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Dissemination Pattern of Available Nutrients and Biological Properties of Soil under Sugarcane–Wheat Cropping System

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ABSTRACT

The depth wise soils of sugarcane- wheat cropping system from four blocks of Moradabad district were analysed to find the physico – chemical properties like soil texture, bulk density, pH, EC, CEC, organic carbon, total nitrogen, macro & micronutrients. The pH of soil samples varied between 7.2 to 8.9. The range of electrical conductivity of 1:2 soil water extraction was 0.139 to 0.705 d Sm^{-1} at 25 ^{0}C. None of the soil was found in saline category. CEC of soil varied between 12.08 to 21.10 cmol (p^+)/kg of soil. Generally, CEC was positively and significantly correlated with clay content. The organic carbon content which decline with soil depth varied between 2.4 to 7.2 g kg/ha soil. Organic carbon was correlated positively and highly significantly with available nitrogen, total nitrogen, positively with available P, K, micronutrient and microbial biomass carbon and negatively with bulk density and CEC in all the cropping sequences soil. The available nitrogen ranged from 55.62 to 138.05 kg/ha. It decline with soil depth. Total nitrogen in soil decline with increasing soil depth and ranged from 522.27 to 2924.78 kg /ha. The available phosphorus and potassium ranged from 4.53 to 26.87 and 92.0 to 189.84 kg $ha^{-1}$and declined with increasing soil depth. Among the different cationic micronutrients with exception of zinc the availability of rest micronutrients was in sufficiency range. In some case the availability of zinc was in deficient range. DTPA extractable Cu ranged from 0.598 to 1.973, Fe 4.245 to 15.413, Mn 2.025 to 4.35 and Zn 0.213 to 1.961 mg kg/ha soil. The availability of these micronutrients declined with increase in soil depth. Except Mn and available potassium others nutrients were significantly and positively correlated with organic carbon. The biological properties of soil, the range of bacteria varied from 2.1 to 5.6 x 10^6, fungi 1.8 x $10^4$to 2.2 x 10^4 and actinomycetes 1.5 x 10^4 to 2.7 x10^4 count g^{-1} soil, microbial biomass carbon 255-290 µg /g soil and dehydrogenase activity 61 to 72 µg TPF g/day.

Key Words: Bulk density, Cropping system, Electric conductivity, Macro & micronutrient, Microbiological properties, Soil texture, Sugarcane-Wheat.

INTRODUCTION

In India, the sugar industry is the second largest agriculture based industry after textile fibers (Krishnamoorthy and Nandhini, 2017). In India Sugarcane- wheat cropping system account for about three fourth of the total food grain production, the nutrient removal by the system for exceeds the amount replenished through fertilizers causing much greater strain on native soil recourse. Cultivation of two cereals for a year on the same piece of land had lead to soil fertility problem and the yield of both crops is decline. Recently stagnation or declining tread in sugarcane- wheat productivity at same location has been reported (Singh *et al,* 1992) which may be associated with declining in soil organic matter content and other edaphic factors. On the other hand crop residues in machine harvested area are being burnet to clear the field for planting the next crop this practice results in loss of valuable organic matter and nutrients particularly nitrogen and sulphur, and caused environmental problem. The incorporation of crop residue in sugarcane – wheat cropping system is therefore, desirable under integrated plant nutrient

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management system but its impact on soil fertility and productivity is not well understood. Continuous cropping of rice- wheat sequence for several decades as well as contrasting need of these two crops has resulted in increased pest pressure, nutrient mining and declining yield in some area. To meet the food demand of an increasing population, tremendous pressure is being put on land resources to fulfill their potential. The capacity of new cultivars to give high yield must be exploited without causing any deterioration in soil quality. However continuous application of excessive amount of fertilizer in intensive cropping system harms the soil. With improvement in irrigation techniques and the introduction of high yielding varieties, sugarcane-wheat cropping system become popular in India. Soil characterization in relation to evaluation of fertility status of the soil of an area or region is an important aspect for sustainable crop production because of imbalance and inadequate fertilizer use efficiency of chemical fertilizer has declined tremendously under intensive cropping system in recent year (Chandra *et al.,* 2008). Information on soil fertility status of macro and micro nutrients of these study area in not available therefore present study was carried out to evaluate the soil fertility status of sugarcane- wheat cropping system in different locations of four block of Moradabad district in Uttar Pradesh.

