TO STUDY THE CORRELATION OF MICRONUTRIENTS WITH PHYSICO- CHEMICAL PROPERTIES OF SOILS OF DISTRICT PALANDRI (AZAD KASHMIR)

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ABSTRACT

A study was designed to evaluate the micronutrients status of soils of district Palandri, Azad Kashmir and to correlate the micronutrients with Physico-chemical characteristics of soil as well as to categorize the soils as high, medium and low in Cu, Zn, Fe, Mn and HWS B. Soil samples were collected from thirty wheat fields and thirty apple orchard soils during 2003. None of the soil sample was low in Cu, Mn and Fe contents. Zn was low in 20% wheat fields and 17% apple orchard soils while HWS B was low in 53 and 40% in wheat and orchard soils, respectively. The pH was negatively correlated with all micronutrients (Cu, Fe, Mn, Zn) while organic matter was positively correlated with all nutrients. Lime was negatively correlated with Zn, Fe, and Mn while positively correlated with Cu and B. The EC had positive correlation with B but negative with other micronutrients. Clay was positively correlated with all micronutrients except B.

Key words: Correlation, micronutrients, physico-chemical properties, plandri soils, Azad Kashmir.

INTRODUCTION

Palandri is a district of Azad Jammu and Kashmir. During summer the temperature ranges from 10-30^{o}C. Its altitude is about 5300 feet above sea level. Vegetables, Cereals (wheat & maize etc.) and orchards are predominantly planted in the district. The land is also under natural forest, trees and grasses (Azad Kashmir at a Glance, 1994).

Micronutrients are just as important in plant nutrition as the major nutrients, they simply occur in plants and soil in much smaller concentration. Plants grown on micronutrient deficient soils can exhibit similar reduction in plants growth and yield as major nutrients. A lack of any one of the micronutrients in the soils can limit plants growth even if all other nutrients are present in adequate amounts (Gupta, 2003).

Zinc is present in several dehydrogenase, protienase and peptidase enzymes. It promotes growth of hormones and starch formation. It is essential for seed maturation and production. It plays essential metabolic role in plants. Cu is present in lactase and several other oxidase enzymes. It plays an important role in several physiological processes like photosynthesis, respiration, carbohydrate metabolism and probably nitrogen fixation. Fe is present in several peroxide, catalase, and cytochrome oxidase enzymes. It participates in oxidation-reduction reactions and is important in chlorophyll formation. It is considered as key metal in energy transformations needed for synthesis and other life processes of cells. Mn activates decarboxylase, dehydrogenase and oxidase enzymes. It is important in photosynthesis protein & carbohydrate metabolism, nitrogen metabolism, and nitrogen assimilation. It is apparently related to some basic processes such as nucleic acid synthesis, cell wall formation and tissue development (Tisdale et al. 1997).

Boron activates certain dehydrogenase enzymes and facilitates sugar translocation. It is important for the synthesis of nucleic acids and plant hormones and is essential for cell division and development. It is related to some basic processes such as protein synthesis, nitrogen and carbohydrate metabolism (Brady and Neil, 1996).

Kahttak and Perveen (1985) reported that 98, 346, 23 and 4 % out of 320 soil samples were found deficient in B, Cu, Fe, Zn, and Mo, respectively while working on the NWFP soils, manganese was found adequate in all the soils.

Majeed (1987) reported the range of hot water soluble boron content from 0.20 to 0.56 mg kg^{-1} while working on the micronutrient status of Muzafarabad Azad Kashmir soils. He also reported that there is negative correlation between Cu and electrical conductivity and positive and non significant between Fe and sand contents.

Ganai *et al.* (1999) reported that depth-wise distribution of DTPA-extractable Zn, Cu, Mn and Fe in almond orchard soils of the Kashmir valley, India and found that the DTPA-extractable Zn was low to medium whereas Cu, Mn and Fe were adequate. They also reported that in surface soils, the available Zn, Cu, Mn and Fe were negatively correlated with $CaCO_3$ content and positively correlated with organic carbon and clay contents.

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Khattak *et al.* (1986) reported that a positive correlation of clay contents with Cu, Mn, B, and negative correlation with Fe while working on Lakki Tehsil soils. He further noted that correlation between clay and Zn was positive and negative in the top soils (0-15 cm) and sub soils (15-45 cm), respectively and reported that salt deposition increases the electrical conductivity.

