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Nutrient Elements and their Relationship with Soil Properties in the Alluvial Fan Region of Gaggar River in Rajasthan

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Abstract Eight pedons of the alluvial fan region of the Gaggar river were studied for distribution and status of the major and micro nutrients and their relationship with soil parameters. The soils were marginal in respect of the major nutrients. Amongst the minor elements Zn may be the first to show deficiency. The aeofluvial nature of the soils appears to be the major cause of variability in the distribution of all the studied elements. Organic matter content is the single property positively affecting the availability of all the nutrients studied. Regression analysis shows that only in case of N and K all the properties account for the variability, while for rest of the nutrients, factors other than those studied appear to be accountable.

Key words Alluvial fan, Gaggar river, Nutrient elements, Regression analysis, Soil properties

Singh and Ahuja (1990) studied the distribution of primary nutrients in the Gaggar river basin in Punjab and Haryana. The same river extends to Rajathan where it gets extinct in the vast sands of the desert. In this paper, the status and distribution of major and micro nutrients in the soils of the alluvial fan region of the Gaggar river and their relationship with several important soil properties has been attempted.

Materials and Methods

The Study area is aeofluvial plain extending between Hanumangarh (29° 34' N Lat. and 74° 17' E Long.) and Anupgarh (29° 12' N Lat. and 74° 12' E Long.) in Rajasthan. Eight representative soil profiles, out of the fortyfive studied were selected (Fig. 1). The samples were collected horizon wise, air dired and ground to pass through 2mm sieve and used for analysis. Physico chemical properties and nutrients content of the soils were determined using standard methods (page 1986).

Results and Discussion

The analytical data (Table 1) shows that soils are fine loamy to fine, moderately calcareous, alkaline, nonsaline and low in organic matter content (less than 0.1%). However, more than 15 ESP of P5 & P7 showed their sodic nature. The CEC of the soils ranges from 10 to 22 c mol (p+) kg^{-1}. The sand/silt ratio shows discontinuity in most of the soils.

Distribution of primary nutrients

The available N content which varies between 22 to 148 kg ha^{-1} (Table 2) is low. However, the content was high in the surface horizon and gradually decreased with depth. Organic carbon content is highly and positively correlated with nitrogen (r = 0.853). Similar observations have been made by Singh and Ahuja (1990) and Goyal and Singh (1987). The low available N content in these soils suggest N application for crop management. The available P ranged between 12 to 42 kg ha^{-1}, and content being slightly higher in surface soils (26 to 42 kg ha^{-1}). The available P related negatively (p = .01) with pH (r = 0.745), free Fe_2O_3 (r = -0.451) and positively (p = .01) with OC (r = 0.336) and ESP (r = 0.69). Singh and Ahuja (1990) observed positive and significant relationship with pH, ESP and EC. The negative correlation of available P with pH has been reported by Jenny *et al.* (1950) and stated that naturally neutral soils are more well supplied with P than arid or alkaline soils. Available K content varied between 22 to 423, being 178 to 345 kg ha^{-1} in the surface soils. The distribution of K however showed no definite trend with depth. This variation may be attributed to the variation in the mineralogy as

