Research Article

Analysis of soil physico-chemical properties of guava orchard in multi zones of district Larkana, Sindh, Pakistan

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Citation

Muhammad Mukhtar Rajput, Allah Wadhayo Gandahai, Mehrunisa Memon, Arshad Ali Kaleri, Mukesh Kumar Soothar, Sajid Hussain Kaleri, Mahendar Kumar Soothar and Ayaz Ali Panhwar. Analysis of soil physico-chemical properties of guava orchard in multi zones of district Larkana, Sindh, Pakistan. Pure and Applied Biology. Vol. 6, Issue 3, pp841-849. <http://dx.doi.org/10.19045/bspab.2017.60088>

Received: 15/03/2017

Revised: 15/06/2017

Accepted: 02/07/2017

Online First: 06/07/2017

Abstract

This study was an effort to assess the soil physico-chemical properties of guava orchards in four Taluka of district Larkana during 2014-15. Composite soil samples were collected from three (4x4 each) blocks (16 tress) of each orchard at three soil depths (0-15, 15-30 and 30-45 cm). The soil samples were analyzed for some physical and chemical properties of the soil. Analytical results of this study described that soils of taluka Bakrani and Dokri orchards were classified as silty clay and Larkana and Ratodero orchards had silty clay loam texture. Electrical conductivity of soil samples of guava orchards in four taluka of district Larkana, showed that 100% of the soils of study area has an average value of ($<1 \text{ dsm}^{-1}$). For pH, however, all soil samples were found medium alkaline (pH 7.6-8.3). In Pakistan, guava is grown on an area of 64.0 hectares with a total production of 546.6 tons. Sindh contributes 9.8 hectares of area under guava with a total production of 75.4 tons (GOP, 2012). In case of organic matter, results of this study revealed that all soil samples were found poor (<0.86) in OM content except surface soil (0-15cm) of Bakrani guava orchards. All the guava orchard soils were put in the categorization of very marginal calcareous (5-10 %). Results regarding soluble Na^+ showed that average soluble Na^+ contents ranged between $0.30\text{-}0.45 \text{ meq L}^{-1}$ across the four taluka's of Larkana. Overall results showed that 100% soil samples were found marginal in soluble Na^+ . Soluble Ca^{2+} ranged between 5.37 to 8.74 meq L^{-1} . Ratodero guava orchard soils have more Ca^{2+} content than other taluka's followed by Larkana. Further study revealed that 100% of the samples were found marginal in Ca^{2+} content. Similarly, 100 % of the soil samples were marginal in Mg content. In this study K ranged between 302-403 with an average K of 351 meq L^{-1} across four taluka.

Keywords: Physico-chemical properties; Organic matter; Calcium carbonate; Potassium in soil

Introduction

Orchard soils under semiarid/arid subtropical regions have low organic carbon content and inherent low soil fertility status [1]. Poor soil fertility seems to be one of the

most important reasons for low fruit productivity [2]. Restoration of the soils are important if tree crops are planted from view point of orchard sustainability and productivity as millions of farmers are

engaged in fruit production, sustaining their livelihood and nutritional security [3]. The environmental condition of Pakistan is good for the cultivation of different varieties of vegetables and fruits. Fruits contribute for the production of drinks [4]. Among fruits guava has importance in Pakistan fruit industry and it is ranked as 4th place on the basis of area (62.5 thousand ha) and production (555 thousand tons) [5]. Sindh contributes 9.8 hectares of area under guava with a total production of 75.4 tons [6]. It has a high nutritional importance. It produces the fruit two times in a year i.e. Kharif (summer) and Rabi (winter) however the most excellent fruit is obtained in winter [7, 8] conducted experiment based on the nutrient requirement of guava trees. [9] determined guava leaves samples and observed NPK and Mg and Zn deficiency in the orchards. Guava is very good source of vitamin C when compared with citrus and apple [10]. Punjab province shares 77% of guava production in the Pakistan [11]. The taking away of nutrients from guava orchards happens because of the harvested fruit, as was stated earlier, and also by pruning the trees. In adult guava orchards, very much pruning is practiced, which may greatly cause in decrease aboveground biomass to 40 to 60%. The scraped material consists of about 24.5 kg of green material per plant (7.8 kg of leaves; 2 kg of boughs and 14.7 kg of branches, twigs and small fruits [12]. Locally, number of guava trees is found unhealthy and premature death is common problem. As a result very little knowledge is available about physico-chemical properties of the soil of guava orchard's [13]. Therefore soil should be analyzed for macro and micro nutrients for improving tree health, fruit yield and quality [14]. Soil fertility is decreasing on daily

