Annals of Plant and Soil Research 21(2): 108-115 (2019)

Macro- and Micro- nutrients status in some soils of Pithoragarh district of Uttarakhand

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Received: February, 2019; Revised accepted: April, 2019

ABSTRACT

An investigation was conducted to analyze the general soil properties and extractable macro- (P, K, Ca, Mg, S) and micro-nutrients (Zn, Cu, Fe, Mn, B, Mo) in the soils of Pithoragarh district and to examine the relationship between general soil properties and soil extractable nutrients. Two hundred ninety soil samples (surface 0-15 cm) were taken from the eight developmental blocks of Pithoragarh district. The soil texture ranged from sandy loam to sandy clay loam, soil pH ranged from 3.96 to 8.61, electrical conductivity ranged from 0.091 to 1.408 dSm^{-1} and soil organic carbon content ranged from 6.02 to 51.34 g kg^{-1} soil. Olsen's and Bray's extractable P ranged from 1.9 to 96.8 mg kg^{-1} soil. Ammonium acetate (1 N, pH 7.0) extractable K, Ca and Mg ranged from 11.4 to 311.6 mg kg^{-1} soil, 478.3 to 3782.6 mg kg^{-1} soil and 26.1 to 2113.0 mg kg^{-1} soil, respectively. Calcium chloride (0.15%) extractable S ranged from 4.2 to 84.5 mg kg^{-1} soil. The DTPA extractable Zn, Cu, Fe, Mn ranged from 0.3 to 16.4 mg kg^{-1}, 0.1 to 13.5 mg kg^{-1}, 4.7 to 120.6 mg kg^{-1} and 2.8 to 99.0 mg kg^{-1} soil, respectively. Water soluble B ranged from 0.44 to 5.25 mg kg^{-1} and ammonium oxalate (pH 3.3) extractable Mo ranged from 0.17 to 1.31 mg kg^{-1} soil. On the basis of calculated nutrient indices (N.I.), the soils of Pithoragarh were medium in extractable P, K but high in rest other nutrients (Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo). Simple correlation analysis revealed that soil pH had a significant and positive correlation with P, K, Ca, Mg, Zn, Cu but negative correlation with Fe, Mn, B and Mo. Soil EC had a significant and positive correlation with K, Ca, S and Zn. Soil organic carbon content had a significant and positive correlation with P, Ca, Mg, Zn, Cu and B.

Keywords: General soil properties, macro-nutrients, micro-nutrients, Pithoragarh soils

INTRODUCTION

The physical and chemical properties of soil, its mineral composition and stock of nutrient resources for plant growth and the changes therein call for a regular monitoring of the nutrient availability, rate of depletion and addition of nutrients to the soil system. Macronutrients P, K, Ca, Mg, S) and micronutrients (Zn, Fe, Cu, Mn, B, Mo) are important to control soil fertility. Soil fertility is one of the important factors deciding the yields of 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. The variation in nutrient supply is a natural phenomenon and some of them may be sufficient whereas, others may turn to be deficient. The crop productivity cannot be boosted further without judicious use of macro- and micronutrient fertilizers to overcome existing deficiencies/imbalances. In Uttarakhand, hill soils are brown to greyish brown and dark grey in color and moderately acidic to neutral in reaction. Hill soils are highly porous with low moisture retention capacity, the soils are moderate to severe erosion prone and terrace cultivation at steep slopes. Wheat, rice, barley, minor millet, sugarcane potato and lentil are the major crops of the hills (Shukla *et al.*, 2013).

MATERIALS AND METHODS

The present investigation was carried out to assess some extractable macro- and micro-nutrients in the soils of Pithoragarh district, Uttarakhand. Pithoragarh is the easternmost Himalayan district which falls in the Kumaon division of the state of Uttarakhand, India. The geographical area of the district is 7,110 km^2 (2,750 sq mi). Its latitude and longitude are 29.58°N and 80.3659° E, respectively. It has an elevation of 1514 meters (4,967 feet). For the Administrative convenience, the district has been divided into 8 developmental blocks viz. Berinag, Bind, Dharchula, Didihat, Gangolihat, Kanalichina, Moonakot, Munsyari. The productivity depends upon nutrient supplying capacity of the soil.

