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RESEARCH ARTICLE

SOIL SERIES CHARACTERISTICS AVAILABLE NUTRIENTS AND YIELD IN THE SOILS OF BARAGAON BLOCK DISTRICT VARANASI (UTTAR PRADESH.)

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Abstract

Soils are finite, precious and resources are shrinking. The nutrients control the productivity from the soils and manage the yields of crops. The Baragaon block of district Varanasi was selected for Land Resource Inventory on 1:10000 Scales for optimal Agricultural Land Use Planning using geospatial techniques. Seven soils series were identified and Soil profile samples were collected and analyzed in laboratory for pH, EC, OC, Caco^3, N, P, K, and micronutrients Zn, Cu, Fe and Mn. Soil samples were found low in organic carbon, available nitrogen and phosphorus while medium and high in potassium. All 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 in soil series of Baragaon Block of Varanasi district, Uttar Pradesh.

Introduction:-

Soil fertility estimation of an area or region is an important quality in context of sustainable agricultural development. Its management is important for the very existence of mankind. Many civilizations prospered or perished based on the kind of land use management of the available soil resource in best way. Characterization of soil 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 the availability of macronutrients of the study area is meager. Therefore, the present study was undertaken to know the macronutrients status of soils of the block Baragaon and an attempt was also made to correlate macronutrients matter of the soils with other soil properties.

Materials and Methods:-

The Baragaon block of Varanasi district covers an area of 174.33 km^2. Prior to the field visit to soil site, satellite imagery of the block was obtained from NRSC and interpretation to gain a preliminary overview of the soils that were likely to occur in the area as well as to determine if there are any major serious inaccuracy limits to arable farming or irrigation such as uneven topography, salinity or the existence of extensive areas of wetland. Concurrent with the study of satellite imagery, background information on the geology of the area as well as information from

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previous soil surveys in the area was obtained from various sources like SRM Map was studied. In the field, the soils were examined along all available access routes. Wherever the vehicle access was not possible over the block area and extensive foot traverses had been made for detailed soil survey. Along these traverses, soils were examined by auger borings to a depth of 150 cm. The succession of horizons in each auger was studied and used to assess the suitability of the soils for arable farming and irrigation. In addition to the augers, 35 profiles were dug in representative locations to characterize the different soil types/ series occurring on the block and these profiles were subjected to detailed descriptions. Soil samples were collected from each horizon for laboratory analysis, 7 representative/ master soil profiles were selected out of 35 and analysed in laboratories for a variety of soil textural and chemical characterization parameters. Soil samples were air dried, grinded and processed to pass through 2 mm sieve and analysed for pH, EC, and texture as per standard methods (Chopra and Kanwar, 2005). Organic carbon, available nitrogen (0.32% alkaline KMnO4) phosphorus (0.5M NaHCO3), potassium (1 N neutral ammonium acetate extractable) and sulphur (turbid metric method) were determined following the methods described by Page et al., (1982). The simple correlation analysis of data was computed in relation to available nutrients with physico-chemical properties of the soils Baragaon block (Tab.1).

Results and Discussion:-

Soil pH and EC

Seven soils series namely-Tari, Dhananjaypur, Gajapur, Paschimpur, Amilo, Sonpurwa and Hirapur were Identified in the Baragaon block. Data presented in Table -1 show that soil pH varied from 6.76 to 10.5 with an average of 8.26. According to classification of soil reaction suggested by Brady, (1985), 3 samples were neutral (pH 6.76 to 7.3), two sample was moderately alkaline (pH 7.9 to 8.4) and rest of the samples are very strongly alkaline 9.1 to 10.5. The minimum value of pH 6.76 was observed in Tari soil series and maximum value of pH 10.05 was observed in Pashchimpur soil series. 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. High pH may be due to presence high sodium due to parent material. The electrical 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 range of organic carbon matter was 0.14 - 0.46 with an average of 0.33 percent. The organic carbon content was low (< 0.50%) in 72% soil samples and remaining 28% were medium (0.50 - 0.75%). Maximum amount of organic carbon (0.46%) was found in soil series Dhananjaypur and minimum in Hirapur soil series. 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. The texture of the soils varied from sandy loam to clay loam. Sand, silt and clay contents of the soils varied from 30.0 - 57.5%, 27.5 - 40.0%, 7.5 - 37.5%, respectively (Table -1).

Available Nitrogen

Available nitrogen status varied from 107.6 - 176.0 kg ha^{-1} with an average value of 178 kg ha^{-1}. On the basis of the ratings suggested by Subbiah and Asija (1956), all the soil samples were found to be low (< 250 kg ha^{-1}). Low nitrogen status in the soils could be due to a low amount of organic carbon in the Hirapur, Tari, Paschimpur, Amilo and Gajapur soil series, whereas Dhananjaypur and Sonpurva are medium. 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 = - 0.213) with pH. Similar result was also reported by Verma et al. (1980).

Available Phosphorus

The available phosphorus matter varied from 12.6 to 20.0 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 (100%) were low (< 20 P2O5 kg ha-1) in available phosphorus status. A significant positive correlation (r = 0.525) 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 = 0.29) with each other because the reservation of added phosphorus increased with an increase of clay (Singh & Mishra, (2012).

Available Potassium

Availability of potassium in the soils Baragaon block ranged between 68.8 and 280 kg ha-1 with an average of 201.1 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 matter (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 matter. It might be due to the presence of most of the mica (biotite and muscovite) in finer fractions.

