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NUTRIENT DYNAMICS IN SOIL OF CANAL COMMAND AREA OF DISTRICT BIKANER, RAJASTHAN

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The surface soil samples were collected to evaluate the fertility status of canal command area of Bikaner districts of Rajasthan from the farmer's fields representing major *kharif* crops of the zone are pearl millet, moth bean, cluster bean & sesame under rainfed condition and ground nut under irrigated conditions. In *Rabi* chickpea, mustard, wheat is the major crops. *Kachri*, snap melon, *mateera* and vegetable cluster bean are most important arid vegetable crops grown throughout arid region in a wide variety of soils. The soils were slightly neutral to alkaline in reaction. The organic carbon content of arid soil ranged from 0.07 to 0.14 per cent with an average value of 0.12 per cent. Available nitrogen (N), phosphorus (P) and potassium (K) content of the arid soils varied from 166 to 309, 8.47 to 16.47 and 210 to 272 kg ha^{-1} with average value of 267, 12 and 228 kg ha^{-1}, respectively. Among major nutrients, about 40 per cent of the soil samples were low, whereas, rest of the samples (60 per cent) were recorded to be medium in available N, 30 and 70 per cent soil samples were observed to be low and medium in available P, whereas, 100 per cent samples were in medium in available K. Nutrient indexing of the areas was low for nitrogen (1.6) and phosphorus (1.7), whereas, it was medium in case of potassium (2.0). With respect to micro-nutrients, 100 and 50 per cent samples were found deficient in DTPA-Zinc and Copper, respectively.

Key words: Canal command area, Nutrient dynamics, Soil of Bikaner

Introduction

The north western region of Rajasthan is characterized by stormy southwest winds along with frequent dust storms. Seventy per cent cultivated areas are rainfed. Crop production during this half gamble with monsoon. Soils of the zone are sandy in texture, very low in fertility with regard to all most all nutrients. Soils are aeolian in nature with extremely high permeability at surface and low in nutrient and water retention capability. Extensive area under the zone has hard pan at varying depths. Some soils of the north western arid region are gypsiferous. The major *kharif* crops of the zone are pearl millet, moth bean, cluster bean & sesame under rainfed condition and ground nut under irrigated environment. In *rabi* chickpea, mustard and wheat is the foremost crops. *Kachri*, snap melon, *mateera* and vegetable cluster bean are most important arid vegetable crops grown throughout arid region in a wide variety of soils. In arid vegetable, blanket use of fertilizers over a period of time has resulted into nutrient disproportion in soil. Moreover, heavy dose of straight fertilizers containing only macro-nutrient has led to scarcity of

macro and micronutrients at various locations[5]. Applications of fertilizers by the farmers in the fields without prior information of soil fertility status results in unfavorable effects on soil as well as on crop in terms of nutrient deficiency/ toxicity either by the insufficient or overdose of fertilizers. For sustainability of the present agricultural system and for management of our soil resources[3], knowledge of the fertility status of soils is vital for making area specific recommendations. The beginning of high yielding varieties has further led to increased nutrients demand[12, 14]. Thus, use of inorganic fertilizers and organic manures become essential for getting higher yield[4]. It is; therefore, key to have information on the current fertility status of soil so as to devise the fertilizer schedule for arid crop for sustainable production. Therefore, the present study was undertaken to judge the macro and micronutrient status of the soils of arid crops region of Bikaner district to evaluate their magnitude of sufficiency/deficiencies and imbalances to refine fertilizer recommendations and promote site specific nutrient management.

Materials and Methods

To determine the soil fertility status of canal command area of Bikaner districts of Rajasthan, a systematic soil survey was carried out during 2018-19. Under this study, farmer's fields were selected randomly by keeping in view the identified major canal command area of Bikaner districts of Rajasthan. Composite surface soil samples (0-15 cm) were collected before sowing *Rabi* and *kharif* crops from these areas and soil samples were air dried followed by sieving by 2 mm sieve to remove gravels, stones and organic and crop residues by using standard procedure. The processed soil samples were analyzed for their available macro and micronutrients for plant growth employing conventional methods. The pH was determined in 1: 2 soil water suspension and organic carbon by acid oxidation of organic matter[20]. Available nitrogen was estimated using the standard method[17]. Available phosphorus and potassium were determined by Bray P and neutral ammonium acetate methods, respectively[2]. DTPA extractable available micronutrients (Zn, Fe, Mn and Cu) in the soils were estimated by Atomic Absorption Spectrophotometer[8]. A recommendation for N, P & K for different soil available nutrients was worked out[9].