MATERIALS AND METHODS

The experiment was conducted during the year 2017-2018. The soil samples from 0-15, 15-30 and 30-45 cm depth were collected from different locations of four block of Moradabad district under Sugarcane- wheat cropping sequence with the help of auger and collected samples were air dried in shade, crushed gently with a wooden roller and pass through 2.0 mm sieve to obtain a uniform representative sample. The processed soil samples were analyzed for physico– chemical properties using standard method for pH and electrical conductivity (1:2 soil water suspensions), organic carbon (Walkley and Black, 1934), available nitrogen (Subhiah and Asija, 1956), available phosphorus (Olsen *et al,* 1954), available potassium (Jackson, 1973) and cationic micronutrients (Fe, Mn, Cu and Zn) in soil samples extracted with a diethylene triamine penta acetic acid (DTPA) solution (0.005M) DTPA + 0.01 M $Cacl_2$ + 0.1 M triethanolamine , pH 7.3 as outlined by Lindsay and Norvell (1978). The concentration of micronutrients was determined by atomic absorbtion spectrophotometer (GBC Avanta PM). For the biological properties Soil samples were incubated at 25 ±1 C for 7 days. Soil moisture content during incubation was adjusted to field capacity for all the microbial counts and biochemical properties were studied as described by Wollum (1982). All the analysis of soil samples was carried out in laboratory of Krishi Vigyan Kendra, Dhamora, Rampur, SVPUA&T, Modipuram Meerut.

RESULTS AND DISCUSSION

The soil samples collected from different locations of four blocks Moradabad district where sugarcane - wheat farming system was followed by farmers usually apply 150-160 kg N/ha along with 75-80 kg P/ha. Zinc application in sugarcane-wheat farming system done by 45 percent of farmers while green manuring practiced by 10-12 percent farmers and biofertilizers use was not prevalent. It was noted that 85 percent farmers reported increased use of fertilizers to harvest same quantity of sugarcane yield at different locations of four blocks of Moradabad districts of Uttar Pradesh.

Chemical properties and Soil Reaction (pH)

It was observed (Table 1) that soil pH ranged between 7.2 to 8.6 for surface soil (0 -15 cm) while 7.5 to 8.9 in subsurface soil (30 - 45 cm). The soil EC ranged from 0.269 to 0.600 dSm^{-1} for surface soil while 0.155 to 0.755 dSm^{-1} in subsurface soil with an average value of 0.392 and 0.336 dSm^{-1}. The CEC ranged from 14.69 to 21.10 cmol (p^+) / kg^{-1} for surface soil (0-15 cm) while 14.33 to 21.01 cmol (p^+) kg^{-1} in subsurface soil (30- 45cm) with an average value of 17.45 and 17.02 cmol (p^+) /kg soil.

Table 1. Physico-chemical properties of soil under sugarcane-wheat cropping sequence in 4 blocks of district Moradabad.