Available Sulphur

In Baragaon block the availability of sulphur varied from 0.04 to 1.39 kg ha^{-1} with a mean value of o.35 kg ha^{-1}. Plant roots absorb sulphur in the form of SO4-2 from the soil solution. Keeping this fact in view, the soil under study may be classified as deficient (< 10 kg ha^{-1}), medium (10-20 kg ha^{-1}) and sufficient (>20 kg ha^{-1}) category as per the categorization given by Hariram and Dwivedi, (1994). According to these categories, all samples were found under deficient. Thus, the soils of Baragaon block of district Varanasi are likely to respond to sulphur fertilization. A positive correlation (r = 0.37) was observed between organic carbon and available sulphur matter. This relationship was existed (Nor, 1981) because most of the sulphur is associated with organic matter.

Micro Nutrients

Micronutrient status in soils varies from 0.27 to 29.67 PPM. Zinc contents are low (< 0.6) in the soils where as medium (0.6-1.2) in Soil series Tari and Dhananjaypur. Copper ranges medium (0.2-0.4) to high (>0.4), iron availability is low (<4.5) to high (>7.5) and manganese is sufficient (>3.5 PPM) except Sonpurwa soil series deficient (<3.5 PPM).

Nutrient Index Value

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

Soil Problem

The soil series Tari, dhananjaypur, Gajapur are normal soils accept Tari is Coarse-loamy in texture. The rest of the soils are suffering from high pH, salinity/ sodicity or erosion and texture. Paschimpur soil series is moderate to strong salinity and sodicity high pH and EC, Amilo slight to strong salinity, high pH and EC and sandy loam texture. The soil series Sonpurwa distress with salinity and lowland & Hirapur slight saline sodic in nature, slight to moderately eroded, high pH and occurring on 1-3% slopes.

Grain Yield

Highest yield of rice (30 qh^{-1}) and wheat (42 qh^{-1}) was observed under Gajapur soil series followed by Dhananjaypur, Tari, Paschimpur (moderate to strong salinity and sodicity), and Amilo 17 & 24 q ha^{-1} (slight to strong salinity). The soil series Sonpurwa & Hirapur sown with only for single crops rice or wheat (10-22 qh^{-1}), mustard (3-6 qh^{-1}) yielded very low due to any degree salinity or erosion.

Suggestion:-

Addition of gypsum or sulphuric acid in saline sodic soils and leaching will improve the soil than plant such as asparagus, beets; cabbage, cauliflower, celery, carrots, lettuce, parsley and spinach grow well in soils whose pH is between 7 and 8.

Table 1:- Physico-chemical characteristics and nutrients status and yield of Rice& Wheat crops of Baragaon block of Varanasi district (Uttar Pradesh).

Soil Series	**pH**	**OC**	**N**	**P**	**K**	**S**	**Yield**
Tari	1.0	-0.4	0.0	0.9	0.4	0.8	-0.2
Dhananjaypur	-0.4	1.0	0.9	-0.5	-0.9	-0.4	0.4
Gajapur	0.0	0.9	1.0	-0.1	-0.8	0.0	0.6
Paschimpur	0.9	-0.5	-0.1	1.0	0.4	0.6	-0.3
Amilo	0.4	-0.9	-0.8	0.4	1.0	0.5	-0.3
Sonpurwa	0.8	-0.4	0.0	0.6	0.5	1.0	0.1
Hirapur	-0.2	0.4	0.6	-0.3	-0.3	0.1	1.0
	0.352	0.003	0.213	0.288	0.055	0.377	0.186

Table 2:- Correlations between soil series and available nutrient and yield Baragaon block of Varanasi district (Uttar Pradesh).

Soil series	**pH**	**EC ds–m^{-1}**	**OC (%)**	**Caco^{3} (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**	**N (kg/h)**	**P (kg/h)**	**K (kg/h)**	**S (kg/h**	**Zn/ PPM**	**Cu/ PPM**	**Fe/ PPM**	**Mn/ PPM**	**Text - ture**	**Produ - ctivity (q/ha.)**
Tari	6.76	0.09	0.16	nil	57.5	35.0	7.5	105.14	13.77	280.0	0.04	0.79	1.8	29.67	13.6	sl-cl	26.0
Dhananjaypur	7.40	0.27	0.46	2.28	57.5	25.0	17.5	175.99	14.56	79.64	0.10	0.73	1.3	11.65	14.6	sl-l	28.0
Gajapur	7.84	0.34	0.32	nil	55.0	20.0	25.0	156.49	15.00	100.2	0.09	0.34	1.0	8.45	8.71	sl-cl	36.0
Paschimpur	10.24	3.47	0.17	2.73	30.0	37.5	32.5	107.59	18.05	275.5	1.30	0.39	2.1	16.34	11.3	cl-cl	27.0
Amilo	9.70	1.12	0.26	nil	57.5	32.5	10.0	146.71	19.97	187.0	0.39	0.41	1.4	9.27	10.7	sl	21.0
Sonpurwa	7.51	0.41	0.45	nil	22.5	40.0	37.5	166.30	12.60	68.88	0.05	0.54	2.7	26.46	2.94	cl	22.0
Hirapur	8.39	0.25	0.14	3.31	55.0	27.5	17.5	104.61	16.7	215.0	0.12	0.27	0.3	4.23	10.2	sicl	10.0
S.E.m + -																	**2.63**
Mean	**8.26**	**0.99**	**0.33**		**47.9**	**31.1**	**21.1**	**177.70**	**18.44**	**201.1**	**0.35**	**0.58**	**1.8**	**17.68**	**12.1**		**24.3**

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