Results and Discussion

Organic carbon: The organic carbon content of readily oxidisable in the soils varied from 0.07 to 0.14 per cent with an average value of 0.12 per cent representing low in organic carbon. The distribution of soil samples under low (<0.5), organic carbon categories was 100 per cent, respectively (Table 1). The low OC the soils might be due to hot arid region, soils contains 60-90 per cent sand which results in low water holding capacity and high infiltration rate. Arid regions is characterized by various abiotic stresses such as high and fluctuating temperature, high wind velocity, low and variable precipitation, drought, salinity, frost during winter and poor soil fertility. In arid region, temperature ranged from 3^0C in winter during December-January to 48-50^0C in summer during May-June. Scanty rainfall is the main characteristic of hot arid region which varies from 100 mm to 2144 mm annually in different regions of India. The hot arid soils are low in organic matter due to low rainfall, high temperature, meager vegetation and single grained sandy soil texture. Another factor might due to intensive cultivation, which has resulted into the decrease of organic matter in the soil over a period of time.

Nitrogen: Available nitrogen estimated by alkaline $KMnO_4$ method varied from 166 to

309 kg/ha with average of 267 kg ha^{-1} with all the samples analyzed which were fall in low availability of nitrogen (Table 2). Nitrogen requirement of crop of canal command area of Bikaner districts of Rajasthan is first limiting factor and its demand by vegetable crops is higher as compared to cereals. But on the perusal of data it is observed that the nitrogen was the most deficient nutrient in these soils. About 40 per cent of the soil samples were found to be low and 60 per cent were having medium in available nitrogen status, whereas not a single soil sample was in high category. Therefore, farmers need to apply nitrogen regularly to get optimum yield based on prescribed by the soil testing laboratories in India are based on soil fertility ratings (Table 4).

Phosphorus: Available phosphorus content in the surface soil as estimated by Olsen P averaged value was 12 kg ha^{-1} and varied between 8.47 to 16.47 kg ha^{-1}. Keeping in view the critical limit of P fixed (Table 1), the available P in the canal command area of Bikaner districts of Rajasthan was found to be in the order of medium in 100 per cent samples, respectively, due to continuous application of P inorganic fertilizers to crops, its high complex/retention in soil and poor recovery (10-15 per cent) of applied P during the growing season [18]. Therefore, phosphorus should be applied on soil test, target yield equation basis and prescribed by the soil testing laboratories in India are based on soil fertility ratings to keep away from over or under use of fertilizers.

Potassium: Averaged value of available potassium content of surface soils was 228 kg $ha^{-}1$ and varied between 210 to 272 kg ha^{-1}. More than 95 per cent of soil samples were medium in available K as per critical limits (Table 1) fixed for canal command area of Bikaner districts of Rajasthan. The main cause of its deficiency in these soils was continuous depletion of K from the soil reserve over the years without its replenishment [15, 16].

Micronutrients: The status of available Zn content in the soils of canal command area of Bikaner districts of Rajasthan between 0.21 to 0.39 mg kg^{-1} with a average value of 0.31 mg kg^{-1} (Table 2 and 3). Based on the critical limit of Zn (0.75 mg kg^{-1}), 100 per cent of samples were found to be deficient in DTPA-extractable Zn and required Zn application for optimum crop production and to get full benefit from NPK fertilization. The mean value of available Fe content of the soils under investigation was9.21 mg kg^{-1} and varied from 6.54 to 10.49 mg kg^{-1} (Table 3). Considering 6.6 mg kg^{-1} DTPA-extractable Fe as the critical limit cultivation[19], none of soil of samples was deficient in available Fe content.

Likewise, average value of Cu content was 0.31 mg kg^{-1} and varied from 0.17 to 0.47 mg kg^{-1}. With 50 per cent samples falling in deficiency range in Cu (Table 4). Soils in general were rich in Mn content with an average value of 6.67 mg kg^{-1}, may be linked to inherent Mn minerals present in the soil. Data indicate that there is no immediate need for applying micronutrients to the crop except for the Zn and Cu

Nutrient Indexing of soil test

Indexing of nutrient (NPK) was used to determine pocket specific nutrient availability of all the canal command area of Bikaner districts of Rajasthan area as in this strategy the variation in field to field is not taken into consideration while the fertilizer recommendations are made on the basis of overall fertility status of the study area[10]. As per nutrient index study of the canal command area of Bikaner districts of Rajasthan, soils were deficient in available N (1.6), whereas in case of P and K it was medium (1.7 and 2.0, respectively). It shows that soil has great requirement for nitrogen followed by K and P was in sufficient amount in most of the soils, hence fertilizers

recommendation should be applied on the basis of soil test (Fig. 1)

