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Short Communication

Status of Macro- and Micronutrients in Some Soils of Tonk District of Rajasthan

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Macronutrients (N, P, K) and micronutrients (Zn, Fe, Cu, Mn) are important soil elements that control its fertility. Soil fertility is one of the important factors controlling yields of the crops. 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 agriculture production. 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. The result of numerous field experiments in different parts of India have, therefore indicated *"fertilizer-induced unsustainability of crop productivity"*(Yadav 2003). Variation in nutrient supply is a natural phenomenon and some of them may be sufficient where others deficient. The stagnation in crop productivity can not be boosted without judicious use of macro- and micronutrient fertilizers to overcome existing deficiencies/imbalances. Although widespread macro- and micronutrients deficiency has been observed in the soils of Rajasthan, specially zinc (46 %) and iron (51.5 %) (Sharma *et al.* 2003), the information with respect to availability of macro and micronutrients and soil characteristics of the study area was lacking. Therefore, an attempt was made to correlate macro- and micronutrient contents of the soil with soil characteristics.

The study area covers 'Uniara' Panchayat Samiti of Tonk district in semi-arid region of Rajasthan. The soils of the area are characterized by light in texture, moderate to high pH and low to medium in organic matter content. Soil samples (0-20 cm) were collected from 120 sites covering 26 Gram Panchayats, keeping in view of the physiographic characteristics in different cross sections of the area as well as variation in soil texture. The processed soil samples were analyzed for physico-chemical properties using standard procedures (Jackson 1973).

General Soil Site Characteristics

It was observed that soil pH varied from 7.1 to 8.6 with an average of 7.8. According to classification of soil reaction suggested by Brady (1985), 14 samples were neutral (pH 6.6 to 7.3), 44 samples were mildly alkaline (pH 7.4 to 7.8), 59 samples were moderately alkaline (pH 7.9 to 8.4) and 3 samples were strongly alkaline (pH 8.5 to 9.0). The minimum value of pH 7.1 was observed in Uniara, Bilotha, Pagra and Khatholi and maximum value of pH 8.6 was observed in Rupwas village. The relative high pH of the soils might be due to the presence of high degree of base saturation. The electrical conductivity, calcium carbonate, organic carbon and clay content of the soils varied from 0.10 to 1.5 dS m^{-1}, 0.2 to 10.5%, 0.19 to 0.90% and 4.23 to 51.40%, with a mean value of 0.53 dS m^{-1}, 4.57, 0.45 and 23.37% respectively. On the basis of the limits suggested by Muhr *et al.* (1963) for judging salt problem of soils, most of samples (95%) were found normal (EC< 1.0 dSm^{-1}) and remaining 5% samples were found in the category of 'soluble salt content critical for germination' (EC 1 to 2 dS m^{-1}). Fifty five per cent soil samples were found non-calcareous ($CaCO_3$ content < 5%) and remaining 45% were slightly calcareous in nature ($CaCO_3$ content between 5 to 15%) as the classification proposed by FAO (1973). The organic carbon content was low (<0.50%) in 63%, medium (0.50 to 0.75%) in 21% and high (> 0.75%) in 16% soil samples. High temperature and good aeration in the soil increases the rate of oxidation of organic matter resulting reduction of organic carbon content. The soil texture varied from loamy sand to clay. Out of 120 samples, 9 (7.5%) fall in the category of sandy clay loam, 34 (28.3%) in clay loam, 27 (22.5%) in loam, 8 (6.7%) in clay, 9 (7.5%) in loamy sand and 33 (27.5%) in sandy loam textural group. The weighted means of soil properties and available macro and micronutrients are presented in table 1.

Available Nitrogen and Effect of Soil Characteristics

Available N content varied from 125 to 555 kg ha^{-1} with an average value of 309 kg ha^{-1}. On the basis of the ratings suggested by Subbiah and Asija (1956), 32% samples were low (< 250 N kg ha^{-1}) 61% medium (250 to 500 N kg ha^{-1}) and only 7% sample were high (>500 N kg ha^{-1}) in available N. A significant positive correlation (r = 0.639**) was found between organic carbon and available nitrogen (Table 2). This relationship was found because most of the soil nitrogen is in organic forms. Similar results were also reported by Verma *et al.* (1980), Kanthalia and Bhatt (1991) and Paliwal (1996). Available N was negatively correlated (r = -0.292**) with pH. This might be due to increased rate of denitrification at lower pH values (Tisdale 1997).

