

Original Research Article

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Delineation of Soil Fertility and Correlation Study of Different Nutrients in Soils of Chunar, Mirzapur, India

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ABSTRACT

Soil fertility is function of nutrient availability in the soil. Continuous cropping in the same piece of land results to nutrient exhaustion. In recent past, rapid decline of soil fertility in Indo-Gangetic plain drawing attention of researchers. To know fertility and nutrients availability in alluvial soil of Mirzapur this experiment was conducted and correlation between different nutrients were traced. Altogether 45 surface soil samples were collected and analyzed for different soil parameters. Results obtained showed that organic carbon was medium to high, nitrogen was extremely low, phosphorus and potassium were high, exchangeable cations (Ca and Mg) were adequate and sulphur was medium. On correlation analysis it was found that pH and EC were significantly and negatively correlated to each other. Significant positive correlation existed between EC and phosphorus, EC and potassium, OC and Fe, phosphorus and Fe, potassium and Fe, Ca and Mg, Ca and Cu and between Fe and Cu while Cu and Zn showed significant negative correlation.

Keywords

Indo-Gangetic plain, Correlation analysis, Exchangeable cations, Soil fertility

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Introduction

Fertility of soil is the capacity of soil to supply nutrients in adequate amount which itself is function of nutrient reserve in the soil. The optimum plant growth and yield depends not only on the nutrient reserve in the soil but also on their availability at a particular time which in turn is controlled by physical and chemical

properties of the soil. Thus we need to maintain this nutrient reserve to get sustainable yield year after year. But it has been noticed in Indo-Gangetic plain that because of continuous rice-wheat cultivation (over 10.5 million ha), fertility of soil is deteriorating day by day, raising a serious problem to the sustainability of Indian agriculture as this part is a major agriculture

belt of the India. Intensive farming, imbalanced fertilizer dose and faulty agriculture practices during Green Revolution period resulted to soil degradation, depletion of soil organic carbon (SOC), and environment problem as well (Ladha *et al.*, 2003; Timsina and Connor, 2001). Imbalanced fertilizers application is a serious threat to sustainability. At the same time to increase productivity from the limited arable land we are in need of external supplement of plant nutrients. But excessive use of fertilizer is always hazardous to the soil and environment as well.

Soil test-based fertilizer recommendation is an effective management tool for increasing productivity of agricultural soils while maintaining sustainability (Srinivasarao *et al.*, 2010; Sahrawat *et al.*, 2010). As soil testing provide information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields (Doneriya *et al.*, 2013). There are several factors hindering adoption of soil testing based fertilizer recommendation in India such as fragmented land, prevalence of small size holding, lack of infrastructural facilities etc (Sen *et al.*, 2006). In addition to these constraints, monoculture and intensive farming practices are resulting to mining of the nutrients and decrease in soil fertility. Thus replenishment of these removed nutrients become essential for maintaining soil fertility and productivity (Kumar *et al.*, 2013). Though, decomposition of crop residue results to partial replenishment of the nutrient but in order to meet actual nutrient demand of crops supplying of nutrients by means of nutrients become essential. Nowadays, widespread deficiency of macro, secondary and micronutrients are emerging in arable land (Singh *et al.*, 2015; Rai and Singh, 2018a; Rai and Singh, 2018b; Krishan *et al.*, 2018) in soils of eastern UP. These deficiencies are so severe and resulting in the emergence of

visual symptoms on crops; thus, significant response has been reported on applying fertilizers to crops. Among all the agricultural inputs, it is the fertilizers that alone contribute to 50% of yield enhancement (Stewart *et al.*, 2005). To get benefit of fertilizers application, they should be applied at the right time, right place and right quantity. Sometime conversion of the natural ecosystem into agricultural land under intensive cultivation severely deplete SOC, thus judicious management of soil under competing and diverse land use is the key to increase soil organic matter (Kumar *et al.*, 2013). Soil testing is determining factor in decision making by farmers regarding type and quantity of fertilizers as per crop and soil requirement. This help in avoiding over-fertilization which might results to nutrient leaching, water pollution and irreversible harm to aquatic life. Keeping this view in mind an attempt was made to analyze soil in Chunar block of Mirzapur district. The objective of the study was to prepare a comprehensive database about the nutrient status of the soils of Chunar block of Mirzapur and to know about deficient nutrient so that decline in fertility can be arrested. Chunar block belongs to the great Gangetic plains (Singh and Gangwar, 1971). Soil of Chunar is transported basaltic type of alluvium and can be considered as zonal lithomorphic variety. Alluvial deposits are of two types: new alluvium (lowland fresh deposits known as Khadar) and the old alluvium (highland deposits liable to denudation it is bangar). Soil of this region is loose, sandy but alkaline in pH und vulnerable to various erosional forces. It always remains in pedologically young condition by repeated input of silt.

