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Available Micro Nutrient Status and Their Relationship with Soil Properties of Raisinghnagar Tehsil, District Sri Ganganagar, Rajasthan, India

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Abstract

In view of scanty information on micronutrient status of soils of Rajasthan the present study was undertaken to study the available micronutrient status and their relationship with physico-chemical properties of the soils of Raisinghnagar block district Sriganganagar, having different cropping systems and irrigated by Gang canal and Bhakhra canal tributaries. Total 108 samples collected from 27 villages of Raisinghnagar block and analyses in the laboratory using standard laboratory procedures. Results of the study indicate that soils of Raisinghnagar block have low to marginal deficiency of Zn, Fe and Mn and only Cu is found at high level in more than 60 percent samples. These micronutrients need to be added to soils keeping in view of agriculture with high yielding varieties and maintain sufficient status for long duration.

Key words: Micro nutrient status, physico-chemical properties and soil etc.

Introduction

Soil is a component of the lithosphere and biosphere system. It is a vital natural resource on which are the supporting life systems and socio-economic development depends. The crisis of land degradation was mainly related to increasing population pressure. The per capita cultivable land has been declined from 0.32 ha in 1950's through 0.14 by the turn of the century to less than 0.1 ha by 2020. The challenge is thus being faced not only of increasing productivity on sustainable basis, but also of the preserving and maintaining of soil resource bases for the posterity. The ability of the land to produce is limited and the limits to produce are set by soil, climate and landform conditions. However, the capacity of a soil to produce is limited and the limits to production are set by intrinsic characteristics, agro-ecological settings, use and management. Soils are crucial to life on earth and are thus one of the most important natural resources. It is at the heart of terrestrial ecology and an understanding of the soil system is key to successful human use of the land and environmental harmony. According to (Lal and Singh, 1998), soil quality degradation process with reference to productivity or fertility encompasses physical chemical and biological degradation process. This is pre-requisite for determining appropriate conservation activities in monitoring our natural resource base. With the advances in information technology the data on soils, weather and other data can be integrated in making such decisions (Das, 1999).

Rajasthan, the largest State in the country in terms of geographical area, is located in the north-western part of the country. It has a geographical area of 3, 42,239 sq. km, which constitute 10.41% area of the country and 5.67% of national population (Census, 2012 Provisional data).

The prospects of agriculture in the State largely depend on timely arrival of monsoon. This year, the rainfall pattern indicates that during the current monsoon season, the State has received 732.82 mm rainfall against the normal rainfall of 418.7 mm. About 61% area lies in arid and semi-arid tracts, where soils are having poor fertility, low water holding capacity, high infiltration rate and shallow in depth in some areas (Mathur and Yadav, 2006). One million hectare area is under problematic soils (saline and alkaline). Due to scarcity of rainfall there is limited availability of ground water. The crops suffer due to high temperature and wind velocity. The water holding capacity is inadequate in lighter soils. The nitrogen and organic carbon status of the soils, in general is medium (Singh *et al*., 2013). The soils are well supplied with potassium. Micro elemental deficiencies particularly zinc and sulphur has also been observed in pockets.Present investigation was useful in judging the deficiency of various element and thereby use of fertilizers depending on their status. The present study was conducted for covering study of correlation between physico-chemical properties and available micronutrients in the soils of Raisinghnagar block district Sriganganagar.

Materials and Methods

Study Area

Sri Ganganagar is a northern most district of Rajasthan state in Western India. The town of Sri Ganganagar is the district headquarters. Sri Ganganagar district is located between latitude 28.4

