Pure Appl. Biol., 7(2): 797-809, June, 2018
http://dx.doi.org/10.19045/bspab.2018.70099

Research Article

Nutritional status of apple orchards soils in district Qilla Saifullah (Balochistan)

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Citation

Zia ul Haq, Zafar Ullah, Saeed Ahmed, Muhammad Raza Siddiqui and Saduddin. Nutritional status of apple orchards soils in district Qilla Saifullah (Balochistan). Pure and Applied Biology. Vol. 7, Issue 2, pp797-809. http://dx.doi.org/10.19045/bspab.2018.70099

Received: 31/03/2018 Revised: 29/05/2018 Accepted: 19/06/2018 Online First: 28/06/2018

Abstract

This research was conducted to study the nutritional status of apple orchards soils in Qilla Saifullah during November, 2011. Soil samples were collected from three depths 0-30, 31-60 and 61-90 cm and analyzed for mineral N, hot water soluble B and AB-DTPA extractable P, K, Zn, Cu, Fe and Mn. The majority of soils were light in texture, alkaline in reaction, non-saline and moderately calcareous. The concentration of N showed that about 77% of the surface soils were adequate in N. The concentration of extractable P was also adequate in 80% samples. The K content showed that 3, 20 and 60% soils in 0-30, 31-60 and 61-90 cm depths, respectively were low. The orchards more than 85% were found low in organic matter. The analysis of AB-DTPA extractable Zn showed that 7, 23 and 47% soils in 0-30, 31-60 and 61-90 cm depth respectively were low. The Cu and Mn results showed that none of orchards were found deficient in all three depths. The results of B showed that 17% in 61-90 cm depth was low whereas 77, 57% and 47% in three depths, respectively were adequate. The soils of apple orchards were low to marginal in Zn, Fe and B to varying levels. The frequency of Zn deficiency was highest followed by Fe and B. AB-DTPA nutrients showed different correlation trends for organic matter, pH and EC. The AB-DTPA extractable Zn, Fe, Cu, Mn and B had positive non-significant correlation with organic matter in the surface and subsurface soil. Micronutrients such as Zn and Fe had negative and non-significant correlation with EC and pH. The AB-DTPA extractable phosphorus showed positive non-significant correlation with organic matter. The AB-DTPA extractable potash had positive significant correlation with lime and organic matter in the surface and subsurface soils and negative non-significant correlation with pH.

Keywords: Apple; Balochistan; Extractable P; Mineral N; Nutritional status; Soils

Introduction

Apple (*Mallus domestica authority*) is a deciduous fruit and belongs to the family Rosaceae. In Pakistan, it is mainly grown in Balochistan and Khyber Pakhtunkhwa (KP). Red Delicious and Golden Delicious are two important verities of apple grown worldwide. Verities of apple grown grown in Qilla Saifullah, Balochistan region are Red, Golden delicious, Kaja. Red Super. Royal gala. Amri and Mashadi **[1]**. The soil and climatic condition of Balochistan are well suited for the production of apple. In Pakistan 110.6 thousand hectares of land is under apple orchards with a production of 525.9 thousand tons. In Balochistan, the area under apple orchards was 102.2 thousand hectare producing

426.8 thousand tons apple [2]. Qilla Saifullah is location in North West Balochistan. Zhob is located in the east of Qilla Saifullah, while Pishin is in the west, in the same way its border touches to Afghanistan and loralai in the north and south, respectively (Figure 1). Qilla Saifullah has been popular for its agriculture and livestock.

Figure 1. Map of the Qilla Saifullah (Balochistan)

Nitrogen (N) is a necessary part of all proteins, all living cells and chlorophyll as well, enzymes and metabolic processes concerned in the synthesis and move of energy, the green color of the plant that is accountable for photosynthesis [3]. Nitrogen (N) and phosphorus (P) are necessary for photosynthesis, in the structure of all sugars, oils and starches, Support with the alteration of solar energy into chemical energy and help in plant maturation by quick root growth as well as encourage blooming, [4]. The plants mostly absorbed Potassium (K) more than other element except nitrogen and, while calcium supports to build the protein and fruit quality [3]. Calcium (Ca) is an important for plant cell wall structure, to give common transport and maintenance of other elements to strengthen the plant. It is also effect of organic acids and alkali salts in a plant [4]. Magnesium (Mg) plays pivotal role in chlorophyll, photosynthesis, enzyme activity and response to soil minerals and fertilizers.

Macronutrients and micronutrients, both are essential and play important role in plant growth and productions as influence on many metabolic activities and enzymatic reactions. e.g., zinc (Zn) plays an important role as a structural constituent of a broad range of enzymes in many biochemical pathways plus protein, axon and carbohydrate. These are a part of enzymes such as peptidase, posphohydrolase, dehydrogenate and

proteins, **[4, 5]**.

Equally copper (Cu) is an element of laccase and cytochrome oxidase, ascorbic acid oxidase and plays a vital role in respiration, photosynthesis, and carbohydrate metabolism. Iron (Fe) plays key role in photosynthesis, nitrogen fixation and energy transformation and hemo-proteins and nonhomo-proteins, ferrodoxins and oxidation-reduction in respiration. Manganese (Mn) is a component of enzymes anginase and phosphotransferase, helps in nucleic acid synthesis, and cell wall and tissue formation **[6]**. Boron (B) activates dehydrogenase, facilitates sugar translocation and helps in the synthesis of plant hormones, nucleic acids and cell division of cell.