Riaz (1988) reported a positive correlation between zinc and electrical conductivity of soil while working on the micronutrient status of the soil series of Quetta district. Khan (1988) reported a negative correlation between zinc and silt content of the soil while working on the micronutrient status of North Waziristan Agency soil.

Sheeja *et al.* (1993) reported that in black soils, available Cu, Zn and Mn were significantly and positively correlated with organic C; available Mn was positively correlated with CEC. In red soils, available Zn and Fe were negatively correlated with pH and $CaCO_3$.

Borges *et al.* (1994) reported that there was a negative correlation between cation exchange capacity, electrical conductivity and sand content and a positive correlation with organic matter, silt and clay contents while analyzing soils from the northern and southern zones of Tenerife for Fe and Mn contents.

Khattak *et al.* (1994) reported that pH and lime were negatively correlated with DTPA and AB-DTPA extractable Zn, Cu and Fe while organic matter and electrical conductivity were positively correlated with DTPA and AB-DTPA extractable Zn, Cu and Mn.

Sankar and Murugappan (1995) reported that Zn had a positive relationship with fine sand. But DTPA Cu was positively correlated with clay, A positive significant relationship of Mn was seen with clay, silt, pH, EC and CaCO3 while a negative correlation between DTPA-Mn and coarse sand was noted.

Khalifa *et al.* (1996) reported that there are high positive correlations among extractable Fe, Mn, and Cu and both clay and organic matter contents of soils while working on ten selected transects, extending from west to east, to represent the soils that border the Nile valley to the east of Assiut city.

Pharande *et al.* (1996) reported that Zn content in soil was positively correlated with clay content but negatively with sand content while working on agriculturally important and widespread Vertisol and Alfisol soil series of Western Maharashtra, India.

Rajakumar *et al.* (1996) reported that DTPA extractable content of available Fe, Mn and Zn correlated significantly and negatively with pH and Cu was negatively with lime (-0.34).

Sheeja *et al.* (1996) reported that all the five micronutrients were negatively and significantly correlated with pH in sandy loam soils, and positively and significantly correlated with organic carbon with the exception of Mn. Available Cu, Zn and Mn showed a positive and highly significant correlation to clay content while studying the distribution of available and total micronutrients in major sweet potato growing soils (laterite, sandy loam and alluvial soils) of India.

Khattak *et al.* (1997) reported that boron indicated a significant positive correlation with the organic matter content of soils and showed positive significant correlation with lime, electrical conductivity and silt and negative with soil pH.

Parmar *et al.* (1999) reported that the relationship of iron was negative significant with soil pH. Buri et al. (2000) collected a total of 172 soil samples from 85 locations within river flood plains and 201 samples from 78 locations within inland valley swamps in the title area and analysed to determine their sulfur (sulfate-S) and micronutrients (Zn, Fe, Mn, Cu, Ni) supplying capacities. Mn significantly correlated positively with total C and available P but showed a negative correlation with pH for lowland types. Gupta et al. (2000) reported that. Zn, Cu, Fe and Mo were significantly correlated with soil pH and organic carbon; however, significant negative correlations were noticed with pH. Zinc and Cu, both were positively correlated with $CaCO_3$.

Patiram *et al.* (2000) collected Soil samples from 0-20, 20-40 and 40-60 cm depths and leaf samples from the non-bearing twigs from the 32 mandarin (Citrus reticulata) orchards of Sikkim to study the micronutrient cation status and reported that soil pH had negative correlation with Fe and Mn.

Considering the importance and keeping in view above-mentioned facts, this study was carried out to determine the micronutrients status of the soils and to correlate the micronutrients with Physico-chemical characteristics of soil as well as to categorize the soils as high, medium and low with respect to Cu, Zn, Fe, Mn and HWS B of district Palandri Azad Kashmir.

