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## STATUS OF SOIL MACRONUTRIENTS IN APPLE ORCHARDS OF DISTRICT KILLA SAIFULLAH BALOCHISTAN

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### ABSTRACT

Apple is grown in huge areas of Balochistan province but its production is reasonably low, probably due to inadequate fertilization. A study was planned to assess the soil macronutrient status of apple orchards from ten sites of district Killa Saifullah Balochistan i.e. Saddar Killa Saifullah, Nasi, Tabli 1, Bandat Merzai, Akhtar Zai, Ali Khail, Dolat Zai, Batozai, Musafur Pur and Bazar Killa Saifullah. Soil samples were collected from five trees of each orchard at 0-15, 15-30 and 30-45 cm depth. The soil samples were analyzed for textural class, pH, EC ( $\text{dS m}^{-1}$ ), organic matter (%), nitrogen (N), phosphorus (P) and potassium (K) contents. The results showed that the soils of Killa Saifullah district were variable in texture; the silty clay texture was at Saddar Killa Saifullah, Tabli 1, Akhtar Zai, Bazar Killa Saifullah and Ali Khail and clay loam in Nasi, Bandat Merzai, Musafirpur and Batozai at all three depths. The EC of all orchards were in normal range (below  $2 \text{ dS m}^{-1}$ ). The pH of the soils was amid 8.07 and 8.20 which indicates their alkaline nature. The maximum pH (8.20) was observed in Dolat Zai while across three depths the maximum pH (8.17) was observed at 30-45 cm depth. The organic matter content was marginal in all orchards except in orchard Dolat Zai (0.81%) and Bazar Killa Saifullah (0.85%) where the organic matter content was low and decreased from upper to lower depths. The N was found low in all locations and soil depths. Soil phosphorus of apple orchards was in medium range at all depths except at two locations Saddar Killa Saifullah and Bazar Killa Saifullah where P content was in the range of 2.14 to  $8.3 \text{ mg kg}^{-1}$  so it was low. The status of soil K content was in medium to high ( $89.0$  to  $154.6 \text{ mg kg}^{-1}$ ) in all orchards at three depths. The significantly positive correlation among organic matter and total nitrogen ( $r^2 = 0.99$ ), P ( $r^2 = 0.55$ ) and K ( $r^2 = 0.26$ ) revealed the role of organic matter in the availability of nutrients. Significantly negative correlation between organic matter and pH ( $r^2 = -0.46$ ) was observed and it showed the role of organic matter in lowering soil pH. This study suggests that the N, P fertilizers, and organic matter should be applied in adequate amounts for better apple production in Killa Saifullah district of Balochistan.

**Keywords:** apple orchard, nitrogen, organic matter, phosphorus, potassium

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## INTRODUCTION

Apple is widely grown fruit around the world. People like apple due to its delightful flavor and richness in potassium, phosphorus, sodium, iron, vitamins content (Boyer, 2004). It is grown from ancient times in Asia and Europe with more than 7500 known cultivars (Philips and John, 2009). Balochistan province is called fruit basket of Pakistan; about 34 percent apple and 70 percent dates production is from this region due to any natural resources such as favorite climate and a variety of plateau of land are here. Pakistan harvests 366000 tons apple fruit from estimated area of 112000 hectares annually and out of this Baluchistan's share in apple production is 251000 tons from an area of 102000 hectares (GoP, 2013).

Soil macronutrients had vital role and should be present in soil in adequate quantity for the healthy apple trees. Nitrogen is essential for vigorous vegetative and floral growth of trees (Reddy *et al.*, 2000). Phosphorus is required for the normal cell division, growth and establishment of sugar-phosphate molecules (Salisbury and Ross, 1992). Potassium is indispensable for increasing resistance of tree from pathogens and insect pests; it also regulates water uptake and improves fruit quality (Marschner, 1995). The optimal quantity of macro nutrients in soil is the basic requirement for good quality apple production (Stiles and Reid, 1991).

The nutrient requirements of apple trees vary at different orchards and may be affected by temperature, light and availability of water. Nutrient deficiencies negatively affect yield and quality of fruits (Hoying *et al.*, 2004). A broad fertility status study of orchards through soil sampling and its analysis offers the basic knowledge regarding presence or absence of any nutrient in the studied area which helps in understanding the need of nutrient requirements. For all the orchards, soil sampling and laboratory testing is vital to know the N, P and K status in soil for deciding the use of fertilizers (Stile, 2004). This study was planned for apple orchards of district Killa Saifullah in Balochistan province to determine the status of nitrogen, phosphorus and potassium in soils of these areas so that we come to know the current status of macronutrients. The findings of this study will be helpful to the farmers of the area to apply macronutrients in adequate amounts for better apple production.