Materials and Methods

Altogether 45 surface soil samples (0-15cm) were collected from Gangpur village of Chunar block in Mirzapur. For collection of soil samples, the field was divided into the

homogenous unit and one composite sample was collected from each sub-unit. Sampling spots were identified by moving in a zig-zag manner. After collection of soil samples, processing was done in soil processing laboratory of the Department of Soil Science and Agricultural Chemistry, IAS, BHU, Varanasi.

Soil pH was determined by combined electrode method (Chopra and Kanwar, 1982); electrical conductivity by conductivity meter (Sparks, 1996); Organic carbon by wet digestion method (Walkley and Black, 1934); available N by alkaline permanganate method (Subbiah and Asija, 1956); available P by Olsen's method (Olsen, 1954); K by ammonium acetate method (Hanway and Heidel, 1952). Available S was determined using 0.15% CaCl₂ (Chesnin and Yien, 1950); cationic micronutrients (Fe, Mn, Cu, Zn) were determined through AAS (Atomic absorption spectrophotometer) using 0.5 M DTPA as an extractant (Lindsay and Norway, 1978); while available B by hot water method (Berger and Troug, 1939). Data obtained was analyzed statistically and correlation coefficient was found between relevant physicochemical properties and soil available nutrients. Data obtained were analyzed statistically and correlation was fetched between relevant physicochemical properties and soil available nutrients.

Results and Discussion

A descriptive statistics and status of nutrients are summarized in tables 1–5 and figure 1, respectively. Mean value of the pH obtained was 8.63 while that of EC was 0.19, range of organic carbon found between 3.10-8.81 g per kg of soil with mean of 5.95. Available nitrogen was extremely low with mean value 159.60 kg/ha, the highest value of available nitrogen was 225.79 kg/ha. Available phosphorus varied between 7.36- 61.43 kg/ha

with mean of 26.81, in case of potassium obtained mean value was 253.45 kg/ha with wide variation in range (100.80-728.00). Results in case of N and P were in agreement with result of Ghosh (2017). All the cationic nutrients including exchangeable and micronutrient were adequate. Medium organic carbon content of this region might be due to addition of organic material by the farmers.

As per report of Tiwari *et al.*, (2003) in Vindhyan soil, low-laying areas are having higher C/ N ratio than that of upland due to presence of sandstone, limestone and shale in low lying area. All the soil samples from both the villages were rated to be low in N instead of being rich in organic matter. There might be several reasons of poor N, such as inadequate addition of nitrogenous fertilizers or excessive loss of N from rhizosphere through leaching or denitrification of nitrate form. Volatization of ammonical form may also be the reason preventing buildup of nitrogen in soil of this region. Hence low level of nitrogen is a matter of great concern to attain sustainable and intensive agriculture system as reported by Yadav *et al.*, (2001).

Available phosphorus ranged between 7.36 to 61.43 kg ha⁻¹ with the mean value of 26.84 kg ha⁻¹. In case of phosphorus result obtained was in agreement what reported by Singh *et al.*, (2017). Earlier, these regions were reported to be low in phosphorus by Yadav *et al.*, (2001) but gradual increase in soil P suggest higher rate of phosphorus application in crops by farmers of this region. Available potash ranged from 100.80 to 728 kg ha⁻¹ with mean of 253.45 kg ha⁻¹. High K in soil is because of dominance of Illitic clay mineral in Indo-Gangetic Plains (Dhaliwal and Gupta, 2006). Illitic clay minerals are weathered form of muscovite and mica clays. Edges of the illitic clay are frayed and wedged open, exposing the interior potassium located deeper within the clay layers. Exchangeable Ca and Mg were

found to be sufficient level in the alluvial soil. 0.15% CaCl₂ extractable available sulphur ranged between 3.73- 36.95 mg kg⁻¹ with the mean value of 15.84 mg kg⁻¹. The result was similar to mean reported by Singh *et al.*, (2015). Majority of soil samples had sufficient level of available S in both the villages. High level of available S in these soils may be probably due to high content of Organic carbon.

