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Evaluation of Soil Fertility for Sustainable Crop Production under Maize – Wheat Cropping System in Different Location of Meerut and Bulandshahr District of Uttar Pradesh

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Abstract

The soil samples were collected from different locations of maize- wheat farming system. The pH of soil samples varied from 7.1 to 8.6. The range of electrical conductivity of 1:2 soil water extraction was 0.196 to 0.391d Sm^{-1} at 25 ^{0}C. None of the soil was found in saline category. CEC of soil varied from 11.34 to 17.13 cmol (p^+) kg^{-1} soil. Generally CEC was positively and significantly correlated with clay content. The organic carbon content which declined a with soil depth varied from 6.7 to 7.7 g kg^{-1} 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 88.79 to 126.94 kg ha^{-1}. It decline with soil depth. Total nitrogen in soil decline a with increasing soil depth and ranged from 1775.13 to 2924.78 kg ha^{-1}. The available phosphorus and potassium ranged from 2.77 to 28.74 and 103.34 to 1291.41 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 0.987 to 7.939, Fe 5.980 to 7.279, Mn 1.921 to 4.443 and Zn 0.669 to 1.613 mg kg^{-1} soil. The availability of these micronutrients declined with increase in soil depth. Except Mn and available potassium other nutrients were significantly and positively correlated with organic carbon.

Key words:- *Maize-wheat, cropping system, physico-chemical and biological properties*

Introduction

Continuous application of excessive amount of fertilizer in intensive cropping system harms the soil. With improvement in irrigation techniques and the introduction of high yield variety: maize – wheat cropping system has become popular in India. Continuous cultivation of same crop on same field by the farmers coupled with inadequate replenishment on nutrients from the external sources has led to severe depletion of soil available nutrients in this area. 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[4] because of imbalance and inadequate fertilizer use efficiency of chemical fertilizer has decline tremendously under intensive cropping system in recent year[2].

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 rice – wheat cropping system of Meerut and Bulandshar district of Uttar Pradesh. An attempt was also made to correlate soil available nutrients content with other soil properties.

Materials and methods

The experiment was conducted during the year 2009-2010. The soil samples of 0-15, 15-30 and30-45 cm depth were collected from four different locations of Meerut and Bulandshar districts under maize wheat

cropping sequence. The processed soil samples were analyzed for physico – chemical properties using standard methods.

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.

Results and Discussion

Soil Reaction (pH)

It was observed (Table 1) that soil pH ranged from 7.1 to 8.6 for surface soil (0 -15 cm) while 7.6 to 8.6 in subsurface soil (30 - 45 cm). The soil EC ranged from 0.196 to 0.391 dSm^{-1} for surface soil while 0.167 to 0.298 dSm^{-1} in subsurface soil. The CEC ranged from 11.34 to 17.13 cmol (p^+) kg^{-1} for surface soil (0-15 cm) while 8.91 to 28.26 cmol (p^+) kg^{-1} in subsurface soil (30-45cm) cmol (p^+) kg^{-1} soil.

Organic Carbon content

The organic carbon in surface (0-15cm) and subsurface soil (30-45cm) varied from 6.7 to 7.7 and 2.8 to 3.3 g kg^{-1} soil , respectively. The Maximum organic carbon content 7.7 g kg^{-1} at surface (0-15 cm) was found in soil of Khandawali Meerut while minimum 4.8 g kg^{-1}in Harthala, Bulandshahr. In the sub surface soil maximum organic carbon content 3.8 g kg^{-1} was found in Nagli Isha, Meerut and minimum 3.2 g kg^{-1} Harthala, Bulandshahr. 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. The organic carbon content of some Aridosols of western Rajasthan ranged from 0.14 to 0.40 % in surface soil. Organic carbon was low and generally decreases with depth[1].