Location	Depth (cm)	pH	EC (dSm^{-1})	CEC (cmol (p^+) kg^{-1})	O.C. g/kg	Available macronutrients		
						N (kg/ha)	P(kg/ha)	K (kg/ha)
Thakurdwara	0-15	7.2	0.352	15.20	7.2	138.05	26.87	165.70
	15-30	7.4	0.283	13.75	6.9	120.51	21.52	121.97
	30-45	7.5	0.239	14.33	3.8	102.62	15.43	105.17
Dilari	0-15	7.6	0.269	14.69	6.5	128.09	19.33	118.71
	15-30	7.8	0.139	12.08	4.8	72.02	12.31	101.47
	30-45	7.8	0.155	14.50	2.4	55.62	10.70	92.00
Bhagatpur Tanda	0-15	8.6	0.600	21.10	6.8	105.65	17.67	217.51
	15-30	8.8	0.705	20.34	4.4	69.46	9.48	189.84
	30-45	8.9	0.755	18.26	2.9	57.90	4.53	158.66
Chhajlait	0-15	7.8	0.346	18.82	6.7	132.70	21.75	162.50
	15-30	7.9	0.154	15.56	5.4	102.20	16.65	144.90
	30-45	8.2	0.195	21.01	3.2	88.86	11.16	127.30
Mean	0-15	7.8	0.392	17.45	6.80	126.12	21.41	166.10
	15-30	7.9	0.320	15.43	5.30	91.05	14.99	139.55
	30-45	8.1	0.336	17.02	3.07	76.25	10.46	120.78

Organic Carbon content

The organic carbon in surface (0-15cm) and subsurface soil (30-45cm) varied from 6.5 to 7.2 and 2.4 to 3.8 g/kg soil with an average value of 6.80 and 3.07 g/kg, respectively. The maximum organic carbon content 7.2 g/kg at surface (0-15 cm) was found in soil of Thakurdwara block while minimum 6.5 g/kg in Dilari block. In the sub surface soil maximum organic carbon content 3.8 g/kg was found in Thakurdwara block and minimum 2.4 g/kg Dilari block. Lower organic carbon in the area may be due to prevailing high temperature and good aeration in the soil which increase the rate of oxidation of organic matter content. Aggarwal *et al* (1990) reported that the organic carbon content of some arid sols of western Rajasthan ranged from 0.14 to 0.40 percent in surface soil. Organic carbon was low and generally decreases with depth.

Nutrients status and soil fertility

Nitrogen

Soil fertility exhibits the status of different soils with regard to the amount and availability of nutrients essential for plant growth. The available nitrogen content in surface (0-15cm) and subsurface soil (30-45cm) varied from 105.65 to 138.05 and 55.62 to 102.62 with an average value of 126.12 and 76.25 kg/ha (Table1) suggesting that all soils were low in available nitrogen. Available nitrogen was found to be maximum 138.05 kg/ha in Thakurdwara and minimum 105.65 kg/ha in Bhagatpur Tanda in surface soil (0-15 cm) while in sub surface soil (30-45cm) the highest available nitrogen 102.62 kg / ha in Thakurdwara and minimum 55.62 kg/ ha in Dilari block. The available nitrogen content was low and generally decreases regularly with increasing depth which is due to decreasing trend of organic carbon with depth and because cultivation of crops is mainly confined to the surface soil only at regular interval the depleted nitrogen is supplemented by the external addition of fertilizers during crop cultivation (Prasuna Rani et al. 1992). Walia *et al* (1998) reported that available nitrogen in the soils of Bundelkhand region accounted for 12 to 40 percent

of total N in the range of 95 to 159 N/kg in surface soil and 51 to 159 mg N/kg in sub surface horizon. The continuous mineralization if organic matter in surface soils was responsible for the higher values.

Phosphorus

In sugarcane- wheat cropping sequence the available phosphorus in surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) varied between 17.67 to 26.87, 9.48 to 21.52 and 4.53 to 15.43 kg/ha with an average value of 21.41, 14.99 and 10.46 kg/ha, respectively. The mean value of available phosphorus for 0- 45 cm depth varied from 2.85 to15.94 kg/ha. The highest available phosphorus was observed in the surface soil and decrease with increasing depth. It might be due to the confinement of crop cultivation to the rhizosphere and supplementing the depleted P by external sources. The lower P content in sub surface soil could be attributed to the fixation of released phosphorus by clay minerals (Leelavathi *et al,* 2009).