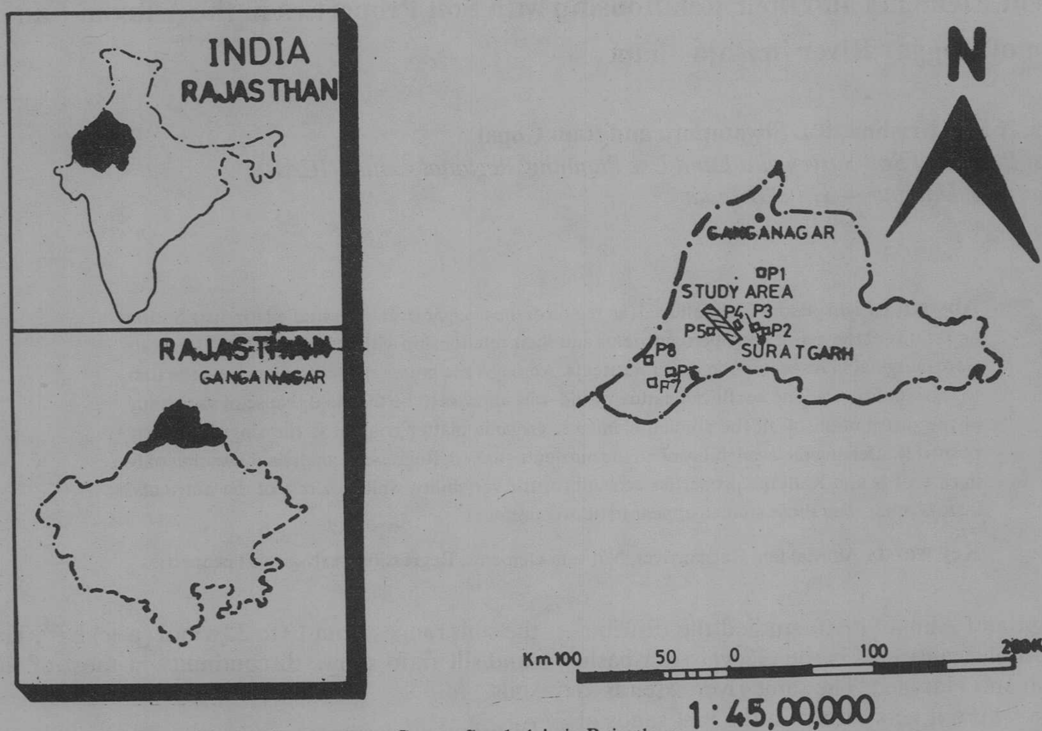

Fig 1 Location map of the study area across Gaggar flood plain in Rajasthan

Table 1 *Range of values of soil parameters*

Parameter	P1	P2	P3	P4	P5	P6	P7	P8
Sand (%)	31.6−76.8	40.9−58.7	35.5−50.6	54.2−59.6	24.4−47.1	34.3−55.6	7.5−35.8	13.1−42.2
Silt (%)	8.8−26.9	21.8−33.1	16.9−35.2	16.2−22.0	30.4−42.8	21.9−31.5	35.0−41.5	30.6−41.7
Clay (%)	14.4−42.5	20.3−29.2	29.3−44.5	21.0−24.8	22.5−34.7	22.5−34.2	29.2−51.0	26.2−45.3
pH	8.4−9.2	8.6−9.0	7.9−9.0	8.6−9.3	9.0−9.8	9.2−10.0	8.2−9.2	8.7−8.9
EC (dSm^{-1})	0.18−0.46	0.16−0.34	0.16−0.61	0.31−0.51	1.94−2.08	0.21−0.62	1.07−5.67	0.34−1.07
Org. C (%)	0.09−0.54	0.16−0.38	0.08−0.27	0.08−0.51	0.1−0.23	0.06−0.15	0.17−0.29	0.13−0.29
Free $CaCO_3$ (%)	0.3−5.9	3.4−6.1	2.6−5.5	6.0−6.4	6.3−7.7	4.5−7.5	8.9−9.9	6.8−7.7
Free Fe_2O_3 (%)	1.4−2.6	0.9−1.3	1.8−2.6	1.6−2.8	1.5−3.3	1.7−1.9	1.9−3.3	1.4−3.3
ESP	3.5−12.5	3.9−5.7	1.7−11.0	8.4−12.5	35.5−57.6	3.3−21.9	37.5−63.1	5.3−17.3
Sand/Silt	1.17−8.73	1.35−2.69	1.01−2.99	2.46−3.64	0.59−1.55	1.09−2.54	0.18−1.02	0.31−1.41

affected by the aeofluvial process of soil formation (Singh & Ahuja 1990). Available K correlated with free $CaCO_3$ ($r=0.365$).