basis because of intensive cropping to fulfill the needs of rapidly rising population [14]. Therefore, this study is proposed to explore orchards of district Larkana, Sindh for their physico-chemical properties.

Materials and methods

This study was conducted to investigate soil physico-chemical properties of guava orchards soil of district Larkana, Sindh. Soil sampling was done to collect samples. The collected soil samples were analyzed for particle size distribution by Hydrometer method, EC and pH were determined by digital EC and pH meter, calcium carbonate, and organic matter was determined by Walkley and Black method, soluble Na⁺, K⁺ were analyzed by ammonium acetate method, extractable Ca⁺ and Mg⁺ were analyzed by ammonium acetate and soluble Cl⁻ was determined by Mohar's titration.

Results and discussion

The result of particle size distribution analysis of guava orchard soils of all Taluka at different soil depths is presented in Figure 1. The data showed a sand percent of 8.8, 15.3, 7.29 and 14.1, silt percent of 42.8, 41.1, 36.6, and 36.9 and clay 48.4, 43.6, 56.11 and 49% in taluka Bakrani and Dokri, Larkana and Ratodero were classified respectively. The soils of Taluka Bakrani and Dokri orchards were classified as silty clay and Larkana and Ratodero orchards had silty clay loam in texture.

Electrical conductivity (dS m⁻¹)

Result for electrical conductivity (EC) of soil samples of guava orchards in four taluka of district Larkana, (Table 1) shows that there is little different in EC of soil at various depths. Higher EC at all depths across taluka values were observed at surface soil than subsurface. However, all soil samples were noted non-saline (<2 dsm⁻¹) as categorized by Jackson [15].

Figure 1. Particle size distribution (%) of four Talukas of guava orchards of district Larkana, Sindh

Table 1. Electrical conductivity (dS m^{-1}) in guava orchard soils of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean $\pm$ standard deviation	Categorization (sample %)		
					Non-saline (<2)	Slightly Saline (2-4)	Moderately Saline (4-8)
Bakrani	0-15	0.30-0.62	0.46	0.46 ± 0.23	100%	-	-
	15-30	0.22-0.50	0.36	0.36 ± 0.20	100%	-	-
	30-45	0.16-0.43	0.29	0.29 ± 0.19	100%	-	-
Dokri	0-15	0.44-0.89	0.66	0.66 ± 0.32	100%	-	-
	15-30	0.31-0.6	0.45	0.45 ± 0.20	100%	-	-
	30-45	0.2-0.53	0.36	0.36 ± 0.22	100%	-	-
Larkana	0-15	0.3-0.6	0.45	0.45 ± 0.21	100%	-	-
	15-30	0.2-0.53	0.36	0.36 ± 0.23	100%	-	-
	30-45	0.18-0.52	0.35	0.35 ± 0.24	100%	-	-
Ratoder	0-15	0.24-0.72	0.48	0.48 ± 0.34	100%	-	-
	15-30	0.21-0.56	0.38	0.38 ± 0.25	100%	-	-
	30-45	0.25-0.57	0.41	0.41 ± 0.23	100%	-	-

pH

Results regarding pH is presented in Table 2. The average soil pH of all taluka was recorded as (8.21), whereas minimum pH value was found (7.78) and maximum pH of (8.88). As compared to other larkana

taluka orchards soil has more average pH (8.74). Whereas, Bakrani (7.92) and Ratodero (7.96) has lowest pH among all four studied talukas.