Available Phosphorus and Effect of Soil Characteristics

The available phosphorus content varied from 9.2 to 65.2 kg ha^{-1} with a mean value of 25.2 kg ha^{-1}. The range is quite large which might be due to variation in soil properties *viz.*, pH, calcareousness, organic matter content, texture and various soil management and agronomic practices. On the basis of the limits suggested by Muhr *et al.* (1963), 35% samples were low (<20 P_2O_5 kg ha^{-1}), 60% medium (20 to 50 P_2O_5 kg ha^{-1}) and 5% were high (>50 P_2O_5 kg ha^{-1}) in available phosphorus. A significant positive correlation (r = 0.797**) was observed between organic carbon and available phosphorus (Table 2). This relationship might be due to the presence of more than 50% of phosphorus in organic forms and after the decomposition of organic matter as humus is formed which forms complex with Al and Fe and that is a protective cover for P fixation with Al and Fe thus reduce phosphorus adsorption/ phosphate fixation (Tisdale *et al.* 1997). Available phosphorus and clay content was found positively correlated (r = 0.711**) (Table 2). Paudia (1987) and Patidar (1989) also reported similar results in the soils of Udaipur district. It has been reported that retention of added phosphorus increased with an increase of clay content (Tisdale *et al.* 1997). Available phosphorus was significant and negatively correlated with pH (r = -0.575**) because at higher pH calcium can precipitate with phosphorus as Ca-phosphate and reduce phosphorus availability (Tisdale *et al.* 1997). Similar results were also noted by Singh (1988) in the soils of Udaipur.

Available Potassium and Effect of Soil Characteristics

Status of available potassium (K_2O) in the soils ranged from 105 to 1059 kg ha^{-1} with an average of 377 kg ha^{-1}. According to Muhr *et al.* (1963) 2.5% samples were low (< 125 K_2O kg ha^{-1}), 41% were medium (125 to 300 K_2O kg ha^{-1}) and 56.5% samples were high (>300 K_2O kg ha^{-1}) in potassium content. A significant positive correlation (r = 0.420**) was observed between organic carbon and available K content (Table 2). This might be due to creation of favourable soil environment with presence of high organic matter. Similar results were also reported by Paliwal (1996) and Chouhan (2001). Available K was positively correlated (r = 0.460**) with clay content (Table 2). It might be due to the presence of most of the mica (biotite and muscovite both) in finner fractions (<0.002 mm size) (Lodha and Seth 1970, Singh *et al.*1985, Patidar 1989).

Soil Nutrient Index

Considering the concept of "Soil Nutrient Index" the soils of study area were found in category of 'medium fertility status' for nitrogen and phosphorus and 'high' with respect to potassium. The values worked out from nutrient index for nitrogen, phosphorus and potassium were 1.75, 1.70 and 2.54 respectively, against the nutrient index values <1.67 for low, 1.67 to 2.33 for medium and >2.33 for high fertility status of area.

Available Micronutrients and Effect of Soil Characteristics

The content of Zn, Fe, Cu and Mn varied from 0.19 to 1.93, 2.23 to 14.16, 0.21 to 1.87 and 6.85 to 45.25 mg kg^{-1} with mean values of 0.83, 5.38, 0.61 and 21.56 mg kg^{-1}, respectively. On the basis of the critical limits suggested by Takkar and Mann (1975) (<0.6 mg kg^{-1} for deficient, 0.6 to 1.2 mg kg^{-1} for marginal and more than 1.2 mg kg^{-1} for sufficient), 32% samples were deficient, 47% were marginal and 21% were sufficient in available Zn. Considering the critical limits (4.5 mg kg^{-1}) proposed by Lindsay and