Regression analysis (Table 3) revealed that all the factors considered together accounted for 73, 39 and 52% variability in N,P and K respectively. Organic carbon positively ($P=0.01$) and pH and free iron negatively ($P=.01$) affected N availability. In case of P, in addition to organic carbon ($p=0.05$), free iron also had positive ($p=0.05$)

Table 2 *Distribution of nutrient elements in soils*

Depth (cm)	Primary nutrients (kg ha^{-1})			Micro nutrients (ppm)			
	N	P	K	Fe	Mn	Cu	Zn
1	2	3	4	5	6	7	8
P1 Hanumangarh (Fine loamy Fluventic Camborthid)							
0 – 16	148	28	314	2.0	1.5	0.6	0.9
16 – 30	132	22	266	1.9	3.0	0.7	0.5
30 – 55	87	17	231	1.8	2.8	0.3	0.8
55 – 74	49	15	166	1.0	1.2	0.3	0.5
74 – 103	42	14	74	0.7	0.3	0.1	0.5
103 – 130	38	15	44	0.8	3.0	0.3	0.8
P2 Surathgarh (Fine Loamy Fluventic Camborthid)							
0 – 19	143	39	178	1.9	1.8	0.9	1.0
19 – 35	106	28	130	1.7	0.9	0.5	0.7
35 – 55	99	26	113	1.6	1.9	0.8	0.8
55 – 77	94	21	156	1.7	2.4	0.7	0.8
77 – 103	78	16	156	1.7	3.0	0.8	0.9
103 – 126	70	14	87	1.1	0.5	0.7	0.9
126 – 140	65	14	113	1.0	1.0	0.6	0.7
P3 Sardargarh (Fine Loamy Fluventic Camborthid)							
0 – 18	123	30	152	0.9	2.3	0.2	0.4
18 – 33	89	33	157	1.0	1.5	0.5	0.9
33 – 50	76	22	100	1.0	1.9	0.7	0.8
50 – 75	62	18	43	1.0	0.7	1.3	1.0
75 – 100	52	16	57	0.9	1.2	0.5	1.0
100 – 125	40	14	22	0.7	0.8	0.4	0.6
P4 Jaitsar (Fine loamy Typic Camborthid)							
0 – 16	108	42	288	1.1	2.7	0.9	0.8
16 – 38	78.	28	329	1.1	2.4	0.8	0.9
38 – 62	58	26	423	1.0	3.1	0.6	1.0
62 – 95	56	24	331	1.0	2.1	0.7	0.7
95 – 125	22	22	288	0.5	0.9	0.4	0.7
P5 Keshavnagar (Fine loamy Typic Camborthid)							
0 – 18	63	34	262	1.0	2.2	0.5	1.4
18 – 42	48	28	243	0.9	1.8	0.5	1.1
42 – 65	43	26	222	0.8	1.7	0.4	0.6
65 – 90	35	26	113	0.9	2.0	0.5	1.3
90 – 120	30	12	135	0.8	2.2	0.3	2.2

contd ...

Table 2 (Contd . . . .)

1	2	3	4	5	6	7	8
		P6 Anupgarh	(Fine loamy Fluventic Camborthid)				
0–15	82	26	222	1.5	2.3	0.3	0.5
15–38	64	27	260	1.3	2.0	0.4	0.8
38–63	46	25	332	1.1	1.9	0.4	0.8
63–90	32	25	332	1.2	2.1	0.3	0.6
90–120	31	20	332	1.0	1.6	0.4	0.5
		P7 5k (Anupgarh)	(Coarse Loamy Typic Camborthid)				
0–18	88	27	244	1.8	2.5	0.2	0.8
18–44	98	24	167	1.4	1.7	0.2	1.1
44–70	98	22	209	1.0	0.8	0.4	0.9
70–100	90	20	231	1.4	0.8	0.3	0.5
100–130	60	15	257	0.8	0.6	0.3	0.5
		P8 Bijnour	(Fine Loamy Typic Camborthid)				
0–17	78	37	345	1.4	2.0	0.8	1.7
17–42	74	36	257	1.0	1.6	0.9	1.5
42–65	62	30	260	0.9	1.1	0.6	1.3
65–90	42	25	262	0.8	0.9	0.7	1.0
90–120	40	20	288	0.9	0.8	0.6	0.8

effect. The availability of K was positively affected ($p = 0.01$) by free iron and negatively by pH.