MATERIALS AND METHODS

In order to evaluate the micronutrient status of district Palandri soils, thirty soil samples of wheat fields and thirty soil samples from apple orchards were collected from different locations of district Palandri. Four to five pits were dug for each sample. Samples were collected from each pit at the depth of 0-30 cm for wheat fields and 0-60cm for apple orchard soils. About one kg of the composite sample was taken through mixing of sub samples. The dried samples were grinded, sieved through 2-mm mesh and stored in bottles. The physico- chemical characteristics of these soil samples were determined in soil science laboratory of University College of Agriculture Rawalakot Azad Kashmir while analysis of micronutrient was conducted in NARC Islamabad (Sept. 2003). The ammonium bicarbonate di-ethylene tri-amine penta acetic acid (AB-DTPA) procedure was followed to determine Zn, Fe, Cu, and Mn in soil (Havlin and Soltanpour, 1981). Hot water soluble boron in soil and plants was determined as described by Sillanpaa, (1982). Soil texture was determined by hydrometer method (Koehler et al, 1984). Lime was determined by acid neutralization method (Richards, 1954). Soil pH was measured in water using 1:5 ratio, while the electrical conductivity were determined from the extract of saturated soil paste (Richard, 1954). Organic matter was determined by Walkley and Black method as described by Jackson (1958). The data obtained were analyzed statistically by computer using "MSTATC" package. The following critical values were used for the interpretation of soil test values (Soltanpour, 1985).

S.No	Micronutrients	Nutrient Content (mg kg^{-1})		
		Low	Medium	High
1	HWS B *	<0.5	0.5-1	>1
	AB-DTPA Extraction Method**			
2	Cu	<0.3	0.3-0.5	>0.5
3	Fe	<3.0	3.0-5.0	>5.0
4	Mn	<0.6	0.6-1.0	>1.0
5	Zn	<0.9	0.9-1.5	>1.5

RESULTS AND DISCUSSION

The location wise results of physico-chemical properties of wheat field and apple orchard soils are given in Table I and II respectively. The range and average values of physico-chemical properties of soil samples are shown in Table III. The location wise results of micronutrient status of wheat field and apple orchard soils are given in Table IV and V, respectively. The range and average values of micronutrient status of soil samples are shown in the Table VI. The classifications of collected soil samples are shown in table VII. The data in table VIII represent the relationship among AB-DTPA extractable micronutrients and HWS B and physiochemical properties.

MICRONUTRIENT STATUS OF SOILS:

Copper Content

The range and average values of Cu content are summarized in Table VI. It is revealed that on average basis concentration of AB-DTPA extractable copper content is high in apple orchard soils as compare to wheat field soils. It might be due to intensive cultivation and relatively higher average pH in wheat field soils as compared to apple orchard soils (Katyal and Randhawa, 1983). By comparing these results with established criteria of Soltanpour (1985), none of soil sample was deficient in AB-DTPA extractable copper concentration in wheat field and apple orchard soils.

Zinc Content

The range and average values of Zn content are summarized in Table VI. High average Zn contents were observed in apple orchard soils with a value of 1.74 mg kg^{-}1, might be due to comparatively low average pH value in apple orchard as compared to wheat field sites. Zn solubility is highly pH dependent and decreased as pH increased (Lindsay, 1979). By comparing AB-DTPA extractable Zn contents with criteria set by Soltanpour (1985), appendix. It was found that 43.33% and 50% samples were found high and 40% and 20% samples were medium and 16.67% and 30% were low in Zn content of wheat field and apple orchard soils, respectively. Similar results were reported by Ganai *et al.* (1999), while working on depth-wise distribution of available micronutrients in soils growing almonds in Kashmir valley.

Iron Content

The range and average values of Fe content are shown in Table VI. Results on basis AB-DTPA extractable Fe content are higher in apple orchard sites as compared to wheat fields. It might be due to lower pH values of apple orchard sites as compared to wheat fields. Iron solubility in soil is highly pH dependent (Lindsay, 1979 and Patiram *et al.* 2000). By comparing available Fe content with established criteria of Soltanpour (1985), all soil samples collected from wheat fields and apple orchards were found high in Fe concentration.

Manganese Content

Table VI. indicate that on average basis AB-DTPA extractable Mn concentration was higher in apple orchard soils as compared to wheat field soils as revealed from the Table III. It might be due to lower pH in apple orchard soils as compared to wheat field soils and regular addition of organic matter from leaves. Manganese solubility in soil is highly pH dependent (Lindsay, 1979. and Patiram *et al.* 2000). By comparing these results with critical values of Soltanpour (1985). Mn contents were high in 96.67% and 93.33% and medium in 3.33% and 6.67% samples of the wheat field and apple orchard soils, respectively.

