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Soil Survey, Analysis, Evaluation and Mapping of Fertility Status of Irrigated Light Soils in Arid Nagaur District of Rajasthan

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ABSTRACT

Soil fertility status is the most important aspect of soil physico-chemical properties in relation to its productivity for sustainable agricultural production. The present investigation was made in 2018-19 to assess the fertility status of irrigated soils in arid Nagaur district of Rajasthan, India. In general, the soils were low in organic carbon and available nitrogen in the district. One hundred and fifty composite surface soil samples at 0-15 cm depth were collected from fields of five tehsils (30 samples each) of Nagaur district. The mean values of available N, P_2O_5, K_2O and S varied from 168.95, 18.09, 158.50 kg/ha and 12.11 ppm in Nagaur; 158.66, 17.56, 134.00 kg/ha and 11.58 ppm in Jayal; 151.82, 16.92, 140.69 kg/ha and 10.56 ppm in Didwana; 153.77, 18.01, 140.47 kg/ha and 10.73 ppm in Ladnu and 149.90, 16.55, 157.00 kg/ha and 11.01 ppm in Nawa, respectively. The nutrient indices for organic carbon, available nitrogen, phosphorus and potassium were 1.00, 1.00, 1.08 and 1.7, respectively. On the basis of the analytical results and taking development indices as unit, a soil fertility map was prepared. It was recommended that there was a need to supply these deficient nutrients through external organic and inorganic sources for sustaining crop productivity and soil health of five tehsils of Nagaur district of Rajasthan. Soil pH and OC showed positive significant correlation with macronutrients.

Key words : Available nitrogen, available phosphorus, available potassium, organic carbon, sulphur, nutrient indices, soil fertility map

INTRODUCTION

Soil is the natural resource for crop production and fertility status is the most important aspect of soil physico-chemical properties for sustainable agricultural production. The decline in soil fertility due to imbalanced fertilizer use has been recognized as one of the most important factors limiting the crop yield (Patil *et al.*, 2016). Light soils are generally poor in fertility and are deficient in nitrogen and organic carbon. The organic carbon is an indicator of organic fractions in the soil formed from microbial decomposition of organic residues (Pharande and Kale, 2019). Information on location-specific status of macro and micronutrients for different soil types, districts and region as well as for the country is essential to determine the nature and magnitude of their deficiencies/toxicities and to formulate strategies for their correction for enhancing crop production (Basumatary *et al.*, 2019). Suitability of soil as a medium for crop production depends upon its ability to provide sufficient amount of water and essential nutrients in available form, which in turn is controlled by its properties (Singh, 2014). Macronutrient availability in soils of western Rajasthan may be influenced by different physiographic regions having difference in soil properties which may finally affect the optimum crop yield. Hence, there is a need to generate database on the status of macronutrients and their deficiency in soils (Meena and Mathur, 2017). It is well known that the optimum plant growth and crop yield depend not only on the total amount of nutrients present in the soil at a particular time but also on their availability which in turn is controlled by physico-chemical properties. The most important constituent in soil is organic matter, an appreciable amount of it in soil tremendously increases soil fertility. Decay of organic matter releases nitrogen, phosphorus and mineral nutrients in forms

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available to plants. Choudhary *et al.* (2017) reported that organic carbon was positively correlated with total and available nitrogen in all soil groups. Assay of soil available nutrient constraints of an area using global positioning system (GPS) will help in formulating site-specific balanced fertilizer recommendation and to understand the status of soil fertility spatially and temporally. Geographic information system (GIS) is a powerful tool which helps to integrate many types of spatial information such as agro-climatic zone, land use, soil management, etc. to derive useful information. Therefore, the present study was carried out to generate information on physico-chemical properties, fertility status and nature of irrigated light soils in arid Nagaur district of Rajasthan.

MATERIALS AND METHODS

The area under study (Fig. 1) lies in the Agro-climatic zone IIA i. e. internal drainage dry zone of Rajasthan. The research site of study was located at 26°25′ and 27°40′ North latitude and 73°10′ and 75°15′ East longitude of Nagaur district of Rajasthan.

One hundred and fifty soil samples each of 2 kg were randomly collected at 0-15 cm depth from the fields where the soils were irrigated representing five tehsils viz., Nagaur, Jayal, Didwana, Ladnu and Nawa (30 samples in each tehsil) of Nagaur district. These samples were air-dried, ground to the size of 0.5 mm through sieve and stored in labelled polythene bags.