The deficiency of micronutrients causes irregular growth of plants that consequence in partial failure of plants. Grain and flower formation fails to develop in severe deficiency. The deficiencies of Micronutrients such as boron **[5, 7]** for a long time reported to potentially cause main problems for apples.

There is need to know the status of the micronutrients in soils and to plan to eliminate deficiencies of micronutrients to improve production, and such informations are limited for apple orchards in Qilla Saifullah. Therefore, this research was planned to assess the nutritional status of apple orchards soils. Specific objectives were: 1) to determine the concentration of macronutrients (N, P and K) in soil of apple orchards, 2) to assess the AB-DTPA extractable micronutrients (Zn, Cu, Fe, Mn and B) in apple orchards and 3) to compare the micronutrients status with the standard criteria for nutrient indexation.

Materials and methods

The proposed study was conducted to assess the nutritional status of soil of 30 apple orchards in district Qilla Saifullah, Balochistan during November, 2011. Soil samples from three depth i.e. 0-30, 31-60 and 61-90 cm from different orchards were collected. Each sample was a composite of 10-15 locations from the same orchard. Soil samples were suitably packed, labeled and transferred to the laboratory of Soil & Environmental Sciences Department, Agriculture University Peshawar, Khyber Pakhtunkhwa. After air-drying, twigs and stones were removed from soil samples, ground and passed through 2 mm sieve and stored for laboratory analysis.

Laboratory analyses

The soil samples were extracted with AB-DTPA solution as described by **[8]** and ready for P by spectrophotometer, K by flame photometer and Zn, Cu, Fe and Mn determined by Atomic Absorption Spectrophotometer and N by Kjeldal apparatus **[9]**. 20 g of soil samples with 40 ml of distilled water and 0.5 ml of 10 percent. $BaCl_2$ solution was boiled for 5 minutes under reflux condenser **[10]**. One ml of the acidified aliquot containing 4 ml curcumine-oxalic acid was dried on water bath at temperature 50±3° C and based for 15 minutes then dissolved in 25 ml of 95 percent ethanol, centrifuged and reading were taken on spectrophotometer **[11]**. Organic matter in soil samples were determined by the Walkyley-Black procedure **[12]**. 1 g soil sample was treated with 10 ml of 1 N $K_2Cr_2O_7$ and 20 ml of concentrated H_2SO_4. After adding 200 ml distilled water upon cooling, the suspension was filtered and the filtrate was titrated against 0.5 N $FeSO_4$ solution using Ortho-phenolphthalein as indicator with the appearance of maroon color as end point. A blank sample was run simultaneously with the soil samples. The amount of organic matter was calculated from the moles of $K_2Cr_2O_7$ utilized in the oxidation of organic C in soil. Soil pH and EC were determined in soil-water (1:5) suspension. For this, 10 g soil was shaken with 50 ml distilled water for 30 min. After filtering, the extract was read on pH meter (InoLab pH level 1) and EC on Conductivity meter (DDC-308A) **[13]**. 50 g air-dry soil was dispersed with 5 ml 10% sodium hexametaphosphate solution in a

mechanical dispersion machine for 5 min. After quantities transfer of the suspension to a 1L Bouyoiucos cylinder, filling the cylinder with distilled water to 1L mark. After thorough mixing, carefully inserted a hydrometer in the suspension and took the hydrometer reading after 40 sec for silt + clay and after 2 hour for clay. Also note temperature of the suspension with each hydrometer reading and made necessary correction in the hydrometer readings. Percent silt and clay were calculated from hydrometer readings while % sand was calculated by difference. Percent sand silt and clay were used to determined soil textural class on the USDA soil textural triangle. The lime content was determinate by acid naturalization (Method 23c, USDA HB 60). Five g soil was transferred to 150-ml flask and mix with 50 ml 0.5N HCl. The suspension was boiled for 5 min and then filtered through filter paper 40. After cooling, the filtrate was titrated against 0.25N NaOH by adding phenolphthalein as indicator till pink color appeared.

Statistical analysis

Descriptive statistics were used to calculate mean, standard deviation and co-efficient of variation [14]. Nutrient status was compared with standard criteria for nutrient indexation.

Results and discussion

Physical and chemical properties

The results obtained on particle soil analysis of apple orchards are presented in (Table 1). It is clear that the soil is normally comprised of large amount of silt followed by sand with less amount of clay. Majority of soils were silt loam (58 samples) and sandy loam (16 samples) and clay loam (12 samples), salty (2 samples) and loamy (2 samples) in texture. These results suggested that the soils of apple orchards were generally light in texture [15]. The results obtained on pH of soils of apple orchards are presented in (Table 1-3). The results showed that the soil pH of selected soil series ranged from 6.4 to 8.8. These results suggested that the soils of apple orchards were generally alkaline in reaction [16].