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Collection and preparation of soil samples

Global Positioning System (GPS) based soil samples were collected from eight developmental blocks of Pithoragarh district of Uttarakhand at 0-15 cm depth. Soil samples were air-dried, ground and passed through 2 mm sieve for chemical analysis. All the samples were stored in the polythene bags until analysis.

Analytical methods

The pH of the soil samples was determined in soil-water suspension (1:2) after half an hour of equilibration using a combined glass electrode equipped pH meter Jackson (1967). The electrical conductivity of soil samples was determined in the supernatants of soil water suspensions (1:2) with the help of a conductivity meter Bower and Wilcox (1965) and the values were expressed as dSm^{-1} at 25º C. Soil organic carbon content in the soil samples was determined by modified Walkley and Black method Jackson (1967). Phosphorus was extracted from neutral to alkaline soils by 0.5 M $NaHCO_3$(pH 8.5) as described by Olsen *et al.* (1954). In acidic soils (pH 4.5-5.5), phosphorus was extracted by 0.03 N NH_4F + 0.025 N HCl as described by Bray and Kurtz (1945). Potassium was extracted from soils by 1N ammonium acetate (pH 7.0) following method of Schollenberger and Simon (1945). Soil samples were also extracted for Ca and Mg in 1 N neutral ammonium acetate extract of soils and quantified by EDTA titration method as outlined by Cheng and Bray (1951). Sulphur in the soil was extracted with 0.15% $CaCl_2$ and S in the extract was determined turbidimetrically using BaCl2 crystals Chesnin and Yien (1951). The content of Zn, Cu, Fe and Mn were determined through DTPA (pH 7.3) extraction as described by Lindsay and Norwell (1978). Hot water soluble B in the soil samples was extracted by following the method of Berger and Troug (1939) and determined by Azomethine H method. Molybdenum in the soil samples was extracted in 1M ammonium oxalate (pH 3.3) and determined using a colorimetric method Grigg (1953).

Table 1: Rating limits for extractable soil macro- and micro-nutrients

Nutrients		Extractable content (mg kg^{-1})		
		Low	Medium	High
P	Olsen's P	< 4.46	4.46-11.16	> 11.16
	Bray's P	< 15.17	15.17-30.35	> 30.35
	K	< 53.57	53.57-125	> 125
	Ca	< 200	200-300	> 300
	Mg	< 12	12-36	> 36
	S	< 10	10-15	> 15
	Zn	< 0.6	0.6-1.2	> 1.2
	Cu	< 0.2	0.2-0.4	> 0.4
	Fe	< 4.8	4.8-8.7	> 8.7
	Mn	< 2	2-4	> 4
	B	< 0.25	0.25-0.50	> 0.50
	Mo	< 0.1	0.1-0.2	> 0.2
Org Carbon (%)		<0.5	0.5-0.75	>0.75

The soil samples were categorized in low, medium and high categories for different nutrients as per the values given in Table 1. Accordingly, areas with nutrient index value > 2.33 could be considered high, those with NI between 1.67 to 2.33 could be considered medium and those with values < 1.67 could be regarded low in the native supply of that nutrient Ramamoorthy and Bajaj (1969). For statistical analysis, simple correlation analysis was done Snedecor and Cochran (1967). The test of significance was performed both at 0.05 and 0.01 probability levels. The data analysis was done with the help of on a computer.

RESULTS AND DISCUSSION

General soil properties

General properties *viz.* pH, EC, organic carbon content and texture of the soils of Pithoragarh district are shown in Table 2.The soils of the Pithoragarh district were acidic to slightly alkaline in reaction as the pH of the district ranged from 3.96-8.61. The highest mean value of pH (7.81) was observed in Gangolihat block. The electrical conductivity of the Pithoragarh district ranged from 0.091-1.408 dS m^{-1}. Among all the blocks the highest average electrical conductivity was found in Gangolihat block (0.583 dS m^{-1}). The organic carbon content in the soils of Pithoragarh district ranged from 6.02-51.34 g kg^{-1}. Among all the blocks the highest average organic carbon content was found in Moonakot block (25.23 g kg^{-1}).