Table 2. pH in guava orchard soils of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean $\pm$ standard deviation	Categorization (sample %)		
					Slightly Alkaline (7.1-7.5)	Medium Alkaline (7.6-8.3)	Strongly Alkaline (8.4-9.0)
Bkrani	0-15	7.6-7.9	7.75	7.75 $\pm$ 0.21	-	100%	-
	15-30	7.8-8	7.9	7.9 $\pm$ 0.07	-	100%	-
	30-45	8.0-8.1	8.05	8.05 $\pm$ 0.07	-	100%	-
Dokri	0-15	7.6-8.74	8.17	8.17 $\pm$ 0.81	-	80%	20%
	15-30	7.8-8.8	8.3	8.3 $\pm$ 0.71	-	80%	20%
	30-45	7.9-8.9	8.4	8.4 $\pm$ 0.71	-	70%	30%
Larkana	0-15	8.2-9.0	8.6	8.6 $\pm$ 0.56	-	10%	90%
	15-30	8.5-8.9	8.7	8.7 $\pm$ 0.21	-	-	100%
	30-45	8.6-9.0	8.8	8.8 $\pm$ 0.21	-	-	100%
Ratodero	0-15	7.6-8	7.8	7.8 $\pm$ 0.21	-	100%	-
	15-30	7.8-8.1	7.95	7.95 $\pm$ 0.21	-	100%	-
	30-45	7.9-8.3	8.1	8.1 $\pm$ 0.28	-	100%	-

Organic matter (%)

The organic matter (OM) content of soil samples of guava orchards in all taluka of district Larkana. (Table 3) showed that there is slightly variation in organic matter content of soil at different soil depths. The Highest organic matter content was found at surface as compared to subsurface soil. All soil samples were found poor (<0.86) in O.M content as categorized by Walkley and Black [16] except surface soil (0-15cm) of Bakrani guava orchards. The lowest OM content was observed in Larkana guava orchard soils which ranged between 0.22

and 0.56 %, 0.38 and 0.70 and 0.59 and 0.84% with average contents of 0.40, 0.51 and 0.69 at 0-15, 15-30 and 30-45 cm soil depth, respectively. [17] evaluated the effect of farm yard manure and inorganic fertilizers applied alone or in combination on the productivity of winter crop of guava. The result is in the line with the result of [18], they studied that by applying organic matter can improve productivity of guava orchard. [14] reported that 95% of the orchards guava orchards in Kohat district of Pakistan were adequate in organic matter in the surface and 48% in the subsurface.

Table 3. Organic matter (%) content in guava orchard soils of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean $\pm$ standard deviation	Categorization (sample %)		
					Poor (<0.86)	Medium (0.86-1.29)	High (>1.29)
Bakrani	0-15	0.85-1.59	1.2	1.2 $\pm$ 0.52	10%	70%	20%
	15-30	0.62-0.98	0.8	0.8 $\pm$ 0.25	70%	30%	-
	30-45	0.28-0.45	0.36	0.36 $\pm$ 0.12	100%	-	-
Dokri	0-15	0.68-1.13	0.90	0.90 $\pm$ 0.32	80%	20%	-
	15-30	0.49-0.65	0.57	0.57 $\pm$ 0.11	100%	-	-
	30-45	0.25-0.50	0.37	0.37 $\pm$ 0.10	100%	-	-
Larkana	0-15	0.54-0.84	0.69	0.69 $\pm$ 0.21	100%	-	-
	15-30	0.38-0.70	0.54	0.54 $\pm$ 0.23	100%	-	-
	30-45	0.22-0.56	0.39	0.39 $\pm$ 0.19	100%	-	-
Ratodero	0-15	0.49-1.18	0.83	0.83 $\pm$ 0.49	80%	20%	-
	15-30	0.32-0.82	0.57	0.57 $\pm$ 0.35	100%	-	-
	30-45	0.21-0.79	0.5	0.5 $\pm$ 0.41	100%	-	-