Organic carbon (OC) of soil was determined by rapid titration method. Available nitrogen (N) by alkaline permanganate method, available phosphorus (P), available potassium (K) by extraction with 1 N ammonium acetate at pH 7 and available sulphur (S) was determined turbid metrically using barium chloride. The nutrient index was calculated by using the equation as given below. In this method, the number of samples in each of the three categories i. e. low (1.67), medium (2.00) and high (2.33) as obtained from the analysis was multiplied by 1, 2 and 3, respectively. The total of the figures thus obtained was divided by total number of samples.

Nutrient index = [(L x 1) + (M x 2) + (H x 3)]/[100]

Where, L, M and H are the number of soil samples falling in category of low, medium and high nutrient status, respectively.

Correlation coefficient ('r' value) was used to measure the relationship between dependent and independent variables. The correlation coefficient between two groups was calculated by using the following formula :

$$r = \frac{\Sigma(XY) - \frac{\Sigma X \Sigma Y}{n}}{\sqrt{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{n}\right]\left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}\right]}}$$

Where, r–Correlation coefficient, X–Independent variable, Y–Dependent variable, n–Total number of respondents.

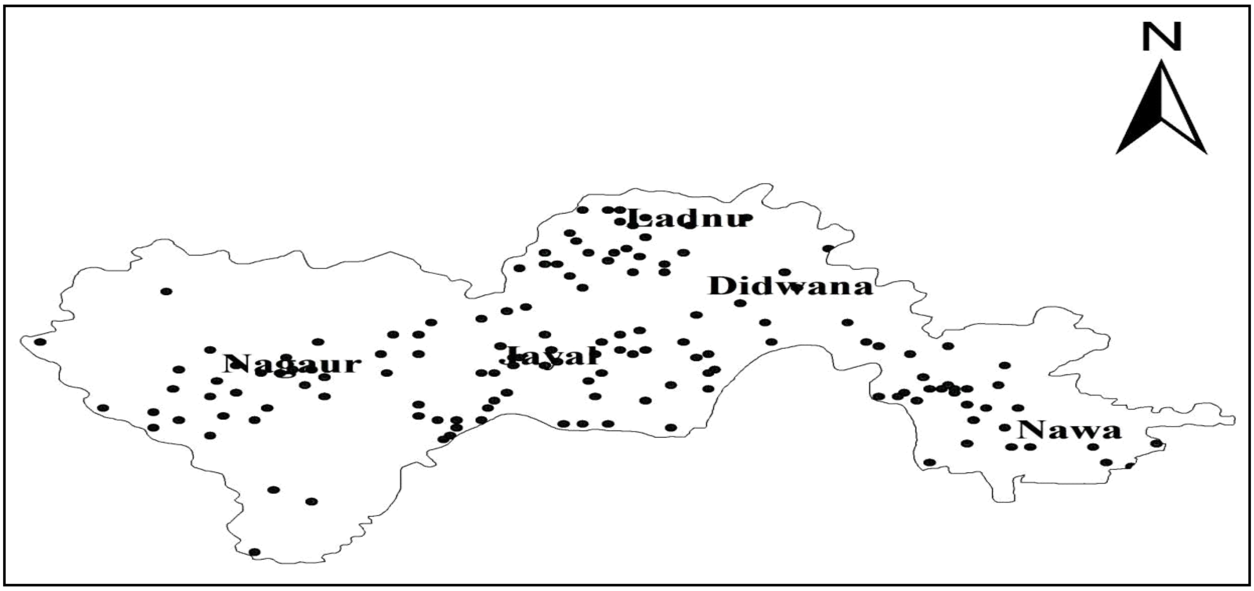

Fig. 1. Location map of study site.