The results obtained on EC of soils of apple orchards are presented in (Table 1-3). The results showed that the EC of all soils at all the three depths of apple orchards was below 4.0 dSm^{-1}. These results suggested that the soils of apple orchards were non-saline [17]. The results obtained on lime content presented in (Table 4) showed that the surface (0-30 cm) soil, it ranged from 8.00 to 22.00 with a mean value of 15.63±3.99. In the depth of (31-60 cm) soil, it ranged from 6.00 to 20.00 with a mean value of 14.27±3.921, the lime contents in the (61-90 cm) soil ranged from 4.00 to 20.00 with a mean value of 12.50±4.265 of lime, generally alkaline in nature [18]. The results obtained on organic matter content in soils of apple orchards are presented in (Table 4 & 5). The results showed that the surface soils generally contained more organic matter than the soils at lower depths. In the surface soil, organic matter ranged from 0.50 to 1.12% with a mean value of 0.81±0.141 (Table 5) in subsurface soil. It ranged from 0.45% to 1.02% with a mean value of 0.75±0.130. In (61-90 cm) it ranged from 0.42% to 0.99% with a mean value of 0.66±0.128. The organic matter contents at surface soil were low in 25, marginal in 5 and in (31-60 cm) soil was low in 26, marginal in 4 orchards. In (61-90 cm) soil was low in 28 and marginal in 2 orchards. And none of the orchards were found adequate in all three depths. The results showed that 83% orchards were low in organic matter in (0-30 cm), 87% in (31-60 cm) and 93% in (61-90 cm) soils. But 17% orchards were marginal in (0-30 cm), 13% in (31-60 cm) and 7% in (61-90 cm) orchards and none of soil samples was adequate in surface soil while subsurface soil [19].

Major nutrients

Mineral nitrogen ($mgkg^{-1}$) and AB-DTPA extractable P and K, and Organic matter content and $CaCO_3$ of soil collected from apple orchards were also measured along with micronutrients and the results obtained

are presented in (Tables 2-4) **[20]**. Data collected on mineral nitrogen in surface (0-30 cm) soils ranged from 11.17to 61.17 $mgkg^{-1}$ soils with mean value of 33.26±15.665 (Table 1). In (31-60 cm) soil, it ranged from 9.87 to 52.30 $mgkg^{-1}$ soil with a mean value of 29.02±13.691 while in (61-90 cm), it ranged from 7.66 to 45.61 $mgkg^{-1}$ soil with a mean value of 22.27±11.679. The data showed that none of the orchard was found low in surface soil 1 and 4 orchards were found low in (31-60 cm) and (61-90 cm) depth respectively. 7, 9 and 11 orchards were found marginal and 23, 20 and 15 orchards were found adequate in nitrogen. The results showed that 3% orchards were low in (31-60 cm), 13% in (61-90 cm), 23% marginal in (0-30 cm), 30% in the (31-60 cm) and 37% in (61-90 cm) soil. The surface (0-30 cm) soil was adequate in N in 77% orchards in (31-60 cm) soil was adequate in 67% orchards While in (61-90 cm) soil was adequate in 50% orchards. The results were also showed by **[21-23]**.

The AB-DTPA extractable P in soils of apple orchards are existed in (Table 2-4). The absorption of extractable P in soils different depths of orchards. The concentration of P was generally high in the surface depth and decreased gradually with increasing soil depth. The concentration of P in the (0-30 cm) soil ranged from 6.00 to 12.00 mg kg^{-1} soil with a mean value of 9.20±1.808 (Table 2), in (31-60 cm) soil, it ranged from 6.00 to 12.00 $mgkg^{-1}$ soil with a mean value of 8.33±1.918 and in (61-90 cm), it ranged from 5.00 to 11.00 $mgkg^{-1}$soil with a mean value of 7.17±1.840. Comparing with the critical values of P in soil reported by **[8]**, the data showed that P was deficient in both surface and sub-surface soils of many orchards. It was obvious that the soils at lower depths in (31-60 and 61-90 cm) were more deficient in P than the surface (0-30 cm) soil. The results showed that none of the orchards were found low in all three depths, marginal 6, 11 and 18, adequate 24, 19 and 12 orchards were found in (0-30, 31-60 and 61-90 cm) depths. Thus, 20% orchards were marginal in P in (0-30 cm), 37% in (31-60 cm) and 60% in (61-90 cm) soil. However, 80% orchards were adequate in P in (0-30 cm), 63% in (31-60 cm) and 40% in (61-90 cm) soil. Similar results were found by **[14, 25]**.

The results obtained on AB-DTPA extractable K in soils of apple orchards are presented in (Table 2-4). The concentration of extractable K in soils varied with depth and with orchards. The concentration of K was greater in the surface (0-30 cm) soil compared with that at lower soil depths. The concentration of K in (0-30 cm) soil ranged from 60.00 to 85.00 mg kg^{-1} soil with a mean value of 70.83± 6.958 (Table 5). In (31-60 cm) soil it ranged from 60.00 to 80.00 $mgkg^{-1}$ soil with a mean value of66.83±5.645. In (61-90 cm), it ranged from 60.00 to 70.00 $mgkg^{-1}$ soil with a mean value of 62.83±3.869. Comparing with the critical values of K in soil established by **[8]**, the data showed that at lower depths (31-60 and 61-90 cm) were more deficient in K than the surface (0-30 cm) soil. The results showed that 1, 6 and 18 orchards were found low in (0-30, 31-60 and 6, marginal 29, 24 and 12 orchards were found in (0-30, 31-60 and 61-90 cm) depths, none of soil were found adequate in all three depths (Table 2) Thus, 3% orchards were low in K in (0-30 cm), 20% in (31-60 cm) and 60% in (61-90 cm) soil, and 97% orchards were marginal in K in (0-30 cm), 80% in (31-60 cm) and 40% in (61-90 cm) soil. The recorded data were also reported by **[23, 26]**.

