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AVAILABLE MACRO NUTRIENTS (N, P, K AND S) IN THE SOILS OF CHIRAIGAON BLOCK OF DISTRICT VARANASI (U.P.) IN RELATION TO SOIL CHARACTERISTICS

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ABSTRACT

Soil fertility evaluation of an area or region is an important aspect in context of sustainable agricultural production. The macro nutrients govern the fertility of the soils and control the yields of crops. The Chiraigaon block of district Varanasi was selected for the study. Ten representative villages were chosen and different number of surface soil samples (0-15 cm) collected and analysed for physico-chemical properties and available N, P, K and S status. Results revealed that texture of soils varied from sandy clay loam to clay. Soil samples were found low in organic carbon, available nitrogen and phosphorus while medium in potassium. About 62 % of samples were found deficient in available sulphur. Significant positive correlations were found to exist between organic carbon and available N, P, K and S status of soil under study.

KEW WORDS: Macro nutrients, soil characteristics

Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agricultural production. Nitrogen, phosphorus, potassium and sulphur are important soil elements that control its fertility and yields of the crops. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. Variation in nutrient supply is natural phenomenon and some of them may be sufficient where others deficient. The stagnation in crop productivity cannot be boosted without judicious use of macro and micronutrient fertilizers to overcome existing deficiencies/imbalances. The information on availability of macro nutrients of the study area is meager. Therefore, the present study was undertaken to know the macro nutrients status of soils of the block Chiraigaon and an attempt was also made to correlate macro nutrients content of the soils with other soil properties.

MATERIALS AND METHODS

The study area covers Chiraigaon block of Varanasi district which has the area of 195.99 km^2. Ten villages namely Bikapur (V_1), Kotawa (V_2), Bankat (V_3), Jasrampur (V_4), Sonbarsha (V_5), Amba (V_6), Chhitauni (V_7), Gobaraha (V_8), Sathawa (V_9) and Ukathi (V_{10}) were selected for the study. Soil samples were collected from each village and composite soil samples (0-15 cm) were prepared. Soil samples were air dried, processed to pass through 2 mm sieve and analysed for pH, EC, bulk density, particle density and texture as per standard methods (Chopra and Kanwar, 2005). Organic carbon, available nitrogen (0.32% alkaline $KMnO_4)_c$ phosphorus (0.5M $NaHCO_3$), potassium (1 N neutral ammonium acetate extractable) and sulphur (turbidimetric method) were determined following the methods described by Page et al., (1982). The simple correlation analysis of data was computed in relation to available nutrient contents with physico-chemical properties of the soils under study.

RESULTS AND DISCUSSION

Soil pH and EC

Data presented in Table -1 show that soil pH varied from 7.2 to 8.2 with an average of 7.4. According to classification of soil reaction suggested by Brady, (1985), 14 samples were neutral (pH 6.6 to 7.3), 35 samples were mildly alkaline (pH 7.4 to 7.8) and one sample was moderately alkaline (pH 7.9 to 8.4). The minimum value of pH 7.2 was observed in sampling sites V_3, V_5, V_6, V_8, and V_{10} and maximum value of pH 8.2 was observed in sampling site V_1. The neutral to alkaline pH may be attributed to the reaction of applied fertilizer material with soil colloids, which resulted in the reaction of basic cations on the exchangeable complex of the soil. The electrical

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conductivity of the soils varied from 0.20-0.52 dS m^{-1} with an average of 0.37 dS m^{-1}. On the basis of limits suggested by Muhr et al., (1965) for judging salt problem of soils, all the samples were found normal (EC < 1.0 dS m^{-1}). The normal electrical conductivity may be ascribed to leaching of salts to lower horizons.

Organic Carbon

The organic carbon content ranged from 0.30-0.75 with an average of 0.45 per cent. The organic carbon content was low (< 0.50 %) in 70 % soil samples and remaining 30 % were medium (0.50-0.75 %). Maximum amount of organic carbon (0.75 %) was found in site V_6 and minimum in site V_4. Soils in low organic carbon are possibly because of high temperature and good aeration in the soil which increased the rate of oxidation of organic matter.

Texture, Bulk Density and Particle Density

The texture of the soils varied from sandy clay loam to clay. Sand, silt, clay, bulk density and particle density of the soils varied from 32.0-46%, 18.5-32.3%, 16.3-32.4%, 1.2-1.6 and 2.0-2.6 g cm^{-3} respectively (Table -1).

Available Nitrogen

Available nitrogen status varied from 154.4-342.2 kg ha^{-1} with an average value of 214.8 kg ha^{-1}. On the basis of the ratings suggested by Subbiah and Asija (1956), 78% of the soil samples were found to be low (< 250 kg ha^{-1}) and remaining in the category of medium (250-500 N kg ha^{-1}). Low nitrogen status in the soils could be due to low amount of organic carbon in the soils. A significant positive correlation (r = 0.930) was found between organic carbon and available nitrogen (Table- 2). Since most of the soil nitrogen is found in organic form, therefore, this relationship was observed. Available nitrogen was negatively correlated (r = -0.476) with pH. Similar result was also reported by Verma et al. (1980).