Table 2: General properties of soils of Pithoragarh district

Blocks	pH(1:2)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	Texture
Bind	4.47-7.88 (6.59)	0.297-0.939 (0.463)	6.73-33.99 (25.16)	sandy clay loam- clay loam
Moonakot	3.96-8.26 (6.06)	0.091-1.408 (0.428)	9.74-51.34 (25.23)	sandy clay loam-silty clay loam
Kanalichina	4.76-8.17 (6.27)	0.169-1.101 (0.442)	6.02-42.13 (21.03)	sandy loam –sandy clay loam
Didihat	4.12-8.06 (5.51)	0.239-0.917 (0.536)	8.50-37.18 (19.24)	sandy loam – sandy clay loam
Dharchula	4.24-7.58 (6.78)	0.183-0.494 (0.294)	9.56-37.71 (24.99)	sandy clay loam-silty clay loam
Munsyari	5.47-8.28 (7.01)	0.235-0.998 (0.534)	8.32-33.46 (19.08)	sandy loam – sandy clay loam
Berinag	6.24-8.61 (7.50)	0.180-0.727 (0.408)	6.27-38.41 (19.18)	sandy clay loam- silty clay loam
Gangolihat	6.54-8.41 (7.81)	0.277-1.215 (0.583)	7.26-42.66 (21.82)	sandy clay loam- silty clay loam
Pithoragarh district	3.96-8.61 (6.69)	0.091-1.408 (0.456)	6.02-51.34 (22.17)	sandy loam –sandy clay loam

Extractable macro-nutrients

The extractable P in the soils of Pithoragarh district ranged from 1.9-96.8 mg $kg^{-1}$with a mean value of 28.48 mg kg^{-1}. Among all the blocks, the highest average extractable P was found in Dharchula block (49.37 mg kg^{-1}). The extractable K in the soils of Pithoragarh district ranged from 11.4-311.6 mg kg^{-1} with a mean value of 93.9 mg kg^{-1}. Among all the blocks, the highest average extractable K was found in Gangolihat block (163.16 mg kg^{-1}). The extractable Ca in the soils of Pithoragarh district ranged from 478.3-3782.6 mg kg^{-1} with a mean value of 1368.5 mg kg^{-1} (Table 3).

Table 3: Extractable macro-nutrient concentration in soils of Pithoragarh district

Blocks	Extractable P (mg kg^{-1})	Extractable K (mg kg^{-1})	Extractable Ca (mg kg^{-1})	Extractable Mg (mg kg^{-1})	Extractable S (mg kg^{-1})
Bind	2.8-89.6 (22.82)	42.55-212.94 (74.34)	608.7-2260.9 (1435.9)	156.5-1408.7 (614.3)	8.45-46.48 (31.16)
Moonakot	1.9-87.2 (18.13)	27.48-260.4 (81.11)	652.17-2130.43 (1253.26)	78.26-495.65 (210.00)	4.23-79.01 (25.64)
Kanalichina	3.7-89.6 (25.16)	27.48-268.01 (73.55)	652.2-3304.3 (1373.9)	26.1-1226.1 (471.5)	4.23-84.50 (17.96)
Didihat	2.8-75.2 (14.04)	20.21-167.75 (66.46)	521.7-2434.8 (1094.6)	26.1-1434.8 (225.0)	4.23-76.05 (30.00)
Dharchula	2.8-96.8 (49.37)	22.81-244.11 (68.18)	521.7-2043.5 (1229.3)	52.2-1513.0 (508.7)	8.45-76.05 (19.01)
Munsyari	3.7-92.0 (33.16)	18.65-289.31 (108.64)	478.3-2217.4 (1255.1)	26.1-730.4 (233.9)	8.45-33.80 (16.06)
Berinag	2.8-58.1 (19.98)	11.38-311.65 (150.59)	521.7-2478.3 (1224.6)	26.1-2113.0 (451.3)	8.45-33.80 (15.91)
Gangolihat	9.7-79.9 (45.18)	17.61-309.05 (163.16)	913.0-3782.6 (2233.3)	26.1-1252.2 (393.9)	8.45-84.50 (29.15)
Pithoragarh district	1.9-96.8 (28.48)	11.4-311.6 (93.9)	478.3-3782.6 (1368.5)	26.1-2113.0 (391.6)	4.2-84.5 (23.4)

Among all the blocks, the highest average extractable Ca was found in Gangolihat block (2233.3 mg kg^{-1}). The extractable Mg in the soils of Pithoragarh district ranged from 26.1-2113.0 mg kg^{-1} with a mean value of 391.6 mg kg^{-1}. Among all the blocks, the highest average

extractable Mg was found in Bind block (614.3 mg kg^{-1}). The extractable S in the soils of Pithoragarh district ranged from 4.2-84.5 mg kg^{-1} with a mean value of 23.4 mg kg^{-1}. Among all the blocks, the highest average extractable S was found in Bind block (31.16 mg kg^{-1}).