HWS Boron Content

The range and average values are summarized in Table VI. On average basis HWS B concentration is higher in apple orchard as compared to wheat field soils. It might be due to lower average pH value of apple orchard soils as compared to wheat field soils. Boron availability decreases with increasing soil pH (Rashid et al. 2001). It was found that 36.67% and 53.33 % samples were high, 10% and 6.67% samples were medium and 53.33% and 40% samples were low in B content in wheat field and apple orchard soils, respectively.

CORRELATION STUDIES

COPPER Vs PHYSICO-CHEMICAL PROPERTIES:

Copper Vs pH

The r-value obtained was –0.506, which showed that there was negative significant correlation ($p<0.05$) (Table VIII & Fig. 1). Gupta et al. (2000) reported that. Zn, Cu, Fe and Mo were significantly correlated with soil pH and organic carbon; however, significant negative correlations were noticed with pH. Zinc and Cu, both were positively correlated with $CaCO_3$. Sheeja et al. (1996) reported that all the five micronutrients were negatively and significantly correlated with pH in sandy loam soils, and positively and significantly correlated with organic carbon with the exception of Mn. Available Cu, Zn and Mn showed a positive and highly significant correlation to clay content while studying the distribution of available and total micronutrients in major sweet potato growing soils (laterite, sandy loam and alluvial soils) of India. Khattak et al. (1994) reported that pH and lime were negatively correlated with DTPA and AB-DTPA extractable Zn, Cu and Fe while organic matter and electrical conductivity were positively correlated with DTPA and AB-DTPA extractable Zn, Cu and Mn.

Copper Vs Organic Matter

The r-value was 0.424 between AB-DTPA extractable copper and organic matter content (Table VIII & Fig. 2). The result showed that there was positive non-significant correlation between copper and organic matter content. These findings were supported by Khalifa *et al.* (1996) and Sheeja et al (1993), who reported high positive correlation between extractable Cu and organic matter.

Copper Vs Lime

The r-value was 0.269 between AB-DTPA extractable copper and lime content (Table VIII & Fig. 3). There was a positive non-significant ($p>0.05$) correlation. Similar results were studied by Gupta et al. (2000).

ZINC Vs PHYSICO-CHEMICAL PROPERTIES:

Zinc Vs pH

The r-value of AB-DTPA zinc content and pH recorded in this study was -0.516 as given in Table VIII & Fig. 4. The negative significant correlation was observed, which was supported by study of Khattak *et al.* (1994), Sheeja *et al.* (1996), Rajkumar *et al.* (1996) and Gupta *et al.* (2000).

Zinc Vs Organic Matter

The r-value between AB-DTPA extractable zinc and organic matter content was 0.512 as shown in Table VIII & Fig. 5. It was obvious that correlation was positive significant. These findings were supported by Khattak *et al.* (1994) and Ganai *et al.* (1999), who reported positive significant correlation between zinc and organic matter.

Zinc Vs Lime:

The r-value recorded was –0.437 between AB-DTPA extractable zinc and lime content as reported in Table VIII & Fig. 6. It was clear that zinc had negative non-significant correlation with lime. Khattak *et al.* (1994) and Ganai *et al.* (1999) reported negative correlation.

IRON Vs PHYSICO-CHEMICAL PROPERTIES

Iron Vs pH

The r-value between AB-DTPA extractable iron content and pH was -0.462 during this study (Table VIII & Fig. 7). The relationship of iron was negative significant with pH. The results were in agreement with results of Khattak et al. (1994), Parmar et al.

(1999) and Gupta *et al.* (2000) who reported negative correlation between iron and pH.

Iron Vs Lime

The r-value between AB-DTPA extractable iron and lime content was –0.345 (Table VIII & Fig. 8). The correlation between iron and lime was negative and non significant. Khattak et al. (1994) reported similar results. However Gupta et al. (2000) reported positive correlation between these two.