## MATERIALS AND METHODS

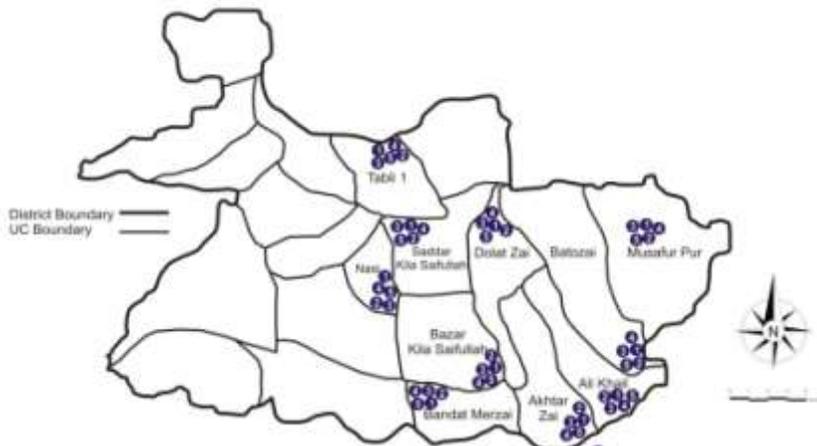
A field study was conducted during 2015 to evaluate the macronutrients status of apple orchards in district Killa Saifullah, Balochistan. The location of district is shown in Figure 1. 150 soil samples were collected randomly from the ten orchards, each from a Union Council viz., Saddar Killa Saifullah, Nasi, Tabli 1, Bandat Merzai, Akhtar Zai, Ali Khail, Dolat Zai, Batozai, Musafur Pur and Bazar Killa Saifullah. The location of sampling sites are shown in Figure 2 from each orchard, five trees were randomly selected to take soil samples at the depth of 0-15, 15-30 and 30-45 cm. In order to have a representative soil sample from each tree, four to six cores were made underneath the tree canopy and composited to one sample. The geographical location of the sampling site was recorded using GPS and is described in Table 1.

All the soil samples were properly labelled and delivered to the laboratory of the Department of Soil Science, Sindh Agriculture University, Tandojam. The soil

samples were air-dried ground and passed through 2 mm mesh. Soil samples from each orchard were analyzed for the determination of texture, pH, electrical conductivity ( $\text{dS m}^{-1}$ ), organic matter (%), nitrogen (%), phosphorus ( $\text{mg kg}^{-1}$ ) and potassium ( $\text{mg kg}^{-1}$ ) content.



**Figure 1.** Map of Balochistan showing location of district Killa Saifullah



**Figure 2.** Map of Killa Saifullah district showing soil sampling sites from apple orchards

**Table 1.** Sampling location and textural class of apple growing areas of district Killa Saifullah, Balochistan

Union Council	GPS location		Textural Class
	Latitude	Longitude	
Saddar Killa Saifullah	30 <sup>o</sup> 41,34.2	68 <sup>o</sup> 20,42.2	Silty clay
Nasi	30 <sup>o</sup> 45,00.3	68 <sup>o</sup> 23,15.0	Clay loam
Tabli 1	30 <sup>o</sup> 38,52.4	68 <sup>o</sup> 29,90.1	Silty clay
Bandat Merzai	30 <sup>o</sup> 41,54.7	68 <sup>o</sup> 19,52.2	Clay loam
Akhtar Zai	30 <sup>o</sup> 39,43.7	68 <sup>o</sup> 29,23.2	Silty clay
Ali Khail	30 <sup>o</sup> 42,10.5	68 <sup>o</sup> 27,53.9	Clay loam
Dolat Zai	30 <sup>o</sup> 43,35.7	68 <sup>o</sup> 22,60.7	Silty clay
Batozai	30 <sup>o</sup> 40,45.2	68 <sup>o</sup> 27,31.4	Clay loam
Musafur Pur	30 <sup>o</sup> 39,26.0	68 <sup>o</sup> 30,60.1	Clay loam
Bazar Killa Saifullah	30 <sup>o</sup> 43,18.9	68 <sup>o</sup> 19,18.2	Silty clay

Soil was analyzed for the physico-chemical properties by standard methods. The texture by Hydrometer method (Bouyoucos, 1962), soil electrical conductivity (EC) and pH were determined in 1:5 soil water extract using digital EC meter and pH meter (McLean, 1982). Organic matter was determined by oxidation method (Walkely and Black, 1934). Nitrogen in soil was determined by Kjeldahl's method (Benton, 2001), P and K by AB-DTPA extraction method (Soltanpour and Workman, 1979). The NPK were categorized as defined by Soltanpor and Schwab (1977).