Nitrogen

The available nitrogen content in surface (0-15cm) and subsurface soil (30-45cm) varied from 88.79 to 126.94 and 42.11 to 82.25 kg ha^{-1} (Table-1) suggesting that all soils were low in available nitrogen. Available nitrogen was found to be maximum 126.94 kg ha^{-1} in Kalakhori, Bulandshahr and minimum 88.79 kg ha^{-1} in Kharkhoda, Meerut in surface soil (0-15 cm) while in sub surface soil 30-45cm) the highest available nitrogen 82.25 kg ha^{-1} in Khandawali and minimum 42.11 kg ha^{-1} in Harthala, Bulandshahr. 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 the reported that available nitrogen in the soils of Bundelkhand region accounted for 12 to 40 % of total N in the range of 95 to 159 N kg^{-1} in surface soil and 51 to 159 mg N kg^{-1} in sub surface horizon[1,8]. The continuous mineralization if organic matter in surface soils was responsible for the higher values.

Phosphorus

In maize- wheat cropping sequence the available phosphorus in surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) varied from 2.77to 28.74, 0.58 to 16.92 and 0.02 to 15.45 kg ha^{-1}, respectively. Available phosphorus was found to be maximum 28.74kg ha^{-1} in Harthala,Bulandshahr and minimum 2.77 kg ha^{-1} in Kharkhoda, Meerut in surface soil (0-15 cm) while in sub surface soil 30-45cm) the highest available nitrogen 15.45 kg ha^{-1} in Harthala and minimum 0.02 kg ha^{-1} in Khandawali, Meerut.kg ha^{-1}. 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[5,6].

Potassium

In maize - wheat cropping sequence the available potassium in surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) varied from 103.39 to 1291.41, 85.05 to 449.34 and 109.39 to 570.83 kg ha^{-1}, respectively. Available potassium was found to be

maximum 1291.41 kg ha^{-1} in Harthala, Bulandshahr and minimum 103.34 ha^{-1} in Kharkhoda, Meerut in surface soil (0-15 cm) while in sub surface soil 30-45cm) the highest available nitrogen 570.83 kg ha^{-1} in Harthala, Bulandshahr and minimum 109.39 kg ha^{-1} in Khandawali, Meerut.kg ha^{-1}. The available potassium was higher in surface soil and it's declined with increasing soil depth.

Micronutrients

Copper

The DTPA extractable Cu in maize - wheat cropping sequence varied from 0.861 to 7.939 mg kg^{-1} soil in surface (0-15cm) while 0.379 to 0.797 and 0.079 to 0.593 mg kg^{-1} in sub surface soil (15-30 & 30-45cm), respectively. All the soil sample in maize-wheat farming system were found to be sufficient in available Cu content by considering the critical limit of 0.20 mg kg^{-1} soil**.** A decreasing trend in available Cu with increasing depth was noticed in all locations. The available Cu was more in surface layer and decreased with depth.

Iron

In sorghum – wheat cropping sequence the DTPA- extractable iron in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied from 5.980 to 7.279, 2.927 to 5.627 and 2.381 to 4.807 mg kg^{-1} soil, respectively. According to critical limit of 4.5 mg kg^{-1} soil. All the surface soil (0-15cm) were sufficient in available Fe. A decreasing trend with depth in available Fe was noticed in all locations of sorghum – wheat farming sequence.

Mn

In maize – wheat cropping sequence the DTPA- extractable Mn content in surface (0-15cm) and subsurface soil (15-30 & 30-45cm) varied from 1.921 to 4.443, 1.517 to 4.071 and 1.264 to 3.360 mg kg-1 soil, respectively.. According to critical limit of 1.0 mg kg^{-1}, all the soils were sufficient in available Mn.

Zn

In maize - wheat cropping sequence the DTPA -extractable Zn ranged from 0.609to 1.013 mg kg^{-1} in surface (0-15cm) While 0.235 to 0.789 and 0.212 to 0.667 mg kg^{-1} soil in sub surface soil (15-30 & 30-45cm), respectively. Considering 0.6 mg kg^{-1} as critical level all the surface soil samples were sufficient in available Zn content.

Microbiological Properties:

Population of bacteria in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied from 4.2 x 10^6 to 8.5 x 10^6, 4.4 x 10^4 to 9.2 x 10^4 and 4.7 X 10^2 to 9.6 x 10^2 count g^{-1} soil with an average value of 6.3 x $10^{6,}$ 6.5 x 10^4 and 6.4 x 10^2 count g^{-1} soil, respectively.