Extractable micro-nutrients

The DTPA extractable Zn in the soils of Pithoragarh district ranged from 0.3-16.4 mg kg^{-1} with a mean value of 3.3 mg kg^{-1}. Among all the blocks, the highest average extractable Zn was found in Dharchula block (4.71 mg kg^{-1}).The DTPA extractable Cu in the soils of Pithoragarh district ranged from 0.1-13.5 mg kg^{-1} with a mean value of 2.2 mg kg^{-1} and among all the blocks the highest average extractable Cu was found in Gangolihat block (3.57 mg kg^{-1}). The DTPA extractable Fe in the soils of Pithoragarh district ranged from 4.7-120.6 mg kg^{-1} with a mean value of 35.1 mg kg^{-1} and the highest average extractable Fe was found in Dharchula block (55.14 mg kg^{-1}). The DTPA extractable Mn in the soils of Pithoragarh district ranged from 2.8-99.0 mg kg^{-1} with a mean value of 27.2 mg $kg^{-1}$and among all the blocks, the highest average extractable Mn was found in Bind block (51.13 mg kg^{-1}). The hot water soluble B in the soils of Pithoragarh district ranged from 0.44-5.25 mg kg^{-1} with a mean value of 1.82 mg kg^{-1} and among all the blocks the highest average hot water soluble B was found in Moonakot block (3.16 mg kg^{-1}). The extractable Mo in the soils of Pithoragarh district ranged from 0.17-1.31 mg kg^{-1} with a mean value of 0.47 mg kg^{-1} and among all the blocks, the highest average extractable Mo was found in Kanalichina block (0.65 mg kg^{-1}).

Table 4: Extractable micro-nutrient concentration in Soils of Pithoragarh district

Blocks	Extractable Zn (mg kg^{-1})	Extractable Cu (mg kg^{-1})	Extractable Fe (mg kg^{-1})	Extractable Mn(mg kg^{-1})	Extractable B (mg kg^{-1})	Extractable Mo (mg kg^{-1})
Bind	1.32-6.27 (2.94)	1.64-4.29 (2.98)	4.71-29.87 (14.11)	20.74-91.01 (51.13)	0.87-4.37 (2.39)	0.17-0.87 (0.46)
Moonakot	0.49-16.44 (2.73)	0.20-4.05 (1.61)	6.44-69.90 (28.69)	5.20-98.97 (36.58)	0.44-5.25 (3.16)	0.17-1.31 (0.53)
Kanalichina	0.67-14.23 (3.42)	0.42-11.96 (2.85)	10.26-55.29 (27.07)	5.35-80.08 (31.41)	0.44-4.37 (1.93)	0.26-1.13 (0.65)
Didihat	0.69-14.70 (3.15)	0.28-7.58 (1.16)	13.98-120.65 (54.12)	2.88-44.61 (12.50)	0.44-2.62 (1.28)	0.17-0.78 (0.33)
Dharchula	0.89-13.78 (4.71)	1.07-6.59 (2.95)	25.81-75.80 (55.14)	7.20-45.13 (20.67)	0.44-3.06 (1.16)	0.17-0.96 (0.49)
Munsyari	0.65-15.05 (4.33)	0.40-2.26 (1.28)	5.34-77.69 (30.13)	2.77-61.26 (18.88)	0.44-3.06 (1.47)	0.17-1.22 (0.43)
Berinag	0.30-7.93 (2.20)	0.09-6.94 (1.18)	9.19-79.82 (38.48)	2.77-47.09 (17.64)	0.44-2.62 (1.19)	0.17-0.78 (0.39)
Gangolihat	0.43-13.89 (3.00)	0.56-13.47 (3.57)	12.08-59.00 (32.21)	4.29-66.12 (23.83)	0.44-3.50 (1.66)	0.17-0.78 (0.43)
Pithoragarh district	0.3-16.4 (3.3)	0.1-13.5 (2.2)	4.7-120.6 (35.1)	2.8-99.0 (27.2)	0.44-5.25 (1.82)	0.17-1.31 (0.47)

