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Correlation between soil physico-chemical properties and available micronutrient in mustard grown area of Gharsana Tehsil of Rajasthan

Mukesh Kumar, Sr Yadav and Mangilal

Abstract
Forty surface soil samples (0-15 cm) were collected from gharsana tehsil of Sriganganagar district were studied for the Zn, Fe, Cu and Mn status in relation to important soil factor. The pH value of soil ranged from 7.70 to 9.87 with a mean value of 8.89 indicating that the soils were, in general alkaline in reaction. The EC, O.C., $CaCO_3$ and CEC ranged from 0.14 to 2.84 dSm^{-1}, 0.04 to 0.26 per cent, 2.97 to 7.65 per cent and 6.08 to 11.61 cmol.(p^+) kg^{-1} with the mean value of 0.52 dSm^{-1}, 0.12 per cent, 4.91 per cent and 8.22 cmol.(p^+) kg^{-1} respectively. All the soil sample had deficient in amount of available Zinc and Iorn and Sufficient in available Manganese content of soil. Zn, Fe, Cu and Mn are highly significantly positively correlated with organic carbon and negatively correlated with $CaCO_3$ and sand content of soil. Clay content of soil highly significantly positively correlated with Fe and Cu but non-significant positively correlated with Zn. CEC contain of soil highly significantly positively correlated with Cu and Fe but non-significant positively correlated with Mn and Zn.

Keywords: Correlation, micronutrient and organic carbon

Introduction
Micronutrients are important for maintaining soil health and also increasing productivity of crops. The soil must supply micronutrients for desired growth of plants and synthesis of human food, increased cropping intensity, introduction of high yielding varieties of crops, use of micronutrients free high analysis N, P and K fertilizers, diminishing use of organic manures and sodicity of irrigation water has caused decline in the level of micronutrient in the soil to below normal at witch productivity of crops cannot be sustained. The deficiencies of micronutrients have become major constraints to productivity, stability and sustainability of soils. Hence an attempt was made to assess the available status of micronutrients and their relationship with different properties of soils of Gharsana tehsil of Sriganganagar district.

Materials and Methods
Forty soil samples (0-15 cm depth) were collected from different village of Gharsana tehsil of Sriganganagar district. Gharsana tehsil is located in north-west part of the Sriganganagar district (Rajasthan) and situated between 29°02' north latitude and 73°05' east longitude and elevation of 156 m from mean sea level. The climate of the area is typically semi-arid. Rainfall and temperatures are the two main elements of the climate. The rainfall is seasonal and not properly distributed and it varies between 100 to 350 mm annually which is mostly received during the months of July to September. The soil samples were air dried and passed through 2mm sieve and analyzed the available Zn, Fe, Mn and Cu in soil samples were extracted with a DTPA solution (0.005 M DTPA + 0.01 M CaCl2 +0.1 M triethonolamine, pH 7.3 and the concentration of micronutrients in the DTPA extracts was determined using by atomic absorption spectrophotometer.

Results and Discussion
Physico-chemical characteristics of soils under mustard
The properties of soil presented in table 2 and 3. Soils were in loamy sand, moderately to highly alkaline in nature, EC is varied from 0.14 to 2.87 dSm^{-1} with mean value 0.52 dS m^{-1}. The organic carbon content in varied between 0.04 to 0.26 per cent.

On the basis of limits suggested by Muhr *et al.* (1967) all the soil samples under investigation rated low (< 0.5 per cent) in the soil organic carbon content. The calcium carbonate content in soils ranged between 2.97 to 7.65 per cent. The CEC of soils varied from 6.08 to 11.61 cmol. (p^+) kg^{-1}. The sand, silt and clay content of soils ranged from 78.65 to 84.50, 10.20 to 14.09 and 4.47 to 7.67 with a mean value 80.37, 12.69 and 6.13 per cent, respectively.