The fungi population in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied from 1.3 x 10^4 to 2.9 x $10^{4,}$ 1.5 x 10^2 to 2.9 x 10^2 and 1.0 x 10^2 to 2.4 x 10^2 count g^{-1} soil with an average value of 3.12 x 10^4, 2.22 x 10^2 and 1.62 x 10^2 count g^{-1} soil, respectively.

Actinomycetes population under maize-wheat cropping sequence in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied from 1.5 x 10^4 to 3.1 x 10^4, 1.6 x 10^2 to 3.2 x 10^2 and 1.2 x 10^2 to 2.1 x 10^2 count g^{-1} soil with an average value of 2.25 x 10^4, 2.30 x 10^2 and 1.57 x 10^2 count g^{-1} soil, respectively.

Microbial biomass carbon in surface (0-15cm) and sub surface soil (15-30 & 30-45cm) varied from 210 to 240, 145 to 165 and 75 to 78 µg g^{-1} soil, with an average value of 227.75, 155.25 and 76.25 µg g^{-1} soil, respectively. The mean value of microbial biomass for 0-45 cm depth varied from 147.00 to 159.33 µg g^{-1} soils.

Dehydrogenase enzyme activity in maize - wheat cropping sequence in surface (0-15 cm) and sub surface soil (15-30 & 30-45cm) varied from 60 to 67, 17 to 35 and 10 to 16 µg TPF g^{-1}soil day^{-1} with an average value of 62.27, 26.00 and 12.50 µg TPF g^{-1}soil day^{-1}, respectively. The mean value of dehydrogenase enzyme for 0-45 cm depth varied from 30 to 37 µg TPF g^{-1}soil day^{-1}.

Correlations

Soil organic carbon showed positive and highly significant correlation with available N ($r = 0.746^{**}$), total N ($r = 0.740^{**}$),

microbial biomass carbon (r = 0.886**), Fe (r = 0.788**) and positive & significant with Zn (r = 0.644*) and only positive correlation with available P (r = 0.368), available K (r = 0.239), Cu (r = 0.539), Mn (r = 0.408) while a negative and highly significant correlation with bulk density (r = - 0.798**) and negative correlation with CEC (r = - 0.202).

The soil pH showed negative correlation with Cu (r = - 0.131), Fe (r = - 0.281) while highly significant & negative correlation with Mn (r = - 0.703**). However, soil pH is positively correlated with Zn (r = 0.218). CEC of soil is significantly and negatively correlated with sand (r = - 0.695*) but positively and significantly with Silt (r = 0.690*) and clay (r = 0.582*). Available soil nitrogen is positively correlated with total N (r = 0.542) while highly significantly and positively with microbial biomass carbon (r = 0.764**).

Table 1 Physico-chemical properties of soil under Maize –wheat cropping sequence Meerut and Bulandshahr districts

Locations	Depth (cm)	pH	EC (dSm^{-1})	CEC($cmol(p^{+})$ kg^{-1})	BD mg/m^{3}	O.C. g/kg	Available macronutrients		
							N ($kgha^{-1}$)	P ($kgha^{-1}$)	K ($kgha^{-1}$)
Harthala (B)	0-15	8.5	0.244	11.69	1.35	6.7	117.69	28.74	1291.41
	15-30	8.7	0.183	11.08	1.38	3.2	58.29	16.92	449.34
	30-45	8.6	0.260	08.91	1.42	3.1	42.11	15.45	570.83
Kalakhori (B)	0-15	8.0	0.391	14.21	1.32	7.6	126.94	15.45	108.57
	15-30	8.3	0.247	11.56	1.35	3.5	84.30	11.06	85.05
	30-45	8.3	0.204	17.04	1.42	3.3	66.36	10.33	115.01
Khandawali (M)	0-15	7.1	0.214	11.34	1.32	7.7	96.09	13.01	341.55
	15-30	7.4	0.228	10.21	1.38	3.6	86.81	0.58	109.70
	30-45	7.6	0.298	17.65	1.43	2.8	82.25	0.02	109.39
Kharkhoda (M)	0-15	8.6	0.196	17.13	1.30	7.5	88.79	2.77	103.34
	15-30	8.5	0.194	29.56	1.33	3.8	78.89	1.21	104.73
	30-45	8.3	0.167	28.26	1.38	3.1	75.65	0.46	119.02
Mean	0-15	-	0.260	13.59	1.32	7.37	107.37	14.99	461.21
	15-30	-	0.210	15.60	1.36	3.52	77.07	7.44	187.20
	30-45	-	0.230	17.96	1.41	3.07	66.59	6.56	228.56