Table 1: Description of sampling site

Sample No.	Name of Villages	Cropping pattern
1.	29 N.P.	Clusterbean-Mustard ,Clusterbean-Wheat, Cotton-Wheat, Bajra-Gram
2.	84 R.B.(A)	Fallow-Mustard, Sorghum-Barley, Moong-Mustard, Cotton-Wheat
3.	2M.K.	Clusterbean-Oat, Til-Gram, Bajra-Gram, Rice-Wheat
4.	Thakri	Moong-Mustard, Cotton-Wheat, Cotton-Gram, Clusterbean-Wheat
5.	4 M.K.	Bajra-Gram, Moong-Mustard, Wheat-Cotton, Clusterbean-Mustard
6.	3 M.K.	Fallow-Sugarcane, Fallow-Sugarcane, Cotton-Wheat, Bajra-Wheat
7.	Muklawa	Sorghum-Gram, Moong-Mustard, Clusterbean-Wheat, Rice-Wheat
8.	84 R.B.(B)	Bajra-Gram, Fallow-Mustard, Cotton-Wheat, Sorghum-Wheat
9.	10T.K.	Moong-Oat, Til-Gram, Clusterbean-Mustard, Cluterbean-Wheat
10.	6 M.K.	Cotton-Wheat, Fallow-Sugarcane, Rice-Wheat, Bajra-Gram
11.	17 P.S. (Pavarsar miner)	Fallow-Mustard, Clusterbean-Wheat, Cotton-Wheat, Moong-Mustard
12.	50 R.B.	Cotton-Wheat, Fallow-Mustard, Cotton-Wheat, Moong-Mustard
13.	14 T.K.	Cotton-Wheat, Fallow-Sugarcane, Clusterbean-Wheat, Moong-Wheat
14.	Jagatsinghwala	Bajra-Wheat, Sorghum-Oat, Cotton-Wheat, Fallow-Mustard
15.	Varawali	Fallow-Mustard, Clusterbean-Wheat, Fallow-Sugarcane, Sorghum-Berseem
16.	32 M.L.(miner lift)	Cotton-Wheat, Rice-Wheat, Rice-Wheat, Clusterbean-Mustard
17.	28 M.L.(Miner lift)	Clusterbean-Wheat, Moong-Mustard, Clusterbean-Mustard-Moong, Cotton-Wheat
18.	Udsar	Bajra-Barley, Fallow-Mustard, Sorghum-Berseem, Clusterbean-Wheat
19.	16 P.S. (Pavarsar miner)	Cotton-Mustard, Cotton-Wheat, Clusterbean-Gram, Fallow-Mustard
20.	14 P.S. (Pavarsar miner)	Cotton-Wheat, Clusterbean-Wheat, Moong-Mustard, Sorghum-Berseem
21.	Ganguwala	Bajra-Gram, Cotton-Wheat, Clusterbean-Mustard, Clusterbean-Wheat
22.	Kardawali	Moong-Gram, Fallow-Mustard, Clusterbean-Mustard, Clusterbean-Wheat
23.	31 M.L.(Miner lift)	Moong- Mustard, Clusterbean-Wheat, Clusterbean-Mustard, Fallow-Mustard
24.	15P.S. (Pavarsar miner)	Fallow-Mustard, Cotton-Wheat, Clusterbean –Mustard, Moong-Gram
25.	7 N.P.	Fallow-Mustard, Clusterbean-Wheat, Clusterbean-Mustard, Clusterbean-Gram
26.	Dabla	Moong-Mustard, Fallow-Mustard, Clusterbean-Mustard, Fallow-Mustard
27.	33 M.L.(Miner lift)	Cotton-Wheat, Clusterbean-Mustard, Til-Barley, Clusterbean-Wheat

Table 2: Procedure used for physico-chemical analysis of soil

Properties	Method applied	Reference
Physical properties		
Bulk density (Mg kg^{-1})	Pycnometer	Black *et al.* (1965)
Particle density (Mg kg^{-1})	Pycnometer	Black *et al.*(1965)
Water holding capacity	Keen box	Piper (1966)
Chemical properties		
pH	Glass electrode pH meter	Jackson (1973)
EC (dSm^{-1})	Electrical conductivity meter	Jackson (1973)
Organic carbon (%)	Wet oxidation method	Walkey and Black (1934)
Cationic Micronutrient Zn, Fe, Cu and Mn (mg/kg)	DTPA solution by Atomic Absorption Spectrophotometer	Lindsay and Norvell (1978)