The data obtained on concentration of AB-DTPA extractable micronutrients in soils of apple orchards are presented in (Tables 5 & 6). The concentration of micronutrients in soils varies with depth and with orchard. The concentration of Zn was generally high in (0-30 cm) soil but decreased gradually with increasing soil depth. The concentration of Zn in (0-30 cm) ranged from 0.85 to 3.65 ugg^{-1} soil with a mean value-of 2.10±0.819 (Table 6).

Table 1. Particle size soil analysis, pH, EC and Lime content (%) of apple orchards in Qilla Saifullah

Soil depth (cm)	pH					EC					Lime content (%)				
	Mean	SD	Min.	Max.	CV (%)	Mean	SD	Min.	Max.	CV (%)	Mean	SD	Min.	Max.	CV (%)
0-30	7.70	0.476	6.44	8.80	6.18	1.60	0.485	0.79	2.45	30.31	15.63	3.99	8.00	22.00	25.52
31-60	7.66	0.437	6.42	8.16	5.70	1.28	0.445	0.62	1.98	34.76	14.27	3.921	6.00	20.00	27.47
61-90	7.62	0.440	6.40	8.20	5.77	1.00	0.345	0.45	1.88	34.5	12.50	4.265	4.00	20.00	34.12
Particle size soil analysis															
Textural class	Silt loam			Silt		Sandy loam			Loam		Clay loam				
No of samples	58			2		16			2		12				

Table 2. Organic matter content (%), Nitrogen content (mg kg^{-1}) and Ammonium bicarbonate- DTPA extractable P concentration (mg kg^{-1}) in soils of apple orchards

oil depth (cm)	Organic matter content (%)					Nitrogen content (mg kg^{-1})					Ammonium bicarbonate- DTPA extractable P concentration (mg kg^{-1})				
	Mean	SD	Min.	Max.	CV (%)	Mean	SD	Min.	Max.	CV (%)	Mean	SD	Min.	Max.	CV (%)
0-30	0.81	0.141	0.50	1.12	17.40	33.26	15.665	11.17	61.17	47.09	9.20	1.808	6.00	12.00	19.65
31-60	0.75	0.130	0.45	1.02	17.33	29.02	13.691	9.87	52.30	47.17	8.33	1.918	6.00	12.00	23.02
61-90	0.66	0.128	0.42	0.99	19.39	22.27	11.679	7.66	45.61	52.44	7.17	1.840	5.00	11.00	25.66

Table 3. Number of apple orchards soils, classified as saline or non-saline, and acidic or alkaline

Soil depth (cm)	pH (6.0-7.5)		pH (7.5-9.0)		EC (<4.0 ds/m)	
	No* of orchards	%	No	%	No	%
0-30	11	36.66	19	63.66	30	100
31-60	12	40	18	60	30	100
61-90	12	40	18	60	30	100

*Out of 30 orchard

In (31-60 cm), it ranged from 0.54 to 2.63 ugg^{-1} soil with a mean value of 1.39±0.673 and in (61-90 cm), it ranged from 0.32 to 2.44 ugg^{-1} soil with a mean value of 1.00±0.535. The concentration of Cu in soil also decreased gradually with increasing soil depth. The concentration of Cu in (0-30 cm), ranged from 2.01 to 6.16 ugg^{-1} soil with a mean value of 4.20±1.205. In (31-60 cm), it ranged from 1.91 to 6.10 ugg^{-1} soil with a mean value of 3.84±1.31 ugg^{-1}and in (61-90 cm), it ranged from 1.11 to 5.91 ugg^{-1} soil with a mean value of 3.55±1.383. The concentration of Fe in soil also generally decreased gradually with increasing soil depth. The concentration of Fe in (0-30 cm) ranged from 3.05 to 9.66 ugg^{-1} soil with a mean value of 6.95±1.917 in (31-60 cm), it ranged from 2.34 to 8.89 ugg^{-1} soil with a mean value of 6.40±1.858 and in (61-90 cm), it ranged from 1.90 to 8.78 ugg^{-1} soil with a mean value of 5.53±1.967. Like other micronutrients, the concentration of Mn in soil was generally high in the surface soil but decreased gradually with increasing soil depth, in (0-30 cm), ranged from 2.90 to 7.72 ugg^{-1} soil with a mean value of 5.47±1.574. In (31-60 cm), it ranged from 2.56 to 7.01 ugg^{-1} soil with a mean value of 4.76±1.475 and in (61-90 cm), it ranged from 2.01 to 7.01 ugg^{-1} soil with a mean value of 4.23±1.459. The concentration of B in (0-30 cm) ranged from 0.72 to 3.16 ugg^{-1} soil with a mean value of 1.68±0.706. In (31-60 cm), it ranged from 0.55 to 3.05 ugg^{-1} soil with a mean value of 1.44±0.756 and in (61-90 cm), it ranged from 0.29 to 2.98 ugg^{-1} soil with a mean value of 1.21±0.775.

