	1.23
T_5 FYM (50% N)+PM (50% N)	0.98	1.33	1.15
T_6 FYM (50% N)+NC (50% N)	0.95	1.43	1.19
T_7 VC (50% N)+PM (50% N)	1.10	1.33	1.22
T_8 VC (50% N)+NC (50% N)	1.01	1.38	1.19
SE (m) ±	0.11	0.10	0.11
CD at 5%	NS	NS	NS

Table 5: Effect of organic nutrient management on DTPA extractable iron (mg kg^{-1}) content

Treatment	Rice		
	2018	2019	Pooled
T_1 Control	25.39	26.41	25.90
T_2 FYM (100% N)	29.33	29.89	29.61
T_3 VC (100% N)	30.03	28.31	29.17
T_4 FYM (50% N)+VC (50% N)	37.81	28.13	32.97
T_5 FYM (50% N)+PM (50% N)	32.17	31.85	32.01
T_6 FYM (50% N)+NC (50% N)	34.41	27.96	31.19
T_7 VC (50% N)+PM (50% N)	30.11	30.87	30.49
T_8 VC (50% N)+NC (50% N)	29.08	26.14	27.61
SE (m) ±	3.96	1.74	3.17
CD at 5%	NS	NS	NS

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