Potassium

The available potassium in surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) varied between 118.71 to 217.51, 101.47 to 189.84 and 92.0 to158.66 kg/ha with an average value of 166.10, 139.55 and 120.78 kg /ha, respectively. The available potassium was higher in surface soil and it's declined with increasing soil depth.

Copper

The DTPA extractable Cu varied between 0.925 to 1.973 mg/kg soil in surface (0-15cm) while 0.881 to 1.213 and 0.150 to 0.890 mg/kg in sub surface soil (15-30 & 30-45cm) with an average value of 1.567, 0.981 and 0.603 mg/kg soil, respectively. All the soil sample in sugarcane- wheat farming system were found to be sufficient in available copper content by considering the critical limit of 0.20 mg/kg soil suggested by Lindsay and Norvell (1978). A decreasing trend in available copper with increasing depth was noticed in all locations. The available copper was more in surface layer and decreased with depth.

Iron

The DTPA- extractable iron in surface (0-15cm) and sub surface soil (15-30 & 30- 45cm) varied between 12.76 to16.710, 5.850 to 10.961 and 4.245 to 8.087 mg/kg soil with an average value of 14.41, 8.75 and 5.88 mg/kg soil, respectively. According to critical limit of 4.5 mg/kg soil as proposed by Lindsay and Norvell (1978) all the surface soil (0-15cm) was sufficient in available iron. A decreasing trend with depth in available Iron was noticed in all locations of sugarcane- wheat farming sequence.

Mn

The DTPA- extractable Mn content in surface (0-15cm) and subsurface soil (15-30 & 30-45cm) varied between 3.267 to 5.191, 2.043 to 4.001 and 2.025 to 3.167 mg/kg soil with an average value of 4.10, 2.944 and 2.388 mg/kg soil, respectively.. According to critical limit of 1.0 mg/kg as proposed by Lindsay and Norvell (1978) all the soil of four block of Moradabad district was sufficient in available Mn.

Zn

The DTPA -extractable Zn ranged between 0.823 to 1.961 mg/kg in surface (0-15cm) While 0.560 to 1.105 and 0.213 to 0.828 mg/kg soil in sub surface soil (15-30 & 30-45cm) with an average value of 1.373, 0.820 and 0.522 mg/kg soil for surface and subsurface soil, respectively. Considering 0.6 mg/kg as critical level (Lindsay and Norvell 1978) all the surface soil sample with exception of Bhagatpur Tanda and Chhajlait sub surface (30-45cm) was sufficient in available Zn content.

Microbiological Properties

In sugarcane- wheat cropping sequence the no. of viable bacteria varied between 3.6 X 10^6 to 5.5 X 10^6, 4.1×10^4 to 5.6×10^4 and 2.1 X 10^2 to 4.8 X 10^2 count/g soil for surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) with an average value of 4.62 X 10^6, 4.62×10^4 and 3.4 x 10^2 count/g soils, respectively. In sugarcane- wheat cropping sequence the fungi population in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied

Table 2. DTPA extractable micronutrients (mg/kg) at various depths under sugarcane-wheat cropping sequence.

Location	Depth (cm)	Available micronutrients			
		Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Thakurdwara	0-15	15.413	4.350	0.925	1.961
	15-30	10.270	3.303	0.881	1.105
	30-45	6.250	2.250	0.775	0.828
Dilari	0-15	12.760	3.860	1.849	1.822
	15-30	7.925	2.043	1.213	0.983
	30-45	4.245	2.025	0.150	0.594
Bhagatpur Tanda	0-15	16.701	5.191	1.973	0.823
	15-30	10.961	4.001	0.912	0.633
	30-45	8.087	3.167	0.890	0.213
Chhajlait	0-15	12.783	3.267	1.523	0.889
	15-30	5.850	2.432	0.920	0.560
	30-45	4.953	2.110	0.598	0.453
Mean	0-15	14.41	4.100	1.567	1.373
	15-30	8.75	2.944	0.981	0.820
	30-45	5.88	2.388	0.603	0.522