Comparing with the critical values of micronutrients concentration in soil, the data showed that the soils of apple orchards incorporated in the survey were deficient in Zn, Fe and B at varying levels. The Zn results showed that 2, 7 and 14 orchards were found low, marginal 7, 11 and 12, adequate 21, 12 and 4 orchards were found in (0-30, 31-60 and 61-90 cm). The soils at lower depths (31-60 and 61-90 cm) were more deficient in Zn than the surface (0-30 cm) soils.

The Zn results showed that the orchards were low 7, 23 and 47%, marginal 23, 37 and 40%, adequate 70, 40 and 13% in (0-30, 31-60 and 61-90 cm). Similar results also found by **[27].** And none of orchards were found deficient in Cu and Mn in at all three depths (Table 6). The results were found by **[24, 28]**. The results of Fe status in soil of apple orchards showed that none of the orchard was found low in surface (0-30 cm), 1 and 3 orchards were found low in (31-60 cm) and (61-90 cm), marginal 5 , 7 and 10, adequate 25 , 22 and 17 orchards were found in (0-30, 31-60 and 61-90 cm). The results showed that the soil was low in Fe 3 and 10% in (31-60 and 61-90 cm), marginal 7, 23 and 33%, adequate 83, 73 in and 57% in (0-30, 31-60 and 61-90 cm). The similar results were found by **[28, 29]**.

With respect to B concentration in soils of apple orchards, the results show that none of the orchards were found low in (0-30 cm) and (31-60 cm), 5 orchard was found low in (61-90 cm) depth respectively, marginal 7, 13 and 11, adequate 23 , 17 and 14 orchards were found in (0-30, 31-60 and 61-90 cm). The results showed that the B was low 17% in (61-90 cm) and marginal 23, 43 and 37%, adequate 77, 57% and 47% in (0-30, 31-60 and 61-90 cm). These results thus suggested that the soils of apple orchards were low to marginal in Zn, Fe and B to varying levels. The frequency of Zn deficiency was highest followed by Fe and B but Cu and Mn deficiency in soils were not prevalent. The results were same as **[28, 30]**.

Correlation

Data presented in (Table 7) shows the relationship of relative concentration of NPK and ABDTPA extractable Cu, Fe, Zn, Mn and Hot water soluble B with various physical and chemical properties of soil. These were statistically analyzed using simple linear correlation. In addition to these graphs of line of regression were also prepared (Figure 2, 3, 4 & 5). The AB-DTPA extractable Zn, Cu, Fe, Mn and B

had positive non-significant correlation with O.M in the surface and subsurface soil. The micronutrients such as (Fe and Zn) had negative non-significant correlation with EC and pH. These results are in conformity with [29]. The AB-DTPA extractable P showed positive non-significant and significant correlation with OM, the results were reported by [25, 29, 31] .The AB-DTPA extractable K had positive significant correlation with OM and Lime in the surface and subsurface and negative non-significant correlation with pH. The results were recorded by [32].

Table 4. Number of apple orchards' soil classified as low, marginal or adequate in organic matter, nitrogen, AB- DTPA extractable P and AB- DTPA extractable K

Property	Soil depth (cm)	Low		Marginal		Adequate	
		No*.of Orchards	%	No. of Orchards	%	No. of Orchards	%
Organic mater	0-30	25	83.33	5	16.66	0	0
	31-60	26	86.66	4	13.33	0	0
	61-90	28	93.33	2	6,66	0	0
Nitrogen	0-30	0	0	7	23.33	23	76.66
	31-60	1	3.33	9	30	20	66.66
	61-90	4	13.33	11	36.66	15	50
Phosphorus	0-30	0	0	6	20	24	80
	31-60	0	0	11	36.66	19	63.33
	61-90	0	0	18	60	12	40
Potassium	0-30	1	3.33	29	96.66	0	0
	31-60	6	20	24	80	0	0
	61-90	18	60	12	40	0	0

*Out of 30 orchards

Table 5. Ammonium bicarbonate- DTPA extractable k concentration (mg kg^{-1}) & Micronutrients concentration in soil (mg kg^{-1} soil) of apple orchard

K & Micronutrient	Soil depth (cm)	Mean	SD	Min.	Max.	CV (%)
K	0-30	70.83	6.958	60.00	85.00	9.82
	31-60	66.83	5.645	60.00	80.00	8.44
	61-90	62.83	3.869	60.00	7.00	6.15
Zn	0-30	2.10	0.819	0.85	3.65	39
	31-60	1.39	0.673	0.54	2.63	48
	61-90	1.00	0.535	0.32	2.44	53.5
Cu	0-30	4.20	1.205	2.01	6.16	28.69
	31-60	3.84	1.314	1.91	6.10	34.21
	61-90	3.55	1.383	1.11	5.91	38.95
Fe	0-30	6.95	1.917	3.05	9.66	27.58
	31-60	6.40	1.858	2.34	8.89	29.03
	61-90	5.53	1.967	1.90	8.78	35.56
Mn	0-30	5.47	1.574	2.90	7.72	28.77
	31-60	4.76	1.475	2.56	7.01	30.98
	61-90	4.23	1.459	2.01	7.01	34.49
B	0-30	1.68	0.706	0.72	3.16	42.02
	31-60	1.44	0.756	0.55	3.05	52.5
	61-90	1.21	0.775	0.29	2.98	64.04

Table 6. Number of apple orchards classified as low, marginal or adequate in micronutrients based on soil concentration