The original data for pH, electrical conductivity ( $\text{dS m}^{-1}$ ), organic matter (%), nitrogen (%), phosphorus ( $\text{mg kg}^{-1}$ ) and potassium ( $\text{mg kg}^{-1}$ ) of apple orchards were subjected to a two factor analysis (orchards and soil depths) using software program Statistix 8.1. The related comparison of mean values was calculated using least significant difference (LSD) test at 0.05% significance level. The mean values were compared with the established critical levels of apple tree.

## RESULTS AND DISCUSSION

Soil texture of orchards of Saddar Killa Saifullah, Tabli 1, Akhtar Zai, Dolat Zai and Bazar Killa Saifullah was silty clay, while orchards of Nasi, Bandat Merzai, Ali Khail, Batozai and Musafur Pur had clay loam texture (Table 1). The sand percentage in the soils of all orchards was low (less than 30%). Apple orchards in district Killa Saifullah are established on terraces due to mountainous landscape of the area and may be due to that reason soils were silty clay and clay loam in texture and fit for apple production.

The data regarding pH value of apple orchards soil in selected Union Councils are shown in Table 2. The significant difference was observed in the pH value of apple orchards at different soil depths in the Nasi, Tabli 1, Bandat Merzai, Akhtar Zai, Ali Khail, Dolat Zai, Batozai, Musafur Pur Sadar Killa Saifullah and Bazar Killa Saifullah orchards. Soils from all the orchards had pH values more than 8.0 and the highest pH was of Dolat Zai (8.20) and lowest was of Musafur Pur (8.07). Depth wise highest pH was noted at the soil depth of 30-45 cm (8.17), followed by 15-30 cm (8.13) and 0-15 cm (8.08), respectively. The soil

pH of different apple orchards was alkaline in nature and low organic matter contents. However, the preferred pH range for apple trees is between 5.5 and 7.0 slightly acidic to neutral (Crop Nutrition 2016), hence the pH of selected orchards should be lowered by organic matter application.

The electrical conductivity of the soil in the orchards of district Killa Saifullah Balochistan are shown in Table 2. There was a significant difference in electrical conductivity for soil depths. Laboratory analysis results had shown that nine orchards soils were non saline as EC was below 2.0 dS m<sup>-1</sup>. Soil of the one orchard Ali Khail was moderately saline with EC more than 2.0 dS m<sup>-1</sup>. The maximum electrical conductivity was noted at the soil depth of 0-15 cm, followed by 30-45 cm and 15-30 cm, respectively. The electrical conductivity levels of all orchard soils were in normal range of 0.29 to 2.46 dS m<sup>-1</sup> and EC can serve as an indirect indicator of the amount of water-soluble nutrients available for plant uptake.

**Table 2.** The average pH and electrical conductivity (dS m<sup>-1</sup>) of soils collected from various apple orchards of district Killa Saifullah, Balochistan

Union Council	pH				EC (dS m <sup>-1</sup> )			
	Soil depths			Mean	Soil depths			Mean
	0-15 (cm)	15-30 (cm)	30-45 (cm)		0-15 (cm)	15-30 (cm)	30-45 (cm)	
Sadar Killa Saifullah	8.10	8.18	8.19	8.15B	0.29	0.29	0.29	0.29D
Nasi	8.06	8.11	8.15	8.11C	0.29	0.28	0.29	0.29D
Tabli 1	8.08	8.13	8.17	8.13B	0.48	0.46	0.61	0.52CD
Bandat Merzai	8.05	8.10	8.14	8.10C	1.17	1.08	1.03	1.09B
Akhtar Zai	8.09	8.14	8.18	8.14B	1.86	1.31	1.38	1.52B
Ali Khail	8.07	8.12	8.16	8.12BC	2.76	2.27	2.33	2.46A
Dolat Zai	8.15	8.20	8.24	8.20A	0.79	0.65	0.89	0.77C
Batozai	8.03	8.08	8.12	8.08C	0.44	0.42	0.49	0.45D
Musafur Pur	8.02	8.07	8.11	8.07C	0.68	0.66	0.79	0.71C
Bazar Killa Saifulah	8.10	8.15	8.19	8.15B	0.85	0.93	0.71	0.83C
Mean	8.08C	8.13B	8.17A	-	0.96A	0.84A	0.88A	-

Same letter within columns and rows are not significantly different at  $P=0.05$ .