Nutrient indices

The nutrient index (N.I.) was calculated for different soil extractable nutrients in different blocks of Pithoragarh district and shown in Table 5 and Table 6. Bind block was medium in P, K and high in all other nutrients. Moonakot block was low in P, medium in K and high in all other nutrients. Kanalichina block was low in K, medium in P and high in all other nutrients. Didihat block was low in P, K, medium in S and high in all other nutrients. Dharchula block was

Table 5: Percent distribution of soil samples in different categories of availability in different blocks of Pithoragarh district

Name of Blocks	Soil Sample		Percent distribution of extractable macro- nutrients				
	No,	Categories	P	K	Ca	Mg	S
Bind	40	Low	40	35	0	0	2.5
		Medium	2.5	57.5	0	0	2.5
		High	57.5	7.5	100	100	95
		NI	2.17	1.72	3.00	3.00	2.92
Moonakot	40	Low	62.5	40	0	0	25
		Medium	10	40	0	0	2.5
		High	27.5	20	100	100	72.5
		NI	1.65	1.80	3.00	3.00	2.47
Kanalichina	40	Low	52.5	52.5	0	0	27.5
		Medium	7.5	37.5	0	2.5	10
		High	40	10	100	97.5	62.5
		NI	1.87	1.57	3.00	2.97	2.25
Didihat	40	Low	80	47.5	0	0	35
		Medium	5	45	0	7.5	2.5
		High	15	7.5	100	92.5	62.5
		NI	1.35	1.60	3.00	2.92	2.27
Dharchula	40	Low	25	50	0	0	37.5
		Medium	2.5	37.5	0	0	0
		High	72.5	12.5	100	100	62.5
		NI	2.47	1.62	3.00	3.00	2.25
Munsyari	30	Low	13.34	30	0	0	46.67
		Medium	10	23.34	0	3.33	0
		High	76.67	46.66	100	96.67	53.33
		NI	2.63	2.16	3.00	2.96	2.06
Berinag	30	Low	6.67	30	0	0	40
		Medium	20	23.34	0	3.33	0
		High	73.33	46.66	100	96.67	60
		NI	2.67	2.16	3.00	2.96	2.20
Gangolihat	30	Low	0	10	0	0	20
		Medium	3.34	23.34	0	3.33	0
		High	96.66	66.66	100	96.67	80
		NI	2.97	2.56	3.00	2.96	2.60
Entire	290	Low	37.93	38.27	0	0	28.63
Pithoragarh		Medium	7.24	37.24	0	2.41	2.41
District		High	54.83	24.48	100	97.59	68.96
		NI	2.17	1.86	3.00	2.97	2.40

low in K, medium in S and high in all other nutrients. Munsyari block was medium in K, S and high in all other nutrients. Berinag block was medium in K, S and high in all other nutrients. Gangolihat block was high in all the nutrients. The nutrient index (N.I.) calculated for different soil extractable nutrients in Pithoragarh district showed that the entire district was medium in P, K and high in all other nutrients (Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo).

Table 6: Percent distribution of soil samples in different categories of availability in different blocks of Pithoragarh district