Calcium carbonate(%)

The CaCO₃ content of this study was categorized according to the categorization for calcareous soils as given by Jackson [15]. All the guava orchard soils were categorized as very marginal calcareous (5-10 %). Table 4 showed that there is slightly variation in CaCO₃ of soil at various depths. The values of CaCO₃of Ratodero soils were observed high at surface soils than subsurface. The lowest content was

observed in Bakrani with the values ranging between 4.2 and 5.32 %, 4.23 and 5.43 and 4.45 and 5.75 % with average of 4.64 and 5.01% at various soil depths respectively. For taluka Dokri and larkana, the CaCO₃ contents were between 5.15 and 5.45 %, 5. 25 and 5.65 % and 5.46 and 5.85 %. The averages contents values of 5.32, 5.66 and 6.1 % respectively at three various soil depths. Similar results were reported by Mehvish *et al.* [14].

Table 4. Calcium carbonate (%) content in guava orchard soils of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean $\pm$ standard deviation	Categorization (sample %)		
					Low (<5)	Marginal (5-10)	Adequate (>15)
Bakrani	0-15	4.45-5.75	5.1	5.1 $\pm$ 0.02	80%	20%	-
	15-30	4.23-5.43	4.83	4.83 $\pm$ 0.02	80%	20%	-
	30-45	4.2-5.32	4.76	4.76 $\pm$ 0.03	80%	20%	-
Dokri	0-15	5.46-5.85	5.65	5.65 $\pm$ 0.02	-	100%	-
	15-30	5.25-5.65	5.45	5.45 $\pm$ 0.02	-	100%	-
	30-45	5.15-5.45	5.35	5.35 $\pm$ 0.01	-	100%	-
Larkana	0-15	5.46-5.67	5.56	5.56 $\pm$ 0.01	-	100%	-
	15-30	5.43-5.50	5.46	5.46 $\pm$ 0.01	-	100%	-
	30-45	5.35-5.45	5.4	5.4 $\pm$ 0.01	-	100%	-
Ratodero	0-15	7.28-7.85	7.56	7.56 $\pm$ 0.01	-	100%	-
	15-30	7.05-7.52	7.28	7.28 $\pm$ 0.01	-	100%	-
	30-45	7.01-7.35	7.18	7.18 $\pm$ 0.01	-	100%	-

Soluble Na⁺ (meqL⁻¹) in Soil

Results regarding soluble Na⁺ (Table 5) showed that a slightly variation was found at different soil depths in all selected Talukas of district Larkana. Average soluble Na⁺ contents ranged between 0.30-0.45 meqL⁻¹ across the four taluka's of Larkana. The orchard of Taluka Dokri contained more Na⁺ than other Taluka orchard soils. Overall results showed that 100% soil samples were found marginal in soluble Na⁺.

Soluble calcium (meqL⁻¹)

The result of soluble Ca has been given in Table 6. It indicates that soluble Ca of four taluka's of district Larkana ranged between 5.37 to 8.74 meq L⁻¹. Guava orchard soils of Ratodero have more Ca content as compared to other taluka's followed by Larkana. Categorization of soil samples for soluble Ca indicates that 100% Ca content of the samples were found marginal.