Micronutrient	Soil depth (cm)	Low		Marginal		Adequate	
		No* .of Orchards	%	No. of Orchards	%	No. of Orchards	%
Zn	0-30	2	6.66	7	23.33	21	70
	31-60	7	23.33	11	36.66	12	40
	61-90	14	46.66	12	40	4	13.33
Cu	0-30	0	0	0	0	30	100
	31-60	0	0	0	0	30	100
	61-90	0	0	0	0	30	100
Fe	0-30	0	0	5	6.66	25	83.33
	31-60	1	3.33	7	23.33	22	73.33
	61-90	3	10	10	33.33	17	56.66
Mn	0-30	0	0	0	0	30	100
	31-60	0	0	0	0	30	100
	61-90	0	0	0	0	30	100
B	0-30	0	0	7	23.33	23	76.66
	31-60	0	0	13	43.33	17	56.66
	61-90	5	16.66	11	36.66	14	46.66

*Out of 30 orchards

Table 7. Correlation of soil nutrients with soil properties

Soil nutrients	Depths (cm)	Soil properties			
		OM	Lime	pH	ECs
N	0-30	0.312	0.358	0.114	-0.227
	31-60	0.312	0.163	0.137	-0.282
	61-90	0.306	0.234	0.179	-0.429
P	0-30	0.257	0.182	-0.054	0.083
	31-60	0.369	0.043	0.010	0.091
	61-90	0.355	-0.125	0.029	-0.152
K	0-30	0.413*	0.309	-0.024	0.069
	31-60	0.434*	0.001	-0.037	0.063
	61-90	0.409*	0.068	-0.075	-0.081
Zn	0-30	0.239	-0.116	-0.003	-0.026
	31-60	0.106	0.172	-0.085	0.304
	61-90	0.119	0.059	-0.190	0.147
Cu	0-30	0.131	-0.274	-0.191	0.182
	31-60	0.170	-0.217	0.166	0.090
	61-90	0.219	-0.089	0.266	0.072
Fe	0-30	0.092	0.107	-0.180	0.117
	31-60	0.121	-0.065	0.264	-0.037
	61-90	0.069	0.053	0.292	-0.066
Mn	0-30	0.043	0.134	0.112	0.014
	31-60	0.026	0.064	0.021	0.109
	61-90	0.243	-0.287	0.179	0.212
B	0-30	0.031	0.033	0.141	-0.053
	31-60	0.036	0.118	0.254	0.189
	61-90	0.225	0.036	0.240	0.364*