Micronutrient status of soils

The zinc content in soils of mustard cultivation area ranged between 0.20 to 0.59 ppm with a mean value of 0.36 ppm. On the basis of the critical limits suggested by Takkar and Mann (1975) (< 0.6 ppm for deficient, 0.6 to 1.2 ppm for marginal and more than 1.2 ppm for sufficient) all the soil samples were deficient in available zinc. The amount of extracted zinc is likely to increase with the increase in fineness of the soil texture. Similar results were also reported by Akbari *et al.* (1995) and Sharma and Choudhary (2007). It has also been reported that organic matter plays an important role in controlling availability of zinc particularly in alkaline soils (Das, 2000) might be due to it provides chelating agents for solubilizing insoluble zinc compounds, formed Carbonic acid due to the decomposition of organic matter which is helpful to lower the pH of soil solution and it protects the conversion of soluble zinc into insoluble form. Hence, it is less subjected to fixation reactions.

The copper content in mustard cultivation it ranges between 0.02 to 0.27ppm with a mean value of 0.05 ppm According critical limits (0.2 ppm) suggested by Lindsay and Norvell (1978), 97.5 per cent soils were deficient in wheat and mustard cultivation, respectively.

The iron content of the soil under mustard crop varied from 1.65 to 4.30 ppm with a mean value of 2.65 ppm. On the basis of critical limits suggested by Lindsay and Norvell (1978) for DTPA extractable iron (4.5 ppm), 100 per cent soil samples are deficient in available iron under the crops.

Manganese content In soils of mustard cultivation ranges from 5.37 to 5.90 ppm with a mean value of 5.74 ppm. Considering 1.0 ppm as critical limits for manganese deficiency (Lindsey and Norvell, 1978), 100 per cent soil samples is found sufficient in available manganese for both the crops. The variation observed in available manganese among different soils might be the result of variable soil factors (pH, OC, CEC, $CaCO_3$ etc.).

Correlation between micronutrient status and soil properties under mustard

Available Zinc

Under mustard cultivation correlation were observed highly significant and positive correlation with organic carbon content (r= 0.381**) and Mn (r=0.385**), significant positive correlate with CEC (r= 0.132*), non-significantly and positive correlation with clay (r= 0.071) and Fe (r=0.029) of soil, while non significantly negative correlation with $CaCO_3$ (r=-0.016) and pH (r=-0.026) recorded (Table 1) Eshwarappa *et al.* (1960) and Kapar and Dev (1977) found significant positive correlation between soil pH and available zinc. Similar types of results have also been reported by Rao *et al.* (1985) and Maji *et al.* (1993). Mondal *et al*. (2015).

Available Copper

Under mustard cultivation available copper was also show highly significant and positive correlation with CEC (r= 0.134**), Fe (r=0.260**) and clay (r=0.274**), non significant and positive correlation with organic carbon (r= 0.003) of soil, while non significantly negative correlation with $CaCO_3$ (r=- 0.030) of soil (Table 1). Sangwan and Singh (1993) found no relationship between electrical conductivity and available copper. Decreases in available copper with increase in pH of the soil may occur due to precipitation of copper as hydroxides at higher pH. Such type of relationship also observed by (Parmer *et al*.1999) found generally negative correlation between pH and available copper. A decrease in available copper with increase in calcium carbonate (Patil and Malewar,1998) as well as increases in available copper with the decrease in calcium carbonate (Kavimandan *et al*.1964;)have been recorded. The organic matter may increase the availability of copper in soils due to the formation of soluble complexing agents which may decrease fixation of copper in soils. Copper also has higher affinity for complexation with organic matter, which may increase its solubility. Furthermore, the availability of copper enhanced with finer fractions of soils and this might be due to the improvement of soil structure and aeration conditions. Besides, more exchange sites are available for its adsorption in fine textured soils.On the other hand, its availability was found to decrease significantly with increase in sand content because the coarseness of soil texture reduces the adsorption of Cu^{2+} ions on exchange sites. On the same line, the availability of copper is significantly reduced at high pH. This might be due to precipitation of Cu^{2+} ions as relatively insoluble hydroxides. Similarly, calcium carbonate has also been reported to decrease the availability of copper by bringing change in soluble Cu^{2+} ions to less soluble compounds like: $Cu(OH)_2$ and $CuCO_3$.