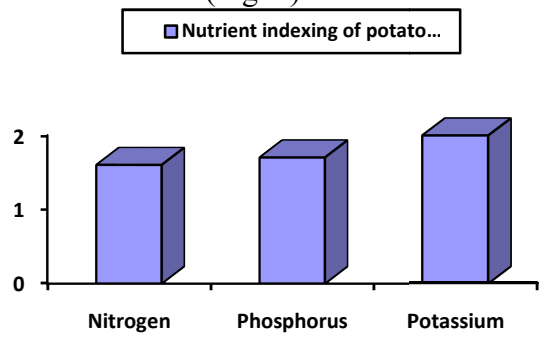

Fig.1 Nutrient indexing of the soils of Canal commends area of Bikaner district

Fertilizer recommendations

Fertilizers application in the crop varies with farmers' perception about the recommendation for the area and their resources. Since farmers are not aware of the available soil nutrient soil status, application rate are not matching with the requirement of the crop[7]. Most of the recommendations prescribed by the soil testing laboratories in India are based on soil fertility ratings (Table 4), the medium soil fertility being equated with general recommended dose. In low and very low or high and very high categories the fertilizer doses are raised or lowered by 25 to 50 percent of the general recommended dose as per situation. Since, nutrient recommendations with this approach are irrespective of yield goal and variation in soil type. These may perform well for moderate yield levels under optimal soil conditions. For high yield expectations as under commercial farming, however the approaches taking in to account yield target are more suitable

Blanket use of macro-nutrients may affect uptake of nutrients[6]. Available nutrients present in the soil or soil solution at a particular time is directly related to optimum plant growth and crop yield and available nutrients is controlled by physic-chemical properties of soil. The crop production in the hot arid regions are constrained by high evapo-transpiration (1 500-2 000 mm/year), low and unpredictable rainfall (100-420 mm/year) and unfavorable soil physical and fertility conditions. Sand dunes is found in arid region of Rajasthan, which are characterized by low organic carbon content, saline/ alkaline problems, light texture, high pH and low CEC of sandy soils of arid region[13]. These soil conditions are not favourable for sufficient availability of macro and micronutrients[1, 15, 16, 21, 11, 20]. The low organic matter has been attributed to high temperature, low rainfall, meager vegetation cover and single grained texture of soil.

Conclusions

Soils of canal command area of Bikaner districts of Rajasthan have heterogeneity with regard to macro and micronutrients availability, which can be attributed to differential use of fertilizers and FYM/organic manures and intensive cultivation. Considerable amount of N and K, both being mobile in nature, is lost in surface runoff during the monsoon season. Nutrient index in over all canal command area of Bikaner districts of Rajasthan was low for nitrogen and medium for potassium and phosphorus. Thus regular application of N and K fertilizers and FYM/organic manures on the basis of soil tests and crop removal for major will help in maintaining soil productivity and fertility in the region. Soil available nutrients and other soil attributes along with yield target equations can be of great use to balance fertilizer recommendations in different canal command area of Bikaner districts of Rajasthan growing pockets. Based on the present study, the recommendation for N application may be increased as per soil test results of the particular area. At the same time, recommendation for P application may be reduced drastically in the major part of the pocket. Further, this will be a step

towards precision application of nutrient not only reducing the cost of fertilizer but also reducing damage to the environment.

OC (%)		Available Nitrogen (N kg ha^{-1})		Available Phosphorus (P_2O_5 kg ha^{-1})		Available Potassium (K_2O kg ha^{-1})	
Rating	Percent samples	Rating	Percent samples	Rating	Percent samples	Rating	Percent samples
Low (≤0.5%)	100%	Low (<280)	40	Low (<51)	30	Low (<285)	-
Medium (0.5-0.75%)	-	Medium (281-560)	60	Medium (51-103)	70	Medium (285-407)	100
High (>0.75%)	-	High (>560)	-	High (>103)	-	High (>407)	-

Table 1. Soil samples (%) falling in different ranges of pH, organic carbon and available N, P & K

Soil properties	Minimum	Maximum	Mean	Median
OC (%)	0.08	0.14	0.12	0.13
Available Nitrogen (kg ha^{-1})	166.10	309.10	267.30	284.90
Available Phosphorus (kg ha^{-1})	8.47	16.47	12.24	12.86
Available Potassium (kg ha^{-1})	210.10	272.80	228.80	225.50
Zn(mg kg-1)	0.21	0.39	0.31	0.30
Cu (mg kg-1)	0.17	0.47	0.31	0.32
Mn (mg kg-1)	4.62	8.97	6.67	6.42
Fe (mg kg-1)	6.54	10.49	9.21	9.11

Table 2. Descriptive statistics of soil properties of samples collected from canal command area of Bikaner districts of Rajasthan

Micronutrient element	Critical limit (mg kg-1)	Samples deficient (%)
Zn	0.75	100%
Cu	0.32	50%
Mn	3.00	-
Fe	6.6	-

Table 3. Micronutrient status (mg kg^{-1}) of soils canal commend area of Bikaner district

Nutrient	Low	Medium	High
N	<280	280-560	>560
P (Olsen) P (Bray)	<10 <35	10-25 35-80	>25 >80
K	<120	120-280	>280

Table 4: Recommendations based on soil fertility rating

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