Table 5. Soluble Na⁺ (meqL⁻¹) in guava orchard soils of four taluka's of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean ± standard deviation	Categorization (sample %)		
					Low (<0.1)	Marginal (0.3-0.7)	Adequate (>2)
Bakrani	0-15	0.32-0.39	0.35	0.35±0.02	-	100%	-
	15-30	0.31-0.38	0.34	0.34±0.02	-	100%	-
	30-45	0.23-0.35	0.29	0.29±0.03	-	100%	-
Dokri	0-15	0.42-0.49	0.45	0.45±0.02	-	100%	-
	15-30	0.41-0.47	0.44	0.44±0.02	-	100%	-
	30-45	0.41-0.45	0.43	0.43±0.01	-	100%	-
Larkana	0-15	0.24-0.49	0.36	0.36±0.01	-	100%	-
	15-30	0.23-0.47	0.35	0.35±0.01	-	100%	-
	30-45	0.21-0.45	0.33	0.33±0.01	-	100%	-
Ratodero	0-15	0.36-0.39	0.37	0.37±0.01	-	100%	-
	15-30	0.32-0.38	0.35	0.35±0.01	-	100%	-
	30-45	0.31-0.36	0.33	0.33±0.01	-	100%	-

Table 6. Soluble Ca²⁺ (meq L⁻¹) in guava orchard soils of four taluka's of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean ± standard deviation	Categorization (sample %)		
					Low (<1-2)	Marginal (2-10)	Adequate (>20)
Bakrani	0-15	5.5-5.9	5.7	5.7±0.1	-	100%	-
	15-30	5.2-5.8	5.5	5.5±0.1	-	100%	-
	30-45	5.1-5.8	5.45	5.45±0.2	-	100%	-
Dokri	0-15	6.56-6.95	6.75	6.75±0.11	-	100%	-
	15-30	6.45-6.75	6.6	6.6±0.11	-	100%	-
	30-45	6.22-6.56	6.42	6.42±0.12	-	100%	-
Larkana	0-15	7.56-7.98	7.77	7.77±0.09	-	100%	-
	15-30	7.54-7.86	7.77	7.77±0.01	-	100%	-
	30-45	7.22-7.55	7.38	7.38±0.01	-	100%	-
Ratodero	0-15	7.66-9.75	8.70	8.70±0.86	-	100%	-
	15-30	7.54-9.65	8.59	8.59±0.6	-	100%	-
	30-45	7.22-9.56	8.39	8.39±0.7	-	100%	-

Soluble magnesium (meq L⁻¹)

The result of soil Mg content (Table 7) in guava orchard of four taluka revealed that

100% soil samples were found marginal. No any single soil sample was found low or adequate in Mg content. Comparatively,

Bakrani orchard soils had higher Mg than other taluka's. Overall Mg content ranged

between 2.5 to 3.7 meq L⁻¹ in all guava orchards of the district.

Table 7. Soluble Mg (meq L⁻¹) in guava orchard soils of four taluka's of district Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean ± standard deviation	Categorization (sample %)		
					Low (<0.5)	marginal (1-3)	Adequate (>7)
Bakrani	0-15	3.56-3.99	3.77	3.77±0.15	-	100%	-
	15-30	3.35-3.77	3.56	3.56±0.15	-	100%	-
	30-45	3.25-3.66	3.45	3.45±0.13	-	100%	-
Dokri	0-15	2.29-2.98	2.63	2.63±0.2	-	100%	-
	15-30	2.26-2.85	2.55	2.55±0.1	-	100%	-
	30-45	2.22-2.55	2.38	2.38±0.3	-	100%	-
Larkana	0-15	2.29-3.67	2.98	2.98±0.1	-	100%	-
	15-30	2.26-3.58	2.92	2.92±0.1	-	100%	-
	30-45	2.2-3.57	2.88	2.88±0.1	-	100%	-
Ratodero	0-15	2.35-3.78	3.06	3.06±0.01	-	100%	-
	15-30	2.24-3.68	2.96	2.96±0.01	-	100%	-
	30-45	2.15-3.58	2.86	2.86±0.00	-	100%	-

Soluble K⁺ (meq L⁻¹) in Soil

Potassium content in soil of selected orchards is presented in Table 8. This table shows that K⁺ ranged between 302-403 with an average K⁺ of 351 meqL⁻¹ across four talukas. Maximum K⁺ as recorded in the soil of Larkana orchard followed by Bakrani. However, Ratodero had relatively lower values of K⁺. In general, result of K⁺

showed that 100% soils were found above adequate level. Similar results are reported by Mehvish *et al.* [14], who assessed fertility status of the soils of 44 guava orchards in Kohat District. They found that Available K was between 103 and 393 mg kg⁻¹, Potassium was marginal in 16% and high in 84%.