to 30.6 and longitude 72.2 to 75.3. Sri Ganganagar is situated at the point where the Sutlej waters enter Rajasthan. The region irrigated by the Gang canal and the Bhakhra canal tributaries. The northern region, which is 3/4 of the district, resembles the fertile plains of Punjab, but some areas, like the area between the towns of Raisinghnagar and Vijaynagar, have desert like conditions. The economy of Sri Ganganagar district is dependent on agriculture. Major crops of the region are wheat, cotton, mustard, guar, grams, bajra, barely and sugarcane. Horticulture is also becoming popular among farmers. Kinnow (a citrus family fruit) is a popular horticultural product; other fruits of the citrus family are also grown. Industries in Sri Ganganagar district are based on agriculture. Raisinghnagar tehsil is one of the nine tehsil of Ganganagar district, Rajasthan, India. It is located in central-western area of the district. Raisinghnagar city is the head quarter of the tehsil. The climate of Raisinghnagar varies to extreme limits. The summer temperature reaches up to 50° Celsius and winter temperature dips just around -1° Celsius. The average annual rainfall is above 40 cm.

Soil sampling and analysis

Surface soil of the farmer's field from different village of Raisinghnagar block of Sri Ganganagar district, were sampled randomly to a depth of 0-15 cm in V shape with the help of *Khurpi* from 27 villages of Raisinghnagar block was presented in table 1. Four soil samples were collected from each village. The Soil sample was mixed thoroughly and about a half kilogram of composite samples from farmer's field at different villages was taken for analysis.

Collected surface soil sample (0-15 cm depth) were brought into laboratory and dried in shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and sieved through 2 mm sieve. Finally dried soil samples were kept in a polythene bag for further physico-chemical analysis (Table 2).

Statistical analysis

The relationship between different soil characteristics and micronutrient contents in soils and plants were determined using correlation coefficients:

$$r = \sqrt{\frac{SP\,(xy)}{SS(x),\ SS\,(y)}}$$

Where: r = Correlation coefficient
P (xy) = Sum product of x, y variables
SS (x) = Sum of square of x variable
SS (y) = Sum of square of y variable

Results and Discussion

Status of available micronutrients viz. Fe, Mn, Zn and Cu in soil

Deficiency of micronutrients is spreading in soils at faster rate, use of high fertilizer and high yielding crop varieties under intensive cropping system have further accelerated the process of micronutrient deficiency in soil solution. Therefore it has become imperative to monitor soils from Fe, Mn, Zn and Cu. These rating limits are irrespective of crops or soils. Critical limits for soil test (values available Fe, Mn, Zn and Cu) used in India is summarized in table 3.

Table 3: Rating limits for soil test values used in India

S.No.	Element	Deficient	Sufficient	High level
1	Fe	<4.50	4.50-9.00	>9.00
2	Mn	<3.5	3.5-7.0	>7.0
3	Cu	<0.20	0.20-0.40	>0.40
4	Zn	<0.60	0.60-1.2	>1.20

The data presented in table 4 and its subparts indicates that the available Fe content of these soils was ranged from 3.32 to 7.99 mg kg^{-1} with an average value of 4.44 mg kg^{-1}. The lowest (3.32 mg kg^{-1}) range was observed in village Kardawali, while highest (7.99 mg kg^{-1}) range was observed in village 31 M.L. with S.D. value of 1.13 and C.V. value of 25.56%. Out of 108 soil samples 48% soil samples found deficient, 52% soil samples were marginal in iron content. However it is to note that 52 soil samples have low to very low available iron (Table 3).

Table 4: Status of available micronutrients viz. Fe, Zn, Mn and Cu in soils of Raisinghnagar block

Soil characteristics	Range	Mean	S.D.	C.V.
Available Fe (mg kg^{-1})	3.32-7.99	4.44	1.13	25.56
Available Mn (mg kg^{-1})	2.01-4.62	2.44	0.47	19.46
Available Cu (mg kg^{-1})	0.32-0.65	0.43	0.096	22.01
Available Zn (mg kg^{-1})	0.35-0.87	0.51	0.14	28.65

Source: Ramamoorthy and Bajaj, 1969

The available Mn content of these soils was varied from 2.01 to 4.62 mg/kg with a mean value of 2.44 mg kg^{-1}. The lowest (2.01mg kg^{-1}) value of Mn was recorded in Dabla village, while highest (4.63 mg kg^{-1}) value of Mn content was observed in Jagatsinghwala village with the S.D. value of 0.47 and C.V. 19.46% (Table 4). Out of 108 soil samples 96% soil samples were found deficient, 4% soil samples found marginal in Manganese content (Table 5). However it is to note that 104 soil samples have low to very low available Mangnese (Table 3).