The results of present investigation were further confirmed by and Balpande *et al.* (2007) [1].

Available Iron

Results found in mustard cultivation area i e. highly significant and positive correlation with organic carbon (r= 0.167**), clay (r=0.389**), silt (r= 0.297**), Cu (r=0.239**), Zn(r=0.029), CEC (r=0.056**), and $CaCO_3$ (r=- 0.068) (Table 1). The results of present investigation were further confirmed the previous researcher i e., Sanwal (2008) [8]. The availability of iron increased significantly with increase in finer fractions (silt and clay) because these fractions are helpful to improve soil structure and aeration which are favourable conditions for increasing its availability. Beside this, the available iron content was found to increase with increase in CEC of soils due to more availability of exchange sites on soil colloids. Similarly, the availability of iron enhanced significantly with increase in organic matter might be due to it is helpful in improving soil structure and aeration, protects the oxidation and precipitation of iron into unavailable forms and supply soluble chelating agents which increase the solubility of iron compounds. On the other hand, its availability was found to be reduced with increase in pH_2 and $CaCO_3$ content of soils. High pH is responsible for its oxidation. Thus, most readily available form of iron is Fe^{2+} ions convert into less soluble form (Fe^{3+} ions) after oxidation. Hence, the availability of iron is reduced at higher pH level. Besides, at high pH iron is also precipitated as insoluble $Fe(OH)_3$ which reduces its availability. The $CaCO_3$ present in soils gets converted into bicarbonate ions which reduce the availability of iron and the chlorosis caused in these conditions is known as a "lime-induced iron chlorosis". The reduction in iron availability with increase in $CaCO_3$ content is because of (i) $CaCO_3$ favours the precipitation or oxidation of Fe^{2+} ions into Fe^{3+} ions (ii) transformation of soluble iron compounds into less soluble iron carbonates or ions which may be retained by free $CaCO_3$ Singh (2007) [9], Sanwal (2008) [8] and Kumar *et al*. (2014) [3].

Available Manganese

The data pertaining correlation between soil characteristics and available manganese in clearly shows highly significant and positive correlation between organic carbon (r= 0.423**) and Zn (r=0.440**), while significantly positive correlation are found between silt (r=0.168*) and highly significant negative correlation are found with $CaCO_3$ (r= -0.198**) and sand (r=- 0.176**) manganese of soils under mustard cultivation (Table 1). The results of present investigation are in accordance with the findings of previous workers like Sanwal (2008) [8]. The reduction in availability of Mn with sand content might be due to less adsorption of its ions on exchange sites. Similar types of result have been reported by Balpande *et al.* (2007) [1]. Increase in the availability of Mn with the increase in organic carbon content might be due to the influence of organic carbon on the solubility and availability of Mn which protect itself from oxidation and precipitation of available Mn into unavailable form. This is in agreement with the findings of Parmar *et al*. (1999). The higher content of DTPA extractable manganese in the soils having more percent of finer fraction was found because increase in finer proportion in soils offered greater exchange sites for holding Mn^{2++} on it. Increase in available form of manganese with the increase in finer fraction of the soil was also reported by Nayak *et al.* (2000) [7] and Singh and Rathore (2013) [10].

Table 1: Correlation matrix for various soil properties of Gharsana tehsil under mustard cultivation

Sample code No.	Content	1	2	3	4	5	6	7	8	9	10	11	12
		EC	pH	OC	CaCO3	CEC	Sand	Silt	Clay	Zinc	Fe	Cu	Mn
1	EC	1.000	-0.315**	-0.078	-0.319**	0.190*	-0.254**	0.197*	0.201**	-0.008	-0.020	-0.047	-0.142
2	pH		1.000	-0.084	0.170	-0.439**	0.166	-0.229**	-0.036	-0.026	-0.061	-0.049	0.114
3	OC			1.000	-0.029	0.454**	-0.086	0.044	0.144	0.381**	0.167	0.003	0.352**
4	CaCO3				1.000	-0.235**	0.783**	-0.616**	-0.533**	-0.016	-0.068	-0.030	-0.147
5	CEC					1.000	-0.239**	0.166	0.362**	0.132	0.056	0.134	0.282**
6	Sand						1.000	-0.842**	-0.662**	-0.050	-0.291**	-0.179*	-0.115
7	Silt							1.000	0.316**	0.015	0.297**	0.186*	0.051
8	Clay								1.000	0.071	0.389**	0.274**	0.137
9	Zinc									1.000	0.029	-0.103	0.385**
10	Fe										1.000	0.239**	-0.363**
11	Cu											1.000	-0.230**
12	Mn												1.000