Table 1. Fertility status of irrigated soils of five tehsils of Nagaur district of Rajasthan

Tehsils	OC (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Available S (ppm)
Nagaur					
Max.	0.49	220.30	20.90	223.17	18.75
Min.	0.14	110.40	14.41	115.72	6.52
Mean	0.35	168.95	18.09	158.50	12.11
S. D.	0.08	33.23	1.88	29.62	3.73
C. V. (%)	23.68	19.67	10.37	18.69	30.79
Jayal					
Max.	0.46	215.30	21.23	224.55	18.72
Min.	0.15	112.30	14.80	99.19	6.20
Mean	0.34	158.66	17.56	134.00	11.58
S. D.	0.07	27.90	1.44	27.21	3.26
C. V. (%)	21.48	17.58	8.17	20.31	28.20
Didwana					
Max.	0.46	218.20	19.15	223.17	18.40
Min.	0.15	112.10	14.60	95.05	6.21
Mean	0.31	151.82	16.92	140.69	10.56
S. D.	0.08	30.27	1.18	27.37	3.69
C. V. (%)	26.10	19.94	6.99	19.45	34.96
Ladnu					
Max.	0.48	220.30	21.23	217.66	19.20
Min.	0.16	114.20	14.60	93.68	5.87
Mean	0.32	153.77	18.01	140.47	10.73
S. D.	0.08	31.71	1.96	33.08	3.68
C. V. (%)	25.49	20.62	10.88	23.55	34.33
Nawa					
Max.	0.50	222.40	19.61	221.79	19.53
Min.	0.10	110.00	13.23	103.32	5.38
Mean	0.29	149.90	16.55	157.00	11.01
S. D.	0.12	35.81	1.68	36.65	4.64
C. V. (%)	40.83	23.89	10.14	23.35	42.18

S. D.–Standard deviation and C. V.–Coefficient of variation.

RESULTS AND DISCUSSION

Soil organic carbon (OC %) of five tehsils recorded was from 0.14-0.49% (Nagaur), 0.15-0.46% (Jayal), 0.15-0.46% (Didwana), 0.16-0.48% (Ladnu), 0.10-0.50% (Nawa), respectively (Table 1). Lower values of organic carbon in irrigated soil were due to continuous organic matter oxidation subjected to anthropogenic activities (Sharma *et al.*, 2015; Behera *et al.*, 2016; Bodar *et al.*, 2018).

The available N content ranged between 110.4 to 220.3 kg/ha (Nagaur), 112.3 to 215.3 kg/ha (Jayal), 112.1 to 218.2 kg/ha (Didwana), 114.2 to 220.3 kg/ha (Ladnu), 110.0 to 222.4 kg/ha (Nawa), respectively (Table 1). The low levels of N were attributed to low OC content, resulting from sub-optimal vegetation, high temperature and high soil pH, favouring higher oxidation and volatilization losses (Sharma *et al.*, 2015; Tundup *et al.*, 2015). The available N content showed a gradual decrease with soil depth following the depth distribution of OC as evident from significant and positive (r=0.931**) correlation between available N and OC.

The available P ranged between 14.41 to 20.90 kg/ha (Nagaur), 14.80 to 21.23 kg/ha (Jayal), 14.60 to 19.15 kg/ha (Didwana), 14.60 to 21.23 kg/ha (Ladnu) and 13.23 to 19.61 kg/ha (Nawa), respectively (Table 1). In this area, the farmers were using only diammonium phosphate (DAP) as a source of nutrients in adequate quality. As a result, available P was low to medium range in the study area. Similar findings were reported by Bodar *et al.* (2018).

The available K ranged between 115.72 to 223.17 kg/ha (Nagaur), 99.19 to 224.55 kg/ha (Jayal), 95.05 to 223.17 kg/ha (Didwana), 93.68 to 217.66 kg/ha (Ladnu) and 103.32 to 221.79 kg/ha (Nawa), respectively (Table 1). Available K was found medium to high due to presence of potash bearing minerals (muscovite, biotite and feldspar) which on weathering slowly released potash (Kumar *et al.*, 2014; Singh and Benbi, 2016).

The available S ranged between 6.52 to 18.75 ppm (Nagaur), 6.20 to 18.72 ppm (Jayal), 6.21 to 18.40 ppm (Didwana), 5.87 to 19.20 ppm (Ladnu) and 5.38 to 19.53 ppm (Nawa), respectively (Table 1). Low and medium level

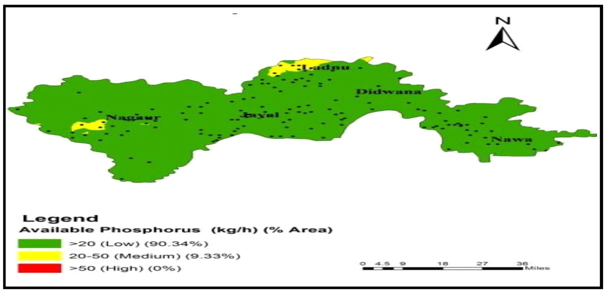

Fig. 2. Status of available phosphorus in irrigated soil of various tehsils of Nagaur district.