MANGANESE Vs PHYSICO-CHEMICAL PROPERTIES

Manganese Vs pH

The r-value obtained between manganese content and pH was -0.129 (Table VIII & Fig. 9). A negative non-significant correlation ($p>0.05$) was observed. Buri et al. (2001) also reported negative correlation between manganese and pH of soil.

Manganese Vs Clay

AB-DTPA extractable manganese had a positive significant correlation with clay content having r-value 0.463 (Table VIII & Fig. 10). These results were supported by the Sankar et al. (1995) and Khalifa et al (1996), who found positive significant correlation.

WS BORON Vs PHYSICO-CHEMICAL PROPERTIES

Boron Vs pH

The r-value between HWS B content and pH recorded in this study was -0.179 as shown in (Table VIII & Fig. 11). The negative non-significant correlation was observed which was supported by study of Khattak *et al.* (1997).

Boron Vs Organic Matter

The r-value between HWS B and organic matter content was 0.459 as given in (Table VIII & Fig. 12). It was obvious that correlation was positive significant between boron and organic matter content. These findings are supported by Khattak et al. (1997), who reported positive significant correlation.

CONCLUSION AND RECOMMENDATIONS

i. All soil samples of wheat field and apple orchard soils were high in Cu and Fe content.
ii. Zn content were high in 43.33 and 50%, medium in 40 and 20% and low in 16.67 and 30% of wheat field and apple orchard soil samples, respectively.
iii. Mn content was high in 96.67 and 93.33% & medium in 3.33 and 6.67% of wheat field and apple orchard soil samples, respectively.
iv. HWS B was high in 36.67 and 53.33%, medium in 10 and 6.67% and low in 53.33 and 40% samples of wheat field and apple orchard soils, respectively.
v. Cu was correlated negatively with pH and positively with clay, Zn was correlated negatively with pH and lime and positively with organic matter, Fe was correlated negatively with pH, positively with organic matter, Mn was correlated negatively with EC and positively with clay, HWS B correlated positively with organic matter and lime.
vi. The soils classified as marginal and low in Zn and B requires fertilization to maintain and improve their nutrient level.
vii. The soil should be sampled periodically to confirm the deficiency of Zn and B.
viii. Organic manures should be added to maintain and improve organic matter level and micronutrient status of cultivated soils.

Fig. No.1: Relationship between Cu and soil pH.

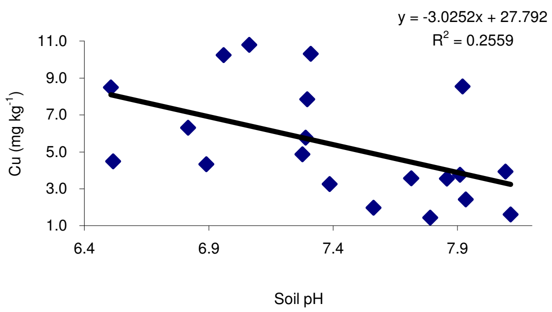

Fig. No.2: Relationship between Cu and O.M

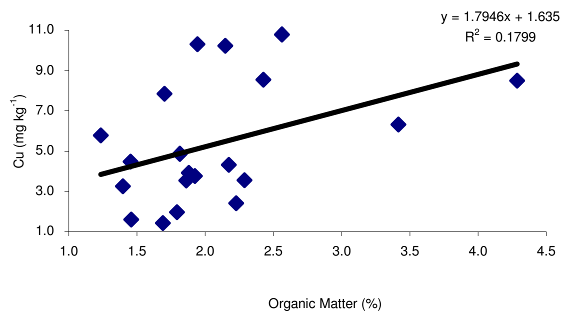

Fig. No.3: Relationship between Cu and Lime content.

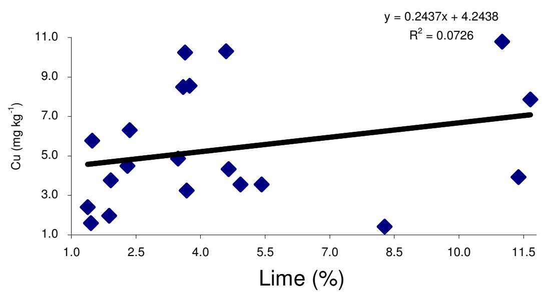

Fig. No. 4: Relationship between Zn and soil pH.