Table 2: Physico-chemical characteristics of soils under mustard cultivation

Sr no.	Sample code no.	pH	EC (dSm^{-1})	Organic carbon (%)	$CaCO_3$ (%)	CEC	Macro nutrients			
							Zn	Fe	Cu	Mn
1	S_1	8.75	0.38	0.13	4.35	8.48	0.30	2.00	0.02	5.83
2	S_2	8.73	0.54	0.10	3.85	6.78	0.51	1.80	0.06	5.78
3	S_3	8.42	2.84	0.12	3.35	8.38	0.53	1.90	0.04	5.84
4	S_4	9.00	0.36	0.09	3.95	8.08	0.50	1.70	0.02	5.85
5	S_5	8.65	0.39	0.11	4.65	8.68	0.36	2.70	0.04	5.78
6	S_6	9.13	0.15	0.12	4.35	8.58	0.43	4.00	0.02	5.80
7	S_7	8.61	0.33	0.08	3.65	7.40	0.44	3.20	0.06	5.60
8	S_8	8.94	0.35	0.17	4.15	9.15	0.29	2.90	0.06	5.68
9	S_9	8.88	0.85	0.13	3.45	9.48	0.41	3.00	0.02	5.70
10	S_{10}	7.94	0.75	0.11	3.15	9.08	0.36	2.40	0.06	5.75
11	S_{11}	8.42	0.65	0.10	3.55	8.78	0.42	2.30	0.04	5.78
12	S_{12}	8.07	0.45	0.09	4.65	9.48	0.45	3.50	0.02	5.82
13	S_{13}	8.63	0.78	0.18	5.85	8.86	0.46	2.10	0.02	5.78
14	S_{14}	9.65	0.30	0.14	6.25	6.28	0.38	1.50	0.02	5.72
15	S_{15}	9.52	0.26	0.17	5.55	8.71	0.40	3.60	0.12	5.81
16	S_{16}	8.82	0.32	0.19	5.95	10.18	0.38	2.20	0.04	5.82
17	S_{17}	8.75	0.14	0.18	6.25	7.28	0.43	3.70	0.04	5.85
18	S_{18}	8.40	0.38	0.15	5.85	8.08	0.40	1.80	0.06	5.59
19	S_{19}	8.80	0.22	0.07	7.65	6.38	0.41	2.20	0.04	5.85
20	S_{20}	9.54	0.48	0.08	5.55	6.28	0.58	3.40	0.04	5.78
21	S_{21}	9.38	0.34	0.10	6.05	7.66	0.57	3.00	0.02	5.86
22	S_{22}	9.00	0.20	0.15	5.95	7.28	0.41	3.50	0.06	5.71
23	S_{23}	8.94	0.66	0.09	6.63	9.93	0.32	4.40	0.06	5.65
24	S_{24}	9.34	0.59	0.15	2.97	6.98	0.33	3.80	0.04	5.64
25	S_{25}	9.49	0.24	0.06	6.35	6.73	0.60	4.30	0.19	6.00
26	S_{26}	9.22	0.18	0.10	4.75	6.08	0.42	3.90	0.04	5.87
27	S_{27}	8.60	0.73	0.13	4.55	11.50	0.35	4.20	0.04	5.36
28	S_{28}	9.16	0.25	0.11	4.35	8.38	0.59	4.10	0.12	5.98
29	S_{29}	9.49	0.78	0.04	4.15	6.18	0.40	1.70	0.04	5.82
30	S_{30}	9.22	0.14	0.05	5.95	6.18	0.48	4.00	0.02	5.52
31	S_{31}	9.00	0.88	0.14	3.35	11.61	0.47	2.80	0.04	5.58
32	S_{32}	8.56	0.30	0.10	5.75	6.98	0.41	4.10	0.12	5.55