Name of Blocks	Soil Sample		Percent distribution of extractable micro-nutrients					
	No.	Categories	Zn	Cu	Fe	Mn	B	Mo
Bind	40	Low	0	0	2.5	0	0	0
		Medium	0	0	22.5	0	0	7.5
		High	100	100	75	100	100	92.5
		NI	3.00	3.00	2.72	3.00	3.00	2.92
Moonakot	40	Low	2.5	2.5	0	0	0	0
		Medium	25	5	5	0	2.5	12.5
		High	72.5	92.5	95	100	97.5	87.5
		NI	2.70	2.9	2.95	3.00	2.97	2.87
Kanalichina	40	Low	0	0	0	0	0	0
		Medium	17.5	0	0	0	10	0
		High	82.5	100	100	100	90	100
		NI	2.82	3.00	3.00	3.00	2.90	3.00
Didihat	40	Low	0	0	0	0	0	0
		Medium	12.5	0	0	2.5	32.5	22.5
		High	87.5	100	100	97.5	67.5	77.5
		NI	2.87	3.00	3.00	2.97	2.67	2.77
Dharchula	40	Low	0	0	0	0	0	0
		Medium	2.5	0	0	0	30	2.5
		High	97.5	100	100	100	70	97.5
		NI	2.97	3.00	3.00	3.00	2.70	2.97
Munsyari	30	Low	0	0	0	0	0	0
		Medium	6.66	0	13.34	10	10	3.33
		High	93.34	100	86.66	90	90	96.67
		NI	2.93	3.00	2.86	2.90	2.90	2.97
Berinag	30	Low	10	10	0	0	0	0
		Medium	33.34	10	0	10	30	13.33
		High	56.66	80	100	90	70	86.67
		NI	2.46	2.70	3.00	2.90	2.70	2.87
Gangolihat	30	Low	3.34	0	0	0	0	0
		Medium	40	0	0	0	16.67	3.33
		High	56.66	100	100	100	83.33	96.67
		NI	2.53	3.00	3.00	3.00	2.83	2.97
Entire	290	Low	1.73	1.38	0.34	0	0	0
Pithoragarh		Medium	16.20	1.72	5.17	2.41	16.20	8.02
District		High	82.07	96.90	94.50	97.59	83.80	88.96
		NI	2.80	2.95	2.94	2.97	2.84	2.83

Correlation between general soil properties and extractable macro- and micro-nutrients

The data on simple correlation studies between extractable macro- and micro-nutrient and soil properties is shown in Table 7. Soil extractable P showed a significant and positive correlation with pH and soil organic carbon content. 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). Similar results were also reported by Meena *et al.* (2006) in Udaipur district of Rajasthan. Extractable K showed a significant and positive correlation with soil pH and EC. Similar results were reported by Sharma *et al.* (2008) in Amritsar district of Punjab. Extractable Ca showed a significant and positive correlation with soil pH, EC and organic carbon content. Extractable Mg showed a significant and positive correlation with soil pH and organic carbon content. Extractable S

showed a significant and positive correlation with soil EC and organic carbon content. Similar results were reported by Sharma *et al.* (2008) in Amritsar district of Punjab and Yurembam *et al.* (2015) in Someshwar watershed of Almora district of Uttarakhand.

Table 7: Simple correlation (r) between general soil properties and extractable macro- and micro-nutrients in soils of Pithoragarh district

Nutrients	pH (1:2)	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)
P	0.564**	0.081	0.221**
K	0.336**	0.206**	0.104
Ca	0.311**	0.351**	0.256**
Mg	0.216**	0.029	0.278**
S	-0.107	0.232**	0.155**
Fe	-0.181**	-0.033	-0.057
Mn	-0.156**	-0.102	0.052
Zn	0.142*	0.240**	0.348**
Cu	0.118*	0.016	0.203**
B	-0.199**	0.021	0.181*
Mo	-0.121*	-0.028	0.010

*** Significant at p ≤ 0.01, *Significant at p ≤ 0.05*

Soil extractable Zn showed a significant and positive correlation with soil pH, EC and organic carbon content. Similar results were reported by Kumar (2015) in soils of Saharsa district of Bihar. Extractable Cu showed a significant and positive correlation with soil pH and organic carbon content. Similar results were also found by Yurembam *et al.* (2015) in Someshwar watershed of Almora district of Uttarakhand. Extractable Fe showed a significant and negative correlation with soil pH. It shows that there is reduction in availability of Fe with increase in pH. Similar results were reports by Chander *et al.* (2014) in vegetable growing soils of sub-humid and wet- temperate zones of Himachal Pradesh. Extractable Mn showed a significant and negative correlation with soil pH indicating that its availability is largely influenced by acidic nature of the soil. Similar results were reports by Chander *et al.* (2014) in vegetable growing soils of sub-humid and wet- temperate zones of Himachal Pradesh. Hot water soluble B showed a positive, significant correlation with soil organic carbon content and negative, significant correlation with soil pH. Similar results were reported by Singh *et al.* (2014) in alluvial soils of Chambal region of Madhya Pradesh. Extractable Mo showed a negative and significant correlation with soil pH in Pithoragarh district.

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