The data revealed that the available Zn content was ranged from 0.35 to 0.87 mg/kg with a mean value of 0.51 mg kg^{-1}. The lowest (0.35 mg kg^{-1}) Zn content was recorded in 31 M.L. village, while highest (0.65 mg kg^{-1}) Zn content was observed in soil of Dabla with S.D. value of 0.4 and C.V. 28.65 (Table 4). The 81% soil samples were found deficient, 19% soil samples were found marginal in Zn content (Table 5). However it is to note that 92 soil samples have low to very low available Zinc (Table 3).

The available Cu content of Raisinghnagar block soil was ranged from 0.30 to 0.65 mg kg^{-1} with an average value 0.43 mg kg^{-1}. The lowest (0.30 mg kg^{-1}) value of Cu content was recorded in 4 M.K. village where as highest (0.65 mg kg^{-1}) value of Cu was recorded in soil of 17 P.S. with S.D. value of 0.096 and C.V. value of 22.01% (Table 4). Out of total analysed soil samples 37% soil samples were found sufficient, 63% soil samples were found marginal in Cu content (Table 5). However it is to note that 64 soil samples have high to very high available copper presented in table 3. The result are in conformation with the finding of Pandey *et al*. (2013) in soils of Dewas district of Madhya Pradesh.

Correlation between physico-chemical properties and available nutrients in the soil of Raisinghnagar

The data on correlation between soil properties and available nutrients in top soil of Raisinghnagar block were presented in table 6. The available Fe in this soil negatively non-significant correlation with EC (r=-0.183), bulk density (r=-0.173) and water holding

Table 5: Classification available Micro nutrients status content in soils of Raisinghnagar block

S.No.	Element	Deficient		Sufficient		High level	
		No. of samples	% of samples	No. of samples	% of samples	No. of samples	% of samples
1	Fe	52	48.18	56	52	0	0
2	Mn	104	96	4	4	0	0
3	Cu	0	0	44	37	64	63
4	Zn	92	81	16	19	0	0

capacity (r=-0.154). Fe in soil non-significant correlation with pH (r=0.180), organic carbon (r=0.011) and particle density (r=0.38). EC, bulk density, water holding capacity were negatively correlated with Fe and Fe is positively correlated with pH, organic carbon and particle density.

The available Mn a negative and significant correlation with organic carbon (r= -0.394**) and bulk density (r=-0.202*). The positive non-significant relationship was observed between Mn and pH (r=0.073), particle density (r=0.068). Mn is negatively correlated with EC (r=-0.086) and water holding capacity.

The available zinc content in these soils were negatively correlated with pH(r=-0.250**) and positively correlated with organic carbon (r=0.389**) thereby indicating the availability of Zn decreases with increases in soil pH. Zn content in soil was non-significantly and positively correlated to particle density (r=-0.054) and water holding capacity (r=0.101). This positive relationship might be attributed to the increased availability of Mn, Zn, and Cu under low pH condition which increased solubility of oxides and hydroxides of micronutrients. These results were confirmatory with results obtained observed negatively correlated with EC (r= -0.126) as reported by Yadav (2010).

Table 6: Correlation between physico-chemical properties and available micronutrients in the soil of Raisinghnagar block

	Fe	Mn	Zn	Cu
pH	0.180	0.073	-0.250**	0.168
EC	-0.183	-0.086	-0.126	0.046
OC	0.011	-0.394**	0.389**	-0.237*
BD	-0.173	-0.202*	-0.052	0.059
PD	0.038	0.068	0.054	-0.102
WHC	-0.154	-0.111	0.101	-0.177

A significant negative correlation (r=-0.237*) was observed between organic carbon and available Cu and non-significant relationship with pH (r=0.168). Significant and negative correlation between available Cu and organic carbon and pH was also observed by Yadav (2008). The positive non-significant relationship was observed between pH (r= 0.168), EC (r=0.046) and bulk density (r=0.059) and Cu content. These results were confirmatory with results obtained similar were shown by Chaudhary *et al*. (2013) in soil of Coimbatore.

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