33	S_{33}	9.10	0.56	0.06	3.15	7.48	0.40	3.30	0.40	5.61
34	S_{34}	8.57	1.45	0.13	5.65	9.48	0.29	3.80	0.12	5.65
35	S_{35}	7.70	0.79	0.12	6.25	9.28	0.34	1.60	0.06	5.83
36	S36	8.92	0.81	0.16	3.65	6.18	0.30	1.50	0.02	5.83
37	S_{37}	8.73	0.14	0.26	3.00	11.60	0.38	1.70	0.08	5.84
38	S_{38}	9.87	0.36	0.13	6.25	7.40	0.47	1.80	0.04	5.83
39	S_{39}	8.68	0.28	0.12	5.55	9.08	0.42	2.70	0.04	5.82
40	S_{40}	9.05	0.16	0.25	5.95	8.54	0.41	1.60	0.02	5.85
MEAN		8.89	0.52	0.12	4.91	8.22	0.42	2.84	0.06	5.76
MAX.		9.87	2.84	0.26	7.65	11.61	0.60	4.40	0.40	6.00
MIN.		7.70	0.14	0.04	2.97	6.08	0.29	1.50	0.02	5.36

Table 3: Partical size distribution and textural class of soils under mustard

Sample code No.	**Sand**	**Silt**	**Clay**	**Textural class**
	(%)			
S_1	79.87	11.98	6.85	Loamy sand
S_2	79.57	12.88	6.15	Loamy sand
S_3	79.07	13.28	6.65	Loamy sand
S_4	79.27	12.98	6.45	Loamy sand
S_5	79.67	13.18	6.95	Loamy sand
S_6	79.37	12.88	7.45	Loamy sand
S_7	79.57	13.48	5.95	Loamy sand
S_8	79.67	12.98	6.15	Loamy sand
S_9	79.07	12.88	6.45	Loamy sand
S_{10}	78.97	13.78	5.95	Loamy sand
S_{11}	78.97	13.18	6.35	Loamy sand
S_{12}	79.07	13.28	6.65	Loamy sand
S_{13}	81.57	11.78	5.55	Loamy sand
S_{14}	83.50	10.20	6.15	Sandy
S_{15}	81.17	11.88	5.35	Loamy sand
S_{16}	81.67	11.48	5.35	Loamy sand
S_{17}	84.00	10.78	4.98	Sandy
S_{18}	81.27	12.28	5.45	Loamy sand
S_{19}	84.50	10.58	4.87	Sandy
S_{20}	81.17	12.88	5.25	Loamy sand
S_{21}	81.47	12.58	5.75	Loamy sand
S_{22}	81.27	12.78	5.75	Loamy sand
S_{23}	83.87	10.88	5.00	Sandy
S_{24}	78.97	12.78	7.45	Loamy sand
S_{25}	81.67	12.18	5.05	Loamy sand
S_{26}	80.77	13.78	4.47	Loamy sand
S_{27}	80.07	12.98	6.75	Loamy sand
S_{28}	80.07	13.48	5.95	Loamy sand
S_{29}	79.77	13.18	6.85	Loamy sand
S_{30}	80.57	13.08	4.55	Loamy sand
S_{31}	79.07	12.98	7.67	Loamy sand
S_{32}	80.17	12.48	6.85	Loamy sand
S_{33}	79.07	12.88	6.75	Loamy sand
S_{34}	80.17	13.48	6.05	Loamy sand
S_{35}	80.67	13.18	5.95	Loamy sand
S_{36}	78.97	13.48	5.65	Loamy sand
S_{37}	78.97	14.08	6.85	Loamy sand
S_{38}	79.27	12.48	7.45	Loamy sand
S_{39}	80.47	12.28	6.75	Loamy sand
S_{40}	78.65	14.09	6.55	Loamy sand
Mean	80.37	12.69	6.13	
Maximum	84.50	14.09	7.67	
Minimum	78.65	10.20	4.47	

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