Table 8. Soluble K⁺ (meq L⁻¹) in guava orchard soils of four Talukas of district Larkana Sindh

Taluka	Soil depth (cm)	Range	Average	Mean ± standard deviation	Categorization (sample %)		
					Low (<60)	Marginal (60-120)	Adequate (>120)
Bakrani	0-15	260-500	380	380±169.7	-	-	100%
	15-30	300-532	416	416±156.9	-	-	100%
	30-45	180-470	325	325±205.1	-	-	100%
Dokri	0-15	180-560	370	370±268.7	-	-	100%
	15-30	260-510	385	385±176.8	-	-	100%
	30-45	180-520	350	350±240.4	-	-	100%
Larkana	0-15	250-560	405	405±212.1	-	-	100%
	15-30	260-510	385	385±134.3	-	-	100%
	30-45	180-470	325	325±162.6	-	-	100%
Ratodero	0-15	190-510	350	350±134.3	-	-	100%
	15-30	200-440	320	320±49.5	-	-	100%
	30-45	210-500	355	355±56.6	-	-	100%

Soluble Cl⁻(meq L⁻¹)

Results for soluble Cl⁻ (Table 9) describes that a slightly variation at various soils depth among all taluka larkana was recorded. An average soluble Cl⁻ content ranged between

0.1-0.3 meqL⁻¹. Ratodero taluka orchards have little more Cl⁻ than other taluka orchards soils. Overall results revealed that 100% soil samples were observed low in Cl⁻ content.

Table 9. Soluble Cl⁻ (meqL⁻¹) in guava orchard soils of four Talukas of District Larkana, Sindh

Taluka	Soil depth (cm)	Range	Average	Mean ± standard deviation	Categorization (sample %)		
					Low (<4)	Marginal (4-10)	Adequate (>10)
Bakrani	0-15	0.02-0.056	0.03	0.03±0.01	100%	-	-
	15-30	0.01-0.054	0.02	0.02±0.01	100%	-	-
	30-45	0.001-0.032	0.01	0.01±0.00	100%	-	-
Dokri	0-15	0.001-0.04	0.01	0.01±0.01	100%	-	-
	15-30	0.001-0.03	0.01	0.01±0.01	100%	-	-
	30-45	0.0001-0.03	0.01	0.01±0.01	100%	-	-
Larkana	0-15	0.001-0.054	0.01	0.01±0.01	100%	-	-
	15-30	0.015-0.042	0.01	0.01±0.01	100%	-	-
	30-45	0.001-0.032	0.001	0.001±0.01	100%	-	-
Ratodero	0-15	0.025-0.056	0.03	0.03±0.00	100%	-	-
	15-30	0.015-0.054	0.029	0.29±0.01	100%	-	-
	30-45	0.01-0.052	0.02	0.02±0.01	100%	-	-

Conclusions

It is concluded from above results that the soils of guava orchards of district Larkana are generally heavy in texture, non-saline, strongly alkaline and poor in organic matter, moderately to medium calcareous in nature. The soil was found marginal in soluble Na, Ca, Mg. The available potassium was quite adequate. Therefore, the application of organic matter and the macro nutrients fertilizers are suggested to maintain soil fertility as well as yield of the guava in the guava orchards.

Authors' contributions

Conceived and designed the experiments: AW Gandahi & M Memon, Performed the Experiments: M Mukhtar, A Ali & S Hussain, Analyzed the Data: M Mukhtar & M Kumar & M Kumar, Wrote the paper: A Ali & M Kumar.

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