Distribution of micro-nutrients

The DTPA-Fe content which range between 0.5 to 2.0 ppm (Table 2) shows a decreasing trend with depth. Similar observations have been recorded by Singh *et al.* (1990) in alluvial soils of Haryana. Irregular distribution in pedon 2,3 and 7 indicates the effect of aeofluvial action. The Fe content was significantly and positively related to snad ($r = 0.201$) and OM ($r = 0.528$) and negatively with free Fe_2O_3 ($r = -0.437$). Free iron had a significantly negative influence on DTPA-Fe extractability. This could be due to oxidation of Fe^{2+} to Fe^{3+} oxide under alkaline conditions (Mishra & Pande 1975). All. studied factors accounted for 48.7% variability.

The DTPA –Mn content which ranged between 0.3 to 3.1 ppm with slightly higher values in the surface horizon (1.5 to 2.7 ppm), showed irregular distribution with depth. Sand, pH and OC ($r = 0.319$, 0.333 and 0.269 resp.) were positively related, while silt, clay, EC, free Fe_2O_3, $CaCO_3$ and ESP ($r = -0.239$, -0.272, - 0.209, 0.239, -0.269 and -0.609 respectively) were negatively correlated with DTPA extractable Mn as also observed by Singh *et al.* (1990). All factor accounted for 35.3% of the variability.

The extractable Cu was irregularly distributed in pedons and varies between 0.1 to 1.3 ppm while in the surface soils it ranges between 0.2 to 0.9 ppm. Cu showed significant relationship with organic carbon ($r = 0.444$) and negative with EC, free Fe_2O_3 ($r = -0.306$) and ESP ($r = 0.976$). DTPA extractable Cu was not influenced significantly with any of the factors studied (Table 3). All the factors put together accounted for 37.1% of the variability.

The DTPA extractable Zn range between 0.4 to 2.2 ppm while in the surface soil this range

Table 3 *Multiple regression analysis relating micro nutrients with soil parameters*

Dependent intercept variables	Independent variables									R^2
	Sand	Silt	Clay	pH	EC	OC	$CaCO_3$	Fe_2O_3	ESP	
Fe	1.6713	1.6885	1.7514	0.9816	−0.4017	2.9591^{++}	−0.4571	−2.5983	0.4817	0.4872
Mn	0.4354	0.3712	0.4520	1.9999	−1.0491	2.0569^{+}	−0.5728	−0.1147	1.3226	0.3528
Cu	0.3533	0.4077	0.3235	−0.706	−0.3587	1.7888	0.7448	0.5339	−1.3805	0.3707
Zn	0.2236	0.2621	0.1920	−0.7979	-2.5016^{+}	0.6613	0.3653	0.0348	2.3766	0.2903

between 0.4 to 1.7 ppm. In the soils studied, the content of Zn was below critical level of 0.6 ppm as suggested by Sharma and Singh (1990) for similar soils in Punjab. Silt and free $CaCO_3$ showed a positive and significant relationship, (r = 0.244 and 0.262 respectively). Similar relationship with silt has also been observed by Joshi *et al.* (1983). Electrical conductivity had a negative (r = -0.135) relationship (Rawat & Mathpal 1981). High salt concentration lead to precipitation of Zn as salts of Ca, (Borah *et al.* 1990) and this may be responsible for the decreased effectivity of DPTA as an extractant. All the factors put to gether accounted for nearly 29% of the variability.

The study reveals that the soils are marginal with respect to the macro elements. Zn is the elements that may be deficient. Variation in the distribution of the elements appears to be due to aeofluvial nature of soils.

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