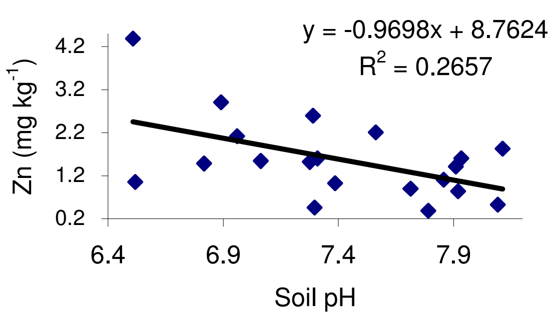

Fig. No. 5:Relationship between Zn and O.M

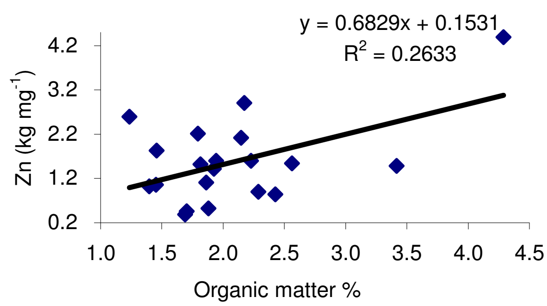

Fig. No.6: Relationship between Cu and Lime content.

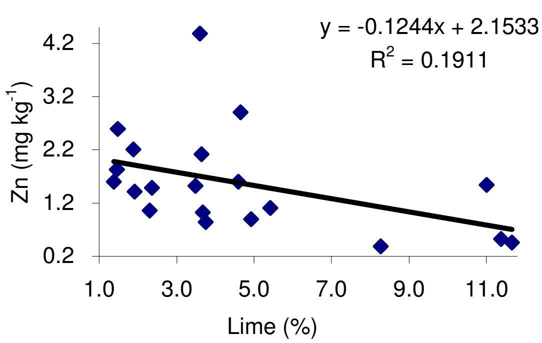

Fig. No.7: Relationship between Fe and soil pH

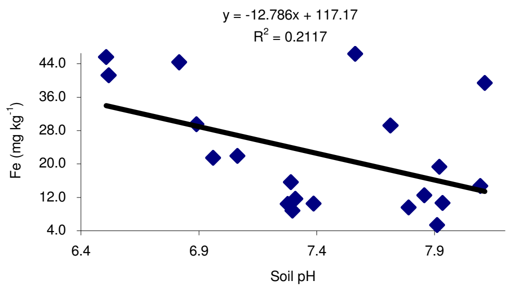

Fig. No.8: Relationship between Fe and Lime

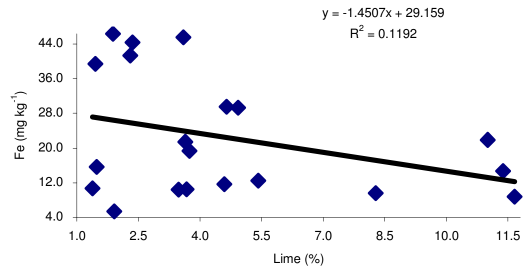

Fig. No.9: Relationship between Mn and soil pH

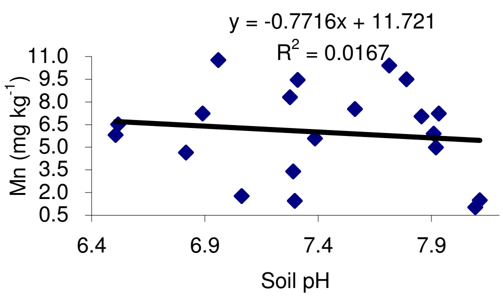

Fig. No.10: Relationship between Mn and Clay

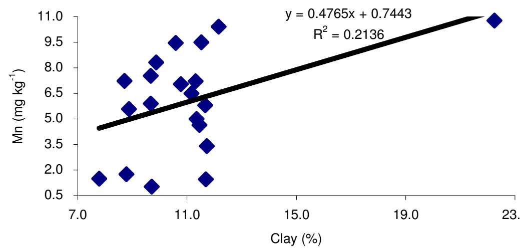

Fig. No.11: Relationship between HWS B and soil pH

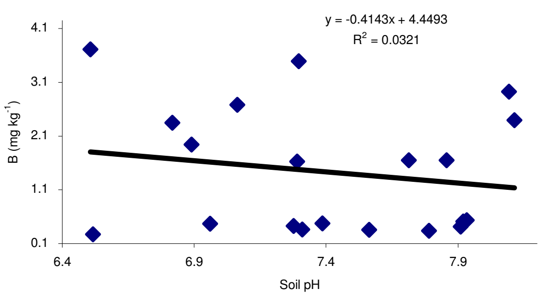

Fig. No.12: Relationship between HWS B and O.M

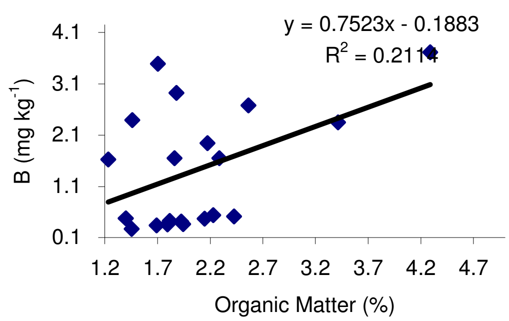

Table I: ***Physico-Chemical Characteristics of Wheat Fields Soils of District Palandri***

S.No	Location	pH	O.M %	$CaCO_3$ %	EC dSm^{-1}	Sand %	Clay %	Silt %	Tex. Class
1	Jessa	7.06	2.56	11.01	1.17	45.24	8.78	45.98	Loam
2	Grad	7.79	1.69	8.27	0.69	83.57	11.52	4.90	Loamy Sand
3	Dhara	7.29	1.23	1.48	1.19	60.43	11.72	27.84	Sandy Loam
4	Gorah	7.56	1.79	1.88	0.27	64.44	9.67	25.89	Sandy Loam