The nitrogen content of the soils of apple orchards of district Killa Saifullah Balochistan are presented in Table 3. There was a significant difference in nitrogen content for orchards and soil depths. The laboratory analysis of soil samples had shown that N % was in low range at all the orchards across three soil depths. On the basis of average values, the nitrogen content (0.05%) of the apple orchards at Akhtar Zai, Ali Khail and Bandat Merzai, were higher than other orchards. The lowest soil N % among the studied orchards was in the orchard Bazar Killa Saifullah (0.04%). The soil nitrogen content was higher at the soil depths 0-15 cm and 15-30 cm as compared to 30-45 cm. As the N content of studied orchards was low in all three depths, the apple trees need regular application of N fertilizers for healthy growth and fruit formation and their deficiency may negatively affect fruit formation (Hoying *et al.*, 2004).

The phosphorus content (mg kg<sup>-1</sup>) of the soils in apple orchards of district Killa Saifullah Balochistan are presented in Table 3. The laboratory analysis of

collected soil samples showed that P content of all the apple orchards at three depths were in medium range (3.3 to 6.5 mg kg<sup>-1</sup>), except in two locations (Saddar Killa Saifullah and Bazar Killa Saifullah) where the P was low (2.66 to 3.37 mg kg<sup>-1</sup>). The average values of P content in the apple orchard Nasi were highest (6.59 mg kg<sup>-1</sup>) and the orchard Saddar Killa Saifullah was lowest (2.66 mg kg<sup>-1</sup>) in P content than all other apple orchards. The soil phosphorus content was higher at the soil depths of 0-15 cm (5.48 mg kg<sup>-1</sup>), followed by 15-30 cm (4.55 mg kg<sup>-1</sup>) and 30-45 cm (3.59 mg kg<sup>-1</sup>). So in majority of the orchards, P was present in sufficient range for healthy and good quality fruit. The possible reason for low macronutrient contents in some orchards soil might be due to lack of organic matter which lowers the fertility in apple growing soils (Bozkurt *et al.*, 2010).

**Table 3.** The nitrogen (%) and phosphorus (mg kg<sup>-1</sup>) content of soils collected from various apple orchards at different soil depths of district Killa Saifullah, Balochistan

Union Council	N (%)				P (mg kg <sup>-1</sup> )			
	Soil depths			Mean	Soil depths			Mean
	0-15 (cm)	15-30 (cm)	30-45 (cm)		0-15 (cm)	15-30 (cm)	30-45 (cm)	
Sadar K Saifullah	0.05	0.04	0.04	0.043C	3.04	2.82	2.14	2.66F
Nasi	0.05	0.05	0.05	0.050AB	8.34	6.70	4.74	6.59A
Tabli 1	0.05	0.05	0.04	0.046B	5.60	5.14	4.24	4.99C
Bandat Merzai	0.06	0.05	0.04	0.050A	6.39	4.99	4.12	5.17C
Akhtar Zai	0.06	0.05	0.04	0.050AB	4.50	4.34	4.21	4.35D
Ali Khail	0.06	0.05	0.04	0.050AB	7.37	5.92	4.18	5.82B
Dolat Zai	0.05	0.04	0.03	0.040C	5.24	4.13	3.20	4.19D
Batozai	0.05	0.05	0.04	0.050AB	6.72	5.53	4.14	5.46B
Musafur Pur	0.06	0.05	0.04	0.050AB	4.04	3.42	2.67	3.37E
Bazar K Saifulah	0.05	0.04	0.03	0.040C	3.54	2.56	2.32	2.81F
Mean	0.05A	0.05A	0.04B	-	5.4A	4.55B	3.59C	-

Same letter within columns and rows are not significantly different at  $P=0.05$ .

The potassium (mg kg<sup>-1</sup>) status in the soils of apple orchards of district Killa Saifullah Balochistan was significantly different at  $P=0.05$  on various locations and depths (Table 4). The laboratory analysis of collected soil samples had shown that K content was in medium to high level (95.3 to 165.4 mg kg<sup>-1</sup>) in all orchards and in all depths. No any location of the studied orchards was found as deficient in K. The soils from apple orchard Tabli 1 contains the highest K content (165.40 mg kg<sup>-1</sup>) among all other orchards and the orchard Saddar Killa Saifullah with low K content (95.33 mg kg<sup>-1</sup>). The maximum potassium content was noted at the soil depth 0-15 cm (138.5 mg kg<sup>-1</sup>), followed by 15-30 cm (132.4 mg kg<sup>-1</sup>) and 30-45 cm (125.6 mg kg<sup>-1</sup>).