* $r_{0.05}$

** $r_{0.01}$

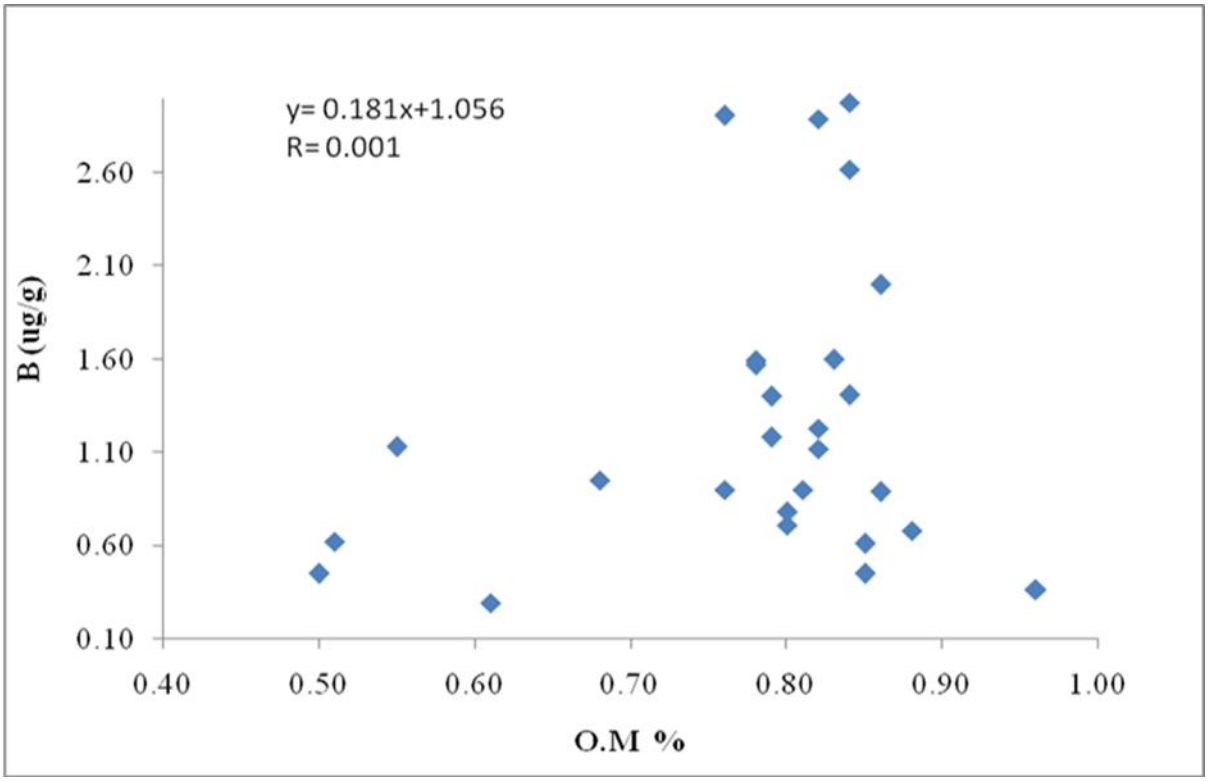

Figure 2. Relationship between B with O.M at surface

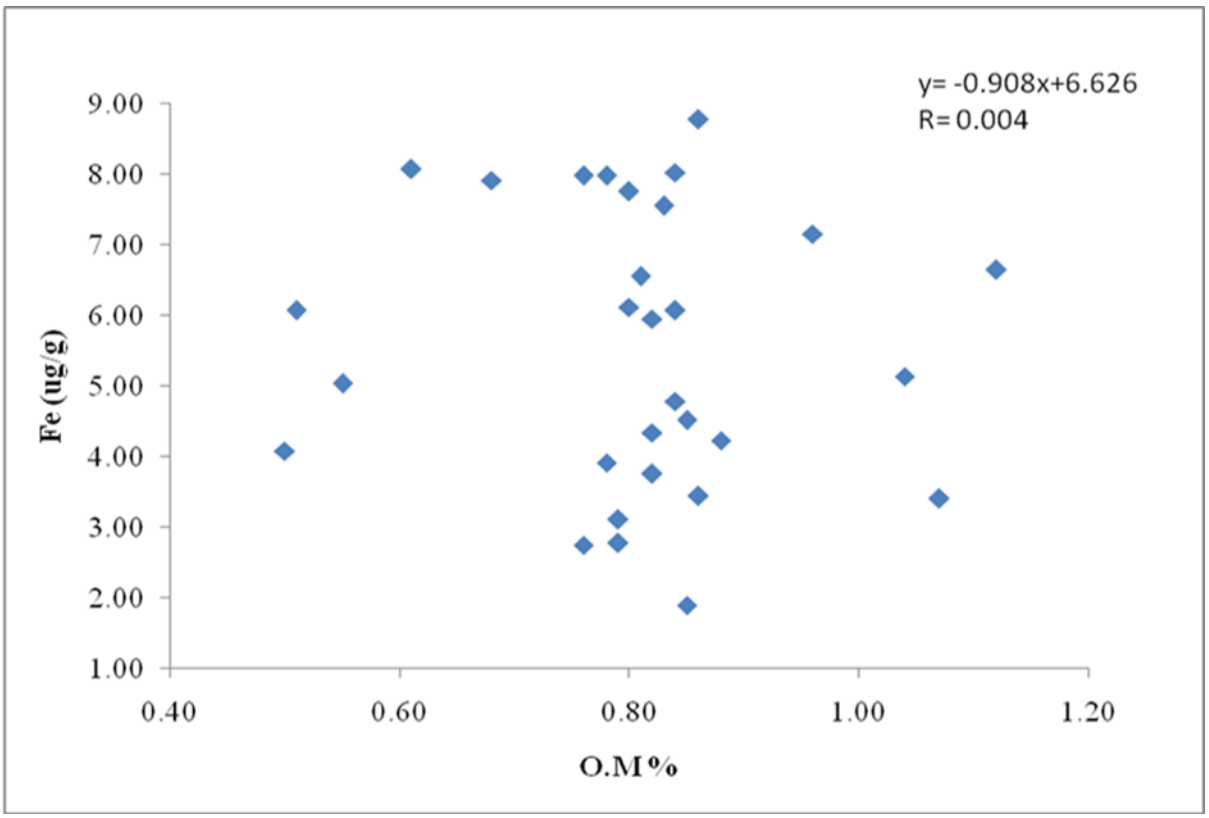

Figure 3. Relationship between AB-DTPA extractable Fe with O.M at surface

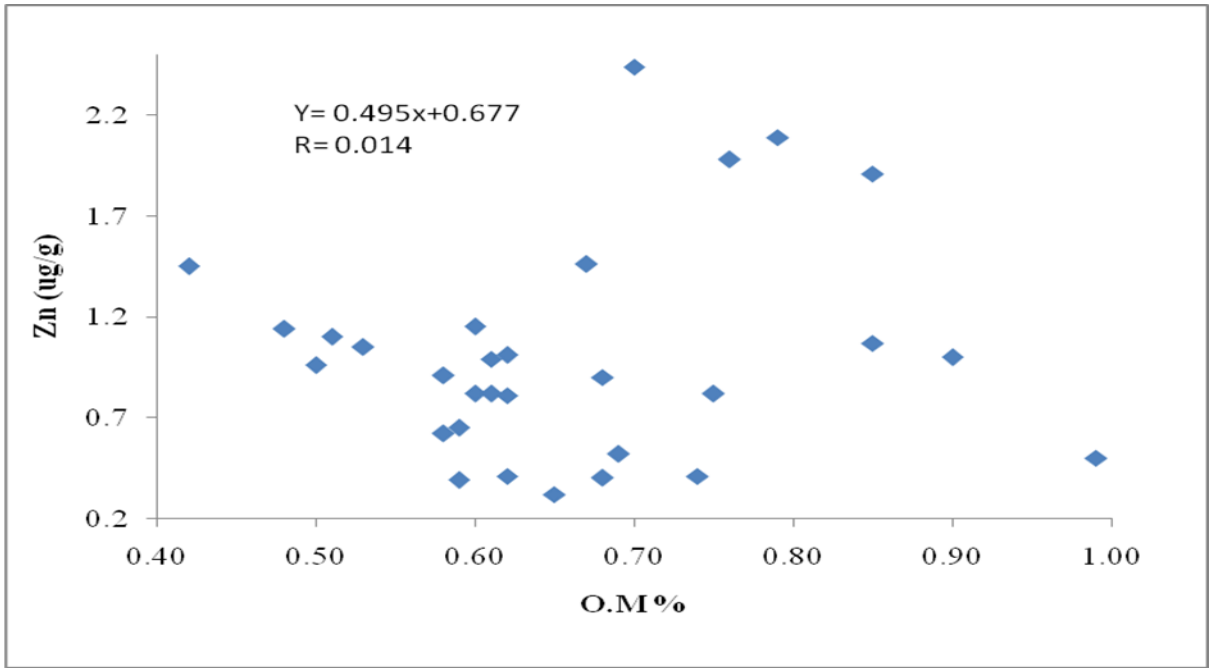

Figure 4. Relationship between AB-DTPA extractable Zn with O.M at surface

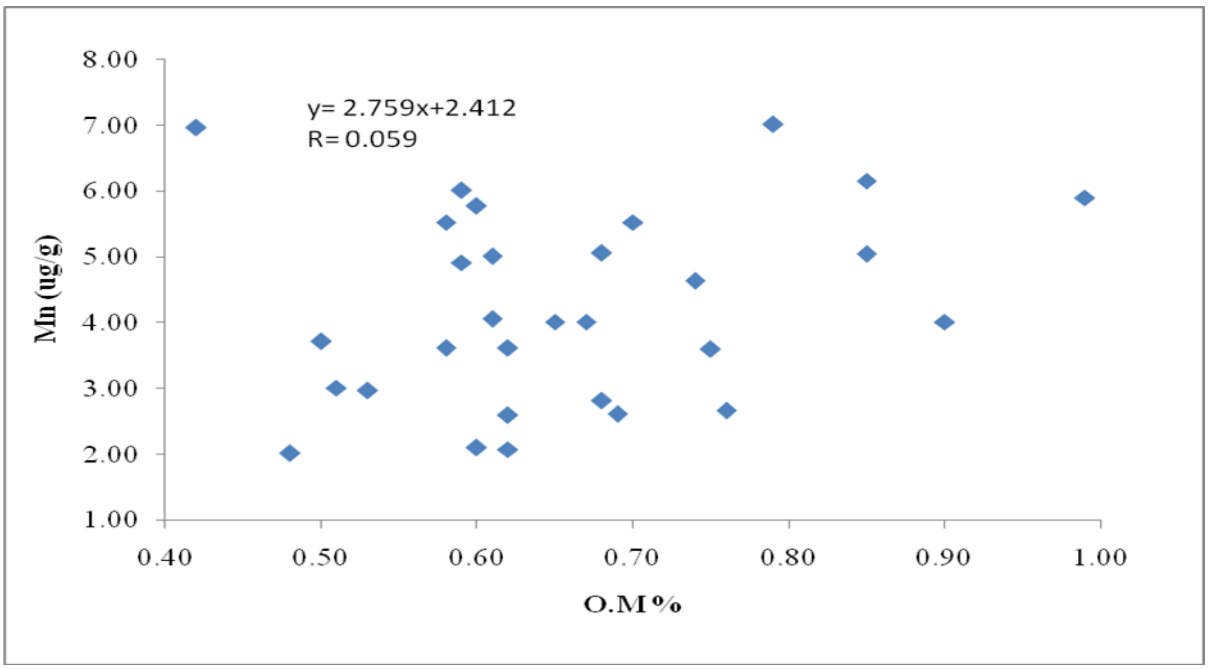

Figure 5. Relationship between AB-DTPA extractable Mn with O.M at surface

Conclusion and recommendations

Apple orchards soils in Qilla Saifullah were found deficient in Zn, Fe and B and their concentration decreased with increasing soil depth; The surface soils generally contained more mineral nitrogen than subsurface soils the results showed that the orchard were found low 3 and 13% in (31-60 and 61-90 cm), marginal 23, 30 and 37%, adequate 77, 67 and 50% orchards were found in (0-30, 31-60 and 61-90 cm); Phosphorus and potassium were deficient in most of orchards in subsurface and further decreased to soil

depth; organic matter was also deficient in subsurface. It ranged 83% to 93% in (0-30 and 61-90 cm), marginal from 17% in (0-30 cm) to 7% in (61-90 cm) and orchards were inadequate at all depths; pH reflected alkaline soils; EC of all soil were below 4.0 $mScm^{-1}$ that showed non-saline soils and soil was light in texture. Experiments should be conducted for the nutrients in low and marginal orchards to find out the optimum dose of these nutrients, and orchards classified as low and marginal should be fertilized with macro and micronutrients fertilizer to maintain soil fertility.

Authors' contributions

Conceived and designed the experiments: Z Ullah & ZU Haq, Performed the experiments: Z Ullah & ZU Haq, Analyzed the data: Z Ullah & MR Siddiqui, Contributed materials/ analysis/ tools: Saduddin, Wrote the paper: Z Ullah

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