5	Layine	7.86	1.86	5.42	1.38	53.24	10.78	35.98	Sandy Loam
6	Pap-e-Nar	7.39	1.40	3.67	1.13	43.84	8.87	47.29	Loam
7	Palandri	8.11	1.46	1.45	1.14	61.84	7.79	30.37	Sandy Loam
8	Nanga Pir	7.91	1.92	1.91	1.35	64.44	9.67	25.89	Sandy Loam
9	Saria	7.92	2.43	3.75	1.39	48.48	11.34	40.17	Sandy Loam
10	Mung	7.28	1.81	3.48	0.20	43.84	9.87	46.29	Loam

Table II: ***Physico-Chemical Characteristics of Apple Orchard Soils of District Palandri***

S.No	Location	pH	O.M %	$CaCO_3$ %	EC dSm^{-1}	Sand %	Clay %	Silt %	Tex. Class
1	Jhanda	6.89	2.17	4.65	1.07	76.24	11.32	12.44	Loamy Sand
2	Tarar Khal	7.93	2.23	1.38	1.65	51.91	8.71	39.38	Loam
3	Mana	8.09	1.88	11.38	1.53	85.51	9.71	4.78	Loamy Sand
4	Bagala	6.52	1.45	2.30	1.54	85.84	11.17	2.99	Loamy Sand
5	Gal Kot	7.71	2.29	4.92	1.10	57.00	12.16	30.84	Sandy Loam
6	Gala	6.96	2.15	3.64	0.56	57.04	22.25	20.71	Sandy Clay Loam
7	Baluch	7.31	1.94	4.60	0.72	76.03	10.58	13.39	Loamy Sand
8	Mohar	7.30	1.70	11.66	1.50	57.24	11.69	31.07	Sandy Loam
9	Dahmun	6.82	3.42	2.36	1.52	42.55	11.46	45.99	Loam
10	Grad Lower	6.51	4.29	3.60	1.20	67.89	11.67	20.44	Sandy Loam

Table III: ***Range and Average of Physicochemical Properties of District Palandri Soils***