Table 1. Salient soil properties (weighted mean) of study area

Sl. No.	Name of village	Number of samples collected	EC (dS m^{-1})	pH	OC (%)	$CaCO_3$ (%)	Clay (%)	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})
1	Uniara	8	0.41	7.6	0.50	5.14	30.52	283.9	30.6	430.0	0.67	5.24	0.54	25.12
2	Aligarh	3	0.68	7.4	0.61	3.38	33.46	410.1	31.8	548.4	0.36	6.97	0.84	12.14
3	Bamniya	3	0.65	7.7	0.57	6.53	33.67	278.4	23.6	300.5	0.44	5.90	0.88	11.21
4	Kholiya	3	0.51	8.1	0.28	3.42	26.26	330.2	17.8	326.5	0.52	3.81	0.35	12.35
5	Kunder	5	0.73	7.8	0.40	6.83	25.26	241.5	21.9	292.5	1.28	4.04	0.36	14.46
6	Sureli	4	0.58	7.6	0.35	4.80	12.68	298.0	21.7	268.4	0.66	3.62	0.38	17.55
7	Banetha	6	0.59	7.6	0.25	6.00	13.19	222.7	16.5	206.1	0.79	4.38	0.51	21.50
8	Sonthra	3	0.81	7.8	0.30	8.46	22.24	279.4	24.3	501.7	0.93	5.60	0.54	30.28
9	Dhikoliya	5	0.83	7.7	0.61	4.05	31.50	241.7	26.0	682.1	1.05	5.83	1.14	10.29
10	Ukhlana	3	0.48	8.0	0.30	1.70	12.32	228.7	14.0	259.5	1.00	4.22	0.41	12.06
11	Panchala	6	0.43	8.0	0.30	2.70	10.07	250.7	14.7	264.1	1.09	6.24	0.84	34.77
12	Shop	6	0.39	8.0	0.41	4.00	19.77	286.2	24.5	403.0	0.88	7.42	0.93	28.24
13	Amli	4	0.92	7.6	0.66	7.92	32.14	438.6	39.7	482.0	1.19	3.57	0.61	17.75
14	Bilotha	4	0.91	7.4	0.79	8.85	33.78	494.4	50.0	532.9	0.54	4.83	0.50	11.85
15	Pagra	3	0.81	7.5	0.74	4.78	42.40	500.0	35.8	656.0	0.76	5.05	0.66	42.00
16	Khatoli	6	0.53	7.5	0.63	8.20	31.33	350.2	30.9	417.1	1.00	6.57	1.19	30.82
17	Deoli	3	1.20	7.6	0.55	2.71	27.79	275.2	25.9	252.1	1.43	6.76	0.76	19.60
18	Chatarpura	4	0.98	7.8	0.60	1.11	27.79	360.4	27.5	255.8	1.18	7.14	0.45	19.41
19	Palai	4	0.42	8.0	0.53	0.60	33.56	318.9	28.7	430.7	0.74	5.25	0.45	17.84
20	Kachrawata	5	0.22	7.5	0.29	4.25	25.00	286.5	22.5	228.7	0.44	5.19	0.49	33.16
21	Bosaroya	5	0.24	7.9	0.48	6.93	29.91	300.2	31.8	469.2	0.58	5.42	0.42	32.07
22	Mohammadgarh	7	0.39	7.7	0.57	4.27	28.76	416.6	28.1	516.5	1.30	6.80	0.59	25.94
23	Kakor	6	0.28	8.0	0.30	2.24	12.62	256.8	19.9	288.2	0.42	5.12	0.54	14.53
24	Rupwas	4	0.32	8.0	0.35	1.08	10.29	278.6	17.1	291.9	0.50	5.11	0.33	15.44
25	Phooletha	6	0.27	7.8	0.27	2.59	12.42	186.0	15.5	305.5	0.65	4.47	0.38	14.78
26	Bilaspura	4	0.24	8.0	0.25	3.51	7.71	244.9	19.9	258.7	0.88	4.51	0.82	16.68
	Range		0.10-1.50	7.1- 8.6	0.19-0.90	0.20-10.10	4.23-51.40	125-555	9.2-65.2	105-1059	0.19-1.93	2.23-14.16	0.21-1.87	6.85-45.25
	Mean		0.53	7.8	0.45	4.57	23.37	309	25.2	377	0.83	5.38	0.61	21.56

Table 2. Correlation coefficient (r) values of pH, organic carbon, calcium carbonate and clay content with macro- and micronutrients

Soil properties	Available Nutrients						
	N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
pH	-0.292**	-0.575**	-	-0.151	-0.052	-0.195*	-0.68**
Organic carbon	0.639**	0.797**	0.420**	0.113	0.226*	0.268*	-
$CaCO_3$	-	-	-	0.058	-0.037	-	0.169
Clay	-	0.711**	0.460**	0.082	0.180*	0.196*	-

** Significant at 1 % level
 * Significant at 5 % level

Norvell (1978), 35% samples were found deficient in DTPA extractable Fe. All the soil samples were sufficient in available Cu and Mn considering 0.2 mg kg^{-1} for Cu and 1.0 mg kg^{-1} for Mn as critical limits suggested by Lindsay and Norvell (1978). A significant negative correlation (r = -0.195*) was observed between soil pH and available copper. Similar relation was also observed by several workers (Sakal *et al.* 1986; Chatterji *et al.* 1999 and Sharma *et al.* 2003). Available Fe and Cu were positively correlated (r = 0.226* for Fe, r = 0.268* for Cu) with organic carbon content. The availability of metal ions (Fe, Cu) increases with increase in organic matter content because organic matter may supply chelating agents. Such relationship was also reported by Khera and Pradhan (1980), Sharma *et al.* (2003). Significant positive correlation was also observed between Fe and Cu with clay content (r = 0.180* for Fe and r = 0.196* for Cu). Increase in the finner fraction of the soil leads to increase in surface area for ion exchange and contribute to greater DTPA extractable forms of metal ions. This is in agreement with the findings of Rai and Mishra (1967) and Sharma *et al.* (2003).

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