between 1.8 x 10^4 to 2.2 x 10^4 , 1.3 x 10^2 to 2.3 x 10^2 and1.0 x 10^2 to 1.7 x 10^2 count /g soil with an average value of 2.07 x 10^4 , 1.87 x 10^2 and 1.5 x 10^2 count/g soil, respectively. In sugarcane-wheat cropping sequence actinomycetes population of surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied between 1.5x 10^4 to 2.0 x10^4 , 1.2 x 10^2 to 2.3 x 10^2 and 1.0 x 10^2 to 1.8 x 10^2 count/g soil with an average value of 2.0 x 10^4, 1.77 x 10^2 and 1.27 x 10^2 count/g soil respectively. In sugarcane- wheat cropping sequence microbial biomass carbon in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied between 255 to 290, 180 to 192 and 79 to 110 µg/g soil with an average value of 275.75, 188.0 and 94.50 µg/g soil, respectively . The mean value microbial biomass carbon for 0-45cm depth varied from 153.00 to 178.33 µg/g soil. In sugarcane- wheat cropping sequence dehydrogenase enzyme activity in surface (0-15cm) and subsurface soil (15-30 & 30-45) varied between 61 to 72, 26 to 41 and 16 to 24 µg TPF/ g soil per day with an average value 67.75, 34.75 and 20.25 µgTPF/g soil /day.

CONCLUSION

The study of soil samples of four blocks of Moradabad district revealed that the soil were normal to moderately alkaline in reaction, low to medium in organic carbon. As far as nutrient status in concerned on the bases of mean value, the soils were low in available nitrogen, low to medium in available phosphorus and potassium and in general sufficient in available Cu, Fe, Mn and Zn in surface soil and declined with soil depth. Among the biological properties of soil, the range of bacteria varied between 3.6 to 5.5 x 10^6, fungi 1.8 x 10^4 to 2.2 x 10^4 and actinomycetes 1.5 x 10^4 to 2.7 x10^4 count/g soil. Microbial biomass carbon 255-290 µg/ g soil and dehydrogenase activity 61 to 72 µg TPF/g/day. All the microbial population, microbial biomass carbon and dehyrogenase activity decline as the soil depth increases.

Table 3. Bacteria, fungi , Actinomycets, microbial biomass carbon and dehydrogenase activity at various depths under sugarcane-wheat cropping sequence.

Location	Deph cm.	Bacteri (Count/g soil)	Fung(Count/ g soil)	Actinomycets, (Count/g soil)	microbial biomass carbon (µg/g soil)	dehydrogenase activity (Mg TPF/g soil)
Thakurdwara	0-15	3.6×10^6	1.8×10^4	1.5×10^4	280	70
	15-30	4.1×10^4	1.3×10^2	1.2×10^2	190	26
	30-45	2.1×10^2	1.0×10^2	1.1×10^2	110	16
Dilari	0-15	4.8×10^6	2.2×10^4	2.7×10^4	255	61
	15-30	4.3×10^4	2.0×10^2	2.3×10^2	190	33
	30-45	2.6×10^2	1.7×10^2	1.8×10^2	90	19
Bhagatpur Tanda	0-15	4.6×10^6	2.2×10^4	2.0×10^4	290	72
	15-30	4.5×10^4	2.3×10^2	2.1×10^2	192	39
	30-45	4.1×10^2	1.7×10^2	1.2×10^2	99	22
Chhajlait	0-15	5.5×10^6	2.1×10^4	1.8×10^4	278	68
	15-30	5.6×10^4	1.9×10^2	1.5×10^2	180	41
	30-45	4.8×10^2	1.6×10^2	1.0×10^2	79	24
Mean	0-15	4.62×10^6	2.07×10^4	2.0×10^4	275.75	67.75
	15-30	4.62×10^4	1.87×10^2	1.77×10^2	188.00	34.75
	30-45	3.4×10^2	1.5×10^2	1.27×10^2	94.50	20.25

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