S. No	Physico-Chemical Properties	Wheat Field Soils		Apple Orchard Soils	
		(mg kg^{-})			
		Range	Average	Range	Average
1	PH	6.35-8.54	7.62	6.10-8.45	7.2
2	Organic Matter %	1.10-3.23	1.82	0.45-4.45	2.35
3	$CaCO_3$ %	0.20-12.54	4.23	1.24-12.35	5.05
4	EC dSm^{-1}	0.15-1.71	0.99	0.38-1.82	1.24
5	Sand %	29.45-84.15	56.94	42.16-87.37	65.73
6	Clay %	7.24-15.54	10	8.02-29.54	12.07
7	Silt %	4.47-55.01	33.06	2.67-46.26	22.2

Table IV: ***AB-DTPA extractable Cu, Zn, Fe, Mn, and HWS B (mg kg^{-}) of wheat fields soils***

S.No	Location	Cu	Zn	Fe	Mn	B
1	Jessa	10.79	1.54	21.92	1.76	2.63
2	Grad	1.43	0.39	9.58	9.50	0.29
3	Dhara	5.78	2.59	15.65	3.41	1.58
4	Gorah	1.97	2.21	46.35	7.53	0.30
5	Layine	3.55	1.11	12.53	7.04	1.60
6	Pap-e-Nar	3.26	1.03	10.52	5.59	0.43
7	Palandri	1.60	1.83	39.44	1.49	2.34
8	Nanga Pir	3.77	2.35	5.41	5.89	0.36
9	Saria	8.55	0.85	19.36	5.00	0.46
10	Mung	4.86	1.52	10.42	8.31	0.38

Table V: ***AB-DTPA extractable Cu, Zn, Fe, Mn, and HWS B(mg kg^{-1}) of apple orchards soils***

S.No	Location	Cu	Zn	Fe	Mn	B
1	Jhanda	4.33	2.91	29.53	7.22	1.89
2	Tarar Khal	2.42	1.60	10.69	7.24	0.49
3	Mana	3.93	0.53	14.71	1.03	2.88
4	Bagala	4.49	1.06	41.29	6.51	0.22
5	Gal Kot	3.56	0.90	29.25	10.41	1.60
6	Gala	10.23	2.12	21.48	10.77	0.42
7	Baluch	10.31	1.60	11.67	9.46	0.31
8	Mohar	7.85	0.46	8.84	1.45	3.44
9	Dahmun	6.32	1.86	44.33	4.65	2.30
10	Grad Lower	8.50	4.39	45.57	5.80	3.66

Table VI: ***Range and Average of AB-DTPA Extractable Micronutrients and HWS B of District Palandri Soils***

S.No.	Nutrients	Wheat Field Soils		Apple Orchard Soils	
		mg kg^{-1}			
		Range	Average	Range	Average
1	Cu	1.06-11.41	4.55	1.51-13.32	6.19
2	Zn	0.31-4.45	1.54	0.24-4.90	1.74
3	Fe	5.54-47.49	19.12	6.25-46.87	25.74
4	Mn	0.94-9.71	5.55	0.83-13.67	6.45
5	HWS B	0.21-2.94	1.04	0.15-3.86	1.72

Table VII: ***Classification of Collected Soil Samples***

S.No	Nutrients	Wheat (%)			Apple (%)		
		High	**Medium**	**Low**	**High**	**Medium**	**Low**
1	Cu	100	-	-	100	-	-
2	Zn	43.33	40	16.67	50	20	30
3	Fe	100	-	-	100	-	-
4	Mn	96.67	3.33	-	93.33	6.67	-
5	HWS B	36.67	10	5333	53.33	6.67	40

Table VIII: ***Relationship Between Micronutrients and Physico-Chemical Characteristics.***

Nutrients mg kg^{-1}	Physico-Chemical Characteristics (r-values)						
	PH	Organic Matter %	Lime %	EC dSm^{-1}	Sand %	Clay %	Silt %
Cu	-0.506*	0.424	0.269	-0.176	-0.204	0.446*	-0.109
Zn	-0.516*	0.512*	-0.437*	0.065	0.024	0.150	-0.053
Fe	-0.462*	0.450*	-0.354	-0.121	0.107	0.034	-0.111
Mn	-0.129	0.036	-0.354	-0.544*	0.092	0.463*	-0.183
HWS B	-0.179	0.459*	0.488*	0.349	-0.019	-0.114	0.041

*=Significant

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