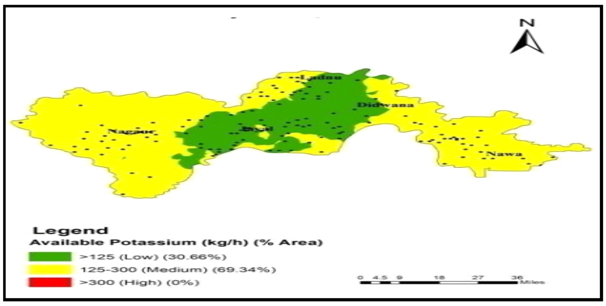

Fig. 3. Status of available potassium in irrigated soil of various tehsils of Nagaur district.

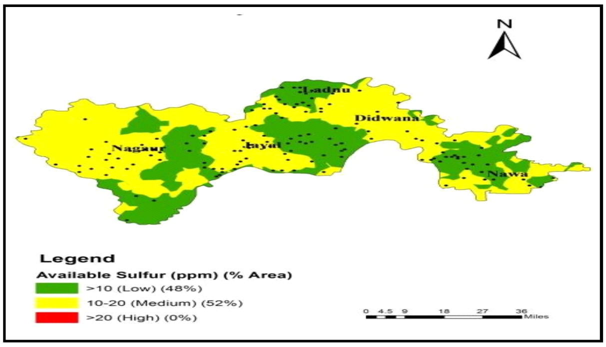

Fig. 4. Status of available sulfur in irrigated soil of various tehsils of Nagaur district.

of available S was due to lack of S addition and continuous removal of S by crops (Patil *et al.*, 2016). Similar results were also reported by Sharma *et al.* (2015).

The nutrient index for OC, available N, available P and available K was 1.00, 1.00, 1.08 and 1.7, respectively (Table 2). In this way, soils of the Nagaur district were found to be low in OC and available N, low to medium in available P (Fig. 2), available K (Fig. 3) and available S (Fig. 4).

By and large, pH showed significant correlation with nutrients like macro and micronutrients. Perusal of the data in Table 3 shows significant negative correlation between pH and N (r = -0.341**), K (r = -0.163*) and S (r = -0.352**). Similarly, a significant negative correlation was found between bulk density and N (r = -0.805**) and S (r = -0.799**). The OC showed positive significant correlation with N (r = 0.931**) and S (r= 0.924**). Similarly, a significant positive correlation was found between bulk clay and N (r = 0.615**) and S (r = 0.612**).

Table 2. Fertility status of soils of Nagaur district and their nutrient index

Nutrients	Low	Medium	High	Total
Organic carbon				
No. of samples	149	1	0	150
Per cent of samples	99.33	0.67	0	100
Nutrient index		1.00 (Low)		
Available nitrogen				
No. of samples	150	0	0	150
Per cent of samples	100	0	0	100
Nutrient index		1.00 (Low)		
Available phosphorus				
No. of samples	137	13	0	150
Per cent of samples	91.33	8.67	0	100
Nutrient index		1.08 (Low)		
Available potassium				
No. of samples	45	105	0	150
Per cent of samples	30	70	0	100
Nutrient index		1.7 (Medium)		

Table 3. Relationship between available macronutrients and physico-chemical properties of representative samples

	N	P_2O_5	K_2O	S
pH	-0.341**	-0.158	-0.163*	-0.352**
Organic carbon	0.931**	0.143	0.088	0.924**
Bulk density	-0.805**	-0.095	-0.086	-0.799**
Clay	0.615**	0.017	0.062	0.612**

*,**Significant at P=0.05 and P=0.01 levels, respectively.

CONCLUSION

The irrigated soil samples of arid Nagaur district of Rajasthan showed low in OC and available N, whereas available P and available K were low to medium in irrigated soils of study area. Hence, the soils required attention regarding integrated nutrient management approaches and regular monitoring for soil health for better crop productivity and sustainable agricultural production.

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