On correlation study it is found that pH showed negative significant correlation with EC (-0.328*), EC showed significant positive correlation with phosphorus (0.315*) and potassium (0.332*) while organic carbon (0.391**), phosphorus (0.403**) and potassium (0.403**) all were significant and positively correlated with Fe content in soil, similarly Fe (0.294*) and Ca (0.346*) both represented significant positive correlation with Cu while Cu showed significant negative correlation with Zn (-0.351*). pH represent activity of hydronium ions in soil while EC

represents presence of dissolved salt in the soil. Higher the H⁺ ion in soil lower the pH higher the electrical conductivity (Volk and Jackson, 1963). Information regarding soil pH and EC help farmers know fertility of soil and amount fertilizer to be added to get economic production (Chavai and Kadam, 2016).

It can be concluded from the present investigation that the soils of Chunar are alkaline in nature; soluble salt was extremely low while SOC was medium. Most of plant nutrients were sufficient to meet crop demand while deficiency of nitrogen and boron were matter of great concern since they were extremely low than required by plants. Hence rather than applying all the plant essential nutrients to the soil it's better to give sufficient nutrients in recommended dose while deficient nutrient must be supplied in a dose 25% more than recommended for maintaining sustainable crop production and soil health in Chunar block of Mirzapur in years to come.

Table.1 Procedures followed for analysis of different soil parameters

Soil test parameter	Method followed	References
pH	Combined electrode	Chopra and Kanwar, 1982
EC	Conductivity meter	Sparks, 1996
Organic carbon	Wet digestion	Walkley and Black, 1934
Texture	Hydrometric method	Bouyoucos, 1962
Available N	Alkaline permanganate method	Subbiah and Asija, 1956
Available P	Olsen method	Olsen et al., 1954
Available K	1 N NH ₄ OAC method	Hanway and Heidel, 1952
Available S	Turbidimetric method	Chesin and Yien, 1950
Available B	Hot water method	Berger and Troug 1939
Cationic micronutrients (Fe, Mn, Cu, Zn)	DTPA solution by Atomic Absorption Spectrophotometer	Lindsay and Norvell, 1978

Table.2 Summary statistics for soil available nutrients of some soils of Mirzapur district micronutrients of the soil

	pH	EC (dS m⁻¹)	OC (g kg⁻¹)	N (kg ha⁻¹)	P (kg ha⁻¹)	K (kg ha⁻¹)	Ca C mol (p+) kg⁻¹	Mg C mol (p+) kg⁻¹	S (mg kg⁻¹)	Fe (mg kg⁻¹)	Mn (mg kg⁻¹)	Cu (mg kg⁻¹)	Zn (mg kg⁻¹)	B (mg kg⁻¹)
Mean	8.63	0.19	5.95	159.60	26.81	253.45	6.57	2.42	15.84	24.16	2.95	1.56	0.75	0.27
Standard Error	0.04	0.02	0.25	5.22	2.17	17.37	0.38	0.14	0.78	0.93	0.21	0.09	0.04	0.04
Median	8.64	0.13	5.81	150.53	25.60	224.00	6.20	2.20	14.97	22.40	2.86	1.41	0.66	0.18
Mode	8.70	0.00	3.55	150.53	35.37	224.00	7.00	2.20	13.65	18.40	1.82	1.33	0.56	0.15
Standard Deviation	0.24	0.14	1.68	35.04	14.58	116.54	2.58	0.96	5.26	6.26	1.42	0.61	0.26	0.28
Sample Variance	0.06	0.02	2.83	1227.50	212.5 5	13582.37	6.67	0.93	27.71	39.18	2.03	0.37	0.07	0.08
Kurtosis	0.42	8.50	-1.25	-0.93	0.04	6.74	0.28	1.41	5.97	1.53	-0.42	1.65	6.29	28.10
Skewness	-0.35	2.97	0.13	0.16	0.77	2.19	0.70	0.96	1.08	1.32	0.62	1.07	2.18	4.84
Range	1.19	0.61	5.71	125.44	54.07	627.20	11.00	4.60	33.23	27.40	5.44	2.73	1.30	1.84
Minimum	7.96	0.10	3.10	100.35	7.36	100.80	2.20	1.00	3.73	16.20	1.02	0.44	0.50	0.03
Maximum	9.15	0.71	8.81	225.79	61.43	728.00	13.20	5.60	36.95	43.60	6.46	3.17	1.80	1.87

Table.3 Number of Soil Samples falling in different fertility level of major nutrients