The organic matter content of orchards is given in Table 4. The results have shown that soils of all orchards are low to medium in organic matter percentage. The average values showed that the organic matter content of the apple orchard Bandat Merzai was highest 1.06% and the lowest (0.81%) was in Dolat Zai among studied orchards. The maximum organic matter was noted at the soil

depth 0-15 cm (1.12%), followed by 15-30 cm (0.98%) and 30-45 cm (0.80%). The soil organic matter have long been considered a necessity for agricultural crops as it is directly or indirectly affects the physical, chemical and biological properties of the soils. The organic matter contents in majority of apple orchards of district Killa Saifullah Balochistan was low when compared to critical ranges as given by Jones *et al.* (1991). The reason for low organic matter content in soil is due to the unavailability of FYM in the apple growing areas and if available, it is costly and the farmers are unable to bear expenses.

**Table 4.** Potassium ( $\text{mg kg}^{-1}$ ) and organic matter (%) content of soils collected from various apple orchards at different soil depths of district Killa Saifullah, Balochistan

Union Council	K ( $\text{mg kg}^{-1}$ )				Organic Matter (%)			
	Soil depths			Mean	Soil depths			Mean
	0-15 (cm)	15-30 (cm)	30-45 (cm)		0-15 (cm)	15-30 (cm)	30-45 (cm)	
Sadar K Saifullah	102.80	94.20	89.00	95.33F	0.98	0.89	0.77	0.88C
Nasi	126.60	115.20	110.60	117.47E	1.12	1.06	0.95	1.04AB
Tabli 1	172.60	166.60	157.00	165.40A	1.12	0.99	0.82	0.98B
Bandat Merzai	152.00	157.20	152.00	153.73B	1.22	1.11	0.86	1.06A
Akhtar Zai	154.60	150.40	144.40	149.80B	1.24	1.05	0.87	1.05AB
Ali Khail	125.20	115.00	110.40	116.87E	1.19	1.05	0.75	0.99AB
Dolat Zai	136.20	132.00	125.20	131.13D	0.98	0.84	0.62	0.81C
Batozai	126.80	113.80	107.00	115.87E	1.10	1.06	0.88	1.01AB
Musafur Pur	143.20	140.60	128.20	137.33C	1.15	0.96	0.86	0.99AB
Bazar K Saifullah	145.80	139.00	132.40	139.07C	1.11	0.83	0.61	0.85C
Mean	138.5A	132.4B	125.6C	-	1.12A	0.98B	0.80C	-

Same letter within columns and rows are not significantly different at  $P=0.05$ .

**Table 5.** Correlation among EC, K, N, O. M., P and pH of soil collected from various apple orchards at different soil depths of district Killa Saifullah, Balochistan

Variables	EC ( $\text{dS m}^{-1}$ )	K (%)	N (%)	O. M (%)	P (%)
K (%)	0.0939 <sup>NS</sup>	-	-	-	-
N (%)	0.0407 <sup>NS</sup>	0.2592**	-	-	-
O. M (%)	0.0428 <sup>NS</sup>	0.2599**	0.9996**	-	-
P (%)	0.1104 <sup>NS</sup>	0.1445 <sup>NS</sup>	0.5519**	0.5516**	-
pH	-0.0084 <sup>NS</sup>	-0.1151 <sup>NS</sup>	-0.4630 <sup>NS</sup>	-0.4622**	-0.3440**

To our knowledge, limited work has been done that describes the physico-chemical properties and macronutrient status of apple orchards of Balochistan. Only one study, Mujtaba *et al.* (2015) was found; these researchers analysed the soil samples of apple orchards of Balochistan and reported that the soils were non-saline, alkaline in reaction (pH 7.8 to 8.0), low in organic matter, N and P contents, and sufficient in K content.

The correlation coefficient of organic matter (%) with pH was negative and non-significant ( $r^2 = -0.4622^{\text{NS}}$ ) as shown in Table 5. The organic matter had

positive significant correlation ( $r^2 = 0.5516^{**}$ ) with P, N ( $r^2 = 0.9996^{**}$ ) and K ( $r^2 = 0.2599^{**}$ ). It is emphasizing that as the organic matter (%) increased, a marginal increase in the potassium (%) was recorded. According to Eyupoglu (1999) the fertility status of Turkish agricultural soils lacks soil organic matter content and it is one of the major reasons for the low fertility. According to Bozkurt *et al.* (2010) one of the major reasons for low fertility in apple growing areas is insufficient organic matter content of the soils.

## CONCLUSION

The soil sampling and analysis showed that apple orchards were low in N, P and organic matter content, sufficient in K content, pH was alkaline and EC was in normal range. On the basis of our findings it is suggested that N, P fertilizers and organic matter should be applied in these orchards for better apple production in Killa Saifullah district of Balochistan.

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