In parentheses B denotes Bulandshahr and M for Meerut.

Table 2 DTPA extractable micronutrient (mg kg^{-1}) at various soil depths under Maize – wheat cropping sequence

Locations	Depth (cm)	Available micronutrients			
		Fe $mgkg^{-1}$	Mn $mgkg^{-1}$	Cu $mgkg^{-1}$	Zn $mgkg^{-1}$
Harthala (B)	0-15	6.145	3.159	0.861	1.613
	15-30	2.927	1.517	0.379	0.789
	30-45	2.381	1.463	0.079	0.667
Kalakhori (B)	0-15	6.215	4.143	7.939	0.823
	15-30	5.473	3.975	0.771	0.420
	30-45	4.752	3.360	0.487	0.263
Khandawali (M)	0-15	7.279	4.443	1.029	0.881
	15-30	4.034	4.071	0.605	0.235
	30-45	3.642	2.840	0.514	0.212
Kharkhoda (M)	0-15	5.980	1.921	0.987	0.669
	15-30	5.627	1.766	0.797	0.410
	30-45	4.807	1.264	0.593	0.355
Mean	0-15	6.404	3.416	2.704	0.996
	15-30	4.515	2.832	0.638	0.463
	30-45	3.879	2.231	0.418	0.374

In parentheses B denotes Bulandshahr and M for Meerut.

Table 3 Bacteria(Countg^{-1}soil), Fungi (Countg^{-1}soil), Actinomycets microbial biomass carbon and Dehydrogenase activity (Mg TPF g^{-1} soil) at various soil depths under Maize – wheat cropping sequence

Location	Depth, cm	Bacteria (Countg^{-1}soil),	Fungi (Countg^{-1}soil),	Actinomycetes (Countg^{-1}soil),	Microbial biomass carbon µg g^{-1} soil	Dehydrogenase activity Mg TPF g^{-1} soil
Harthala (B)	0-15	4.2×10^{6}	1.3×10^{4}	1.5×10^{4}	226	60
	15-30	4.4×10^{4}	1.5×10^{2}	1.7×10^{2}	155	35
	30-45	4.8×10^{2}	1.1×10^{2}	1.2×10^{2}	77	16
Kalakhori (B)	0-15	5.3×10^{6}	1.6×10^{4}	1.9×10^{4}	240	67
	15-30	5.1×10^{4}	1.8×10^{2}	1.6×10^{2}	145	32
	30-45	4.7×10^{2}	1.0×10^{2}	1.2×10^{2}	75	12
Khandawali (M)	0-15	7.2×10^{6}	2.7×10^{4}	2.5×10^{4}	235	60
	15-30	7.5×10^{4}	2.9×10^{2}	2.7×10^{2}	165	20
	30-45	6.5×10^{2}	2.4×10^{2}	2.1×10^{2}	78	10
Kharkhoda (M)	0-15	8.5×10^{6}	2.9×10^{4}	3.1×10^{4}	210	64
	15-30	9.2×10^{4}	2.7×10^{2}	3.2×10^{2}	156	17
	30-45	9.6×10^{2}	2.1×10^{2}	1.8×10^{2}	75	12
Mean	0-15	6.3×10^{6}	3.12×10^{4}	2.25×10^{4}	227.75	62.27
	15-30	6.5×10^{4}	2.22×10^{2}	2.30×10^{2}	155.25	26.00
	30-45	6.4×10^{2}	1.62×10^{2}	1.57×10^{2}	76.25	12.50

In parentheses B denotes Bulandshahr and M for Meerut.

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