Soil Test Parameters	Gangpur (45)		
	Low (%)	Medium (%)	High (%)
Available N (Kgha ⁻¹)	45(100%)	0(0.00%)	0(0.00%)
Available P (Kgha ⁻¹)	6(13.33%)	16(35.55%)	23(51.11%)
Available K (Kgha ⁻¹)	3(6.66%)	22(48.89%)	20(44.44%)

Table.4 Number of Soil Samples Falling in Different Fertility level of Secondary Nutrients

Soil test parameters	Gangpur(45)	
	Deficient	Sufficient
Exch. Ca(C mol(p+) kg ⁻¹)	0(0.00%)	45(100%)
Exch. Mg(C mol(p+) kg ⁻¹)	0(0.00%)	45(100%)
Avail. S(mg kg ⁻¹)	3(6.66%)	42(93.%)

Fig.1 Status of available macro and micronutrients in Gangpur village of Mirzapur district

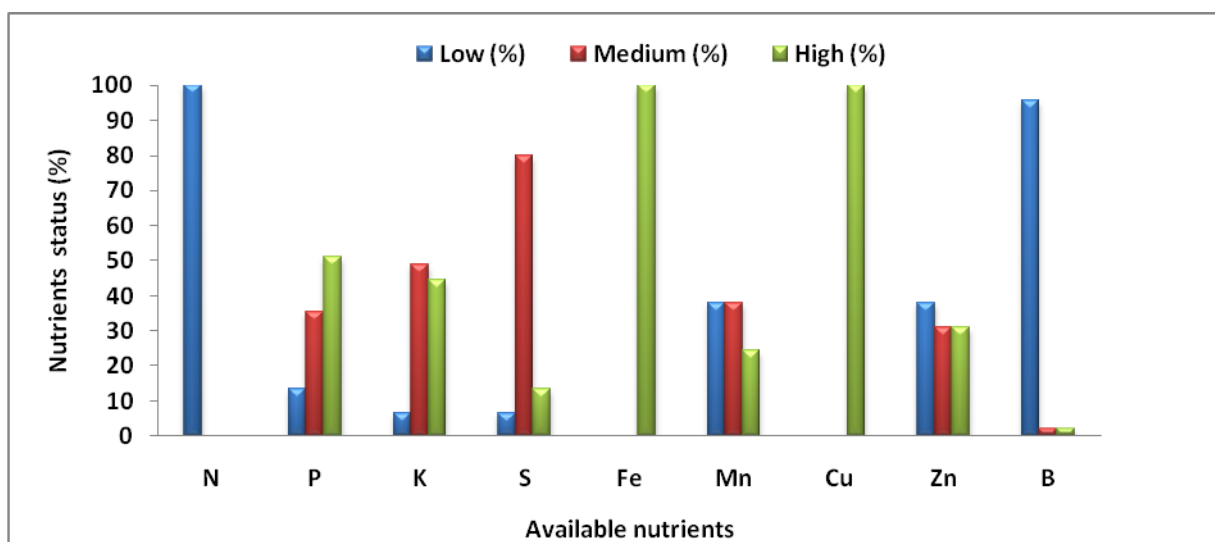


Table.5 Correlation between physicochemical properties and available major, secondary and micronutrients of the soil

	PH	EC	OC	N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn	B
PH	1.000													
EC	-0.328*	1.000												
OC	0.046	0.191	1.000											
N	-0.129	0.032	0.229	1.000										
P	-0.208	0.315*	0.022	-0.013	1.000									
K	-0.128	0.332*	0.135	-0.153	0.444**	1.000								
Ca	-0.135	-0.282	0.034	-0.208	-0.088	-0.027	1.000							
Mg	0.168	-0.148	-0.148	-0.115	-0.013	0.037	0.474**	1.000						
S	-0.009	0.181	0.016	0.189	0.238	0.222	-0.164	0.045	1.000					
Fe	-0.148	0.051	0.391**	-0.028	0.403**	0.403**	0.069	0.260	0.027	1.000				
Mn	-0.048	0.039	-0.082	-0.174	0.104	0.125	0.168	-0.193	-0.089	-0.102	1.000			
Cu	-0.177	-0.158	-0.021	0.017	-0.013	0.255	0.346*	0.126	0.092	0.294*	0.143	1.000		
Zn	-0.118	0.172	0.013	0.103	-0.095	-0.053	-0.088	-0.028	-0.275	-0.141	-0.260	-0.351*	1.000	
B	0.051	0.060	0.060	0.103	0.209	0.043	-0.083	-0.009	-0.049	0.184	-0.170	-0.161	0.003	1.000

*correlation is significant at 5% level of significance

**correlation is significant at 1% level of significance

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