Available Phosphorus

The available phosphorus content varied from 8.2 to 25.0 kg ha^{-1} with a mean value of 12.8 kg ha^{-1}. On the basis of the limits suggested to Muhr et al. (1963), most of the soil samples (94 %) were low (< 20 P_2O_5 kg ha^{-1}) in available phosphorus status and rest were under medium (20-50 kg ha^{-1}) category. A significant positive correlation (r = 0.625) was observed between organic carbon and available phosphorus (Table -2). This indicates that presence of organic matter increases the availability of phosphorus in soil. According to Tisdale et al. (1997), about 50% of phosphorus is found in organic form and decomposition of organic matter produces humus which forms complex with Al and Fe and protects the P fixation. Available phosphorus and clay was found to be significantly and positively correlated (r = 0.316) with each other because the retention of added phosphorus increased with an increase of clay.

Available Potassium

Status of available potassium in the soils ranged between 134.6 and 310.4 kg ha^{-1} with an average of 201.7 kg ha^{-1}. According to Muhr et al., (1965), most of the soil samples (96 %) were found under medium (125-300 kg ha^{-1}) range. A significant positive correlation (r = 0.625) was observed between organic carbon and available K content (Table 2). This might be due to creation of favorable soil environment with presence of organic matter. Similar relationship was also reported by Chauhan (2001). Significant positive correlation was also found between available potassium and clay content. It might be due to the presence of most of the mica (biotite and muscovite) in finer fractions.

Available Sulphur

The available sulphur status varied from 6.0-16.6 ppm with a mean value of 9.5 ppm. Plant roots absorb sulphur in the form of SO_4^{-2} from the soil solution. Keeping this fact in view, the soil under study may be classified as deficient (< 10 ppm), medium (10-20 ppm) and sufficient (>20 ppm) category as per the categorization given by Hariram and Dwivedi (1994). According to these categories, 62% samples were found under deficient and remaining 38% samples were found under medium category. Thus, the soils of Chiraigaon block of district Varanasi are likely to respond to sulphur fertilization. A positive correlation (r = 0.051) was observed between organic carbon and available sulphur content. This relationship was existed because most of the sulphur is associated with organic matter (Nor, 1981).

Nutrient Index Value

Considering the concept of nutrient index value

the soils of study area were found in the category of 'medium fertility status' for potassium and low with respect of nitrogen phosphorus and sulphur. The nutrient index value for N, P, K, and S were 1.22, 1.06, 2.04; 1.40 and 1.28 respectively against the nutrient index values < 1.6 for low, 1.67-2.33 for medium and >2.33 for high fertility status (Meena et al., 2006).

Table 1: Physico-chemical properties and nutrient status of soil under study

S.N.	Site	No. of samples	pH	EC ($dS\ m^{-1}$)	Sand (%)	Silt (%)	Clay (%)	BD* $g\ cm^{-3}$	PD* $g\ cm^{-3}$	Porosity (%)	O.C. (%)	Available N ($kg\ ha^{-1}$)	Available P ($kg\ ha^{-1}$)	Available K ($kg\ ha^{-1}$)	Available S (ppm)
1.	V_1	6	7.7	0.35	36.8	23.4	21.2	1.33	2.28	41.0	0.40	195.5	11.5	168.8	9.5
2.	V_2	5	7.5	0.40	39.8	24.3	27.8	1.32	2.36	43.8	0.50	221.0	16.3	245.7	9.4
3.	V_3	4	7.4	0.40	38.6	23.9	29.2	1.37	2.17	36.0	0.52	227-8	11.6	209.0	9.6
4.	V_4	5	7.5	0.34	40.7	21.8	22.2	1.34	2.26	40.1	0.39	193.4	12.8	184.3	8.1
5.	V_5	5	7.4	0.34	41.8	25.8	27.2	1.32	2.36	43.8	0.48	232.2	12.8	220.2	9.8
6.	V_6	6	7.4	0.39	39.0	25.7	27.6	1.38	2.25	37.9	0.54	246.8	17.0	220.6	12.9
7.	V_7	4	7.5	0.35	41.7	23.1	26.6	1.42	2.42	40.8	0.43	201.6	11.6	189.1	7.9
8.	V_8	5	7.4	0.44	40.9	24.2	25.9	1.32	2.30	42.0	0.44	209.8	11.2	197.1	9.4
9.	V_9	4	7.5	0.34	38.4	20.9	25.8	1.30	2.17	39.8	0.44	213.2	11.8	192.9	8.4
10.	V_{10}	6	7.4	0.37	40.1	23.2	26.2	1.35	2.28	40.2	0.44	207.6	11.8	190.0	10.7
	Range		**7.2-8.2**	**0.20-0.52**	**32.0-46.0**	**18.5-32.3**	**16.3-32.4**	**1.2-1.6**	**2.0-2.6**	**25.0-53.8**	**0.30-0.75**	**154.4-342.2**	**8.2-25.0**	**134.6-310.4**	**6.0-16.6**
	Mean		**7.4**	**0.37**	**39.7**	**23.6**	**25.9**	**1.34**	**2.28**	**40.5**	**0.45**	**214.8**	**12.8**	**201.7**	**9.5**

BD*= Bulk density, PD*= Particle density, OC= Organic carbon

Table 2: Correlation between soil characteristics and available nutrients

Soil properties	Available nutrients			
	N	P	K	S
pH	-0.476**	-0.116	-0.388**	-0.276**
Organic carbon	0.930	0.623	0.801	0.051**
Clay	0.763**	0.316**	0.746**	0.290*

** Significant at P=0.05 and P=0.01 level respectively

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