Physico-chemical characteristics and nutrient status of guava (*Psidium guajava* L.) orchards in North-Western India

ABSTRACT

One hundred eight soil samples were collected from 12 guava orchards existing at different locations as well as 108 soil samples from non-orchard soils adjoining in the vicinity of selected orchards spread over five blocks of district Rewari namely Bawal, Rewari, Jatusana, Khol and Nahar. Guava orchards having at least a 3-acre area were selected for the nutritional survey and soil sampling from each acre from 3 depths (0-15, 15-30, 30-60 cm) on these randomly selected sites was done in August 2019. The samples were collected and analyzed for physico-chemical properties and available nutrients viz., nitrogen, phosphorus and potassium. The composite leaf sample of guava plants was also collected from each orchard. Rewari district soils (orchard and non-orchard) were sandy loam to loamy sand in nature. The calcium carbonate content in soils showed an increasing trend with depth and it increased significantly with an increase in sand and pH. Soils were alkaline with low organic carbon and nearly one-third of samples were saline. Available nitrogen was low, available phosphorus was low to medium while available potassium was medium to high in soil samples. Despite the high content of available potassium in soils, the plant leaves were found deficient in potassium. Therefore, the use of balanced fertilizers is required for sustainable and enhanced productivity of the guava orchards.

Keywords: nutrients, guava, soil samples, leaf samples

INTRODUCTION

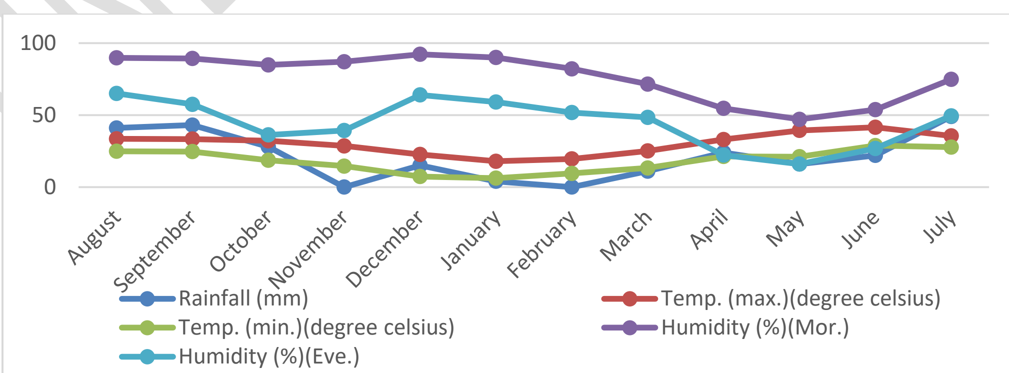
Guava *(Psidium guajava* L.) is an important fruit of tropical & subtropical areas which can be successfully grown with good profits and can be very handy in "Doubling the farmer's income". It belongs to the family Myrtaceae and is considered a hardy tree that is capable of growing under varied agro-climatic conditions without much care. Portuguese introduced guava in India and subsequently, it became a commercial fruit crop of this country. India is the largest producer of fruits in the world with 18.8 million tonnes annual production against the world's 46.5 million tonnes and accounts for which is 40.4 % of the total global share (Anonymous, 2018). The productivity of Indian orchards is 12.36 metric tonne ha^{-1} whereas, the world is 16.37 metric tonne ha^{-1} and hence considerably lower (Anonymous, 2018). In India, guava is cultivated throughout the country, but the leading states are Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra, Punjab, Haryana and Bihar. Haryana has a 12090 ha area and 137020 MT production of guava (Anonymous, 2018a). Major guava growing areas are Sirsa, Fatehabad, Hisar, Jind, Jhajjar, Mahendergarh, Rewari, Sonipat, Karnal, Yamuna Nagar, Ambala and

UNDER PEER REVIEW

Mewat. The popular cultivars of guava grown by farmers are Hisar Safeda, Hisar Surkha, Allahabad Safeda and L-49. Guava fruits are an important source of vitamins and minerals in the human diet. Several marvelous industrial products like jam, jelly, sharbat, canned fruit (Dhillon, 2013) and non - alcoholic beverages can be prepared from guava fruits (Bhatnagar and Sharma, 2018). Guava can be grown on varied soils ranging from clay to sandy and with acidic (4.5) to alkaline (8.5) pH and hence it occupies a significant place in the horticultural wealth of our nation (Sharma and Kumawat, 2019). In Haryana, there is a prevalent practice of leasing the guava orchards, who don't have ample knowledge of orchards management and as a result, constant mining of soil takes place ultimately leading to soil exhaustion. Besides this, at some places even though the soil may be rich in total nutrients but their availability is limited due to unfavorable soil conditions. Use of leaf analysis to indicate the availability of nutrients in fruit crops has long been accepted. Du Plessis *et al.* (1973) evaluated the nutrient status of guava trees in South Africa and suggested tentative levels of macronutrients in leaves. However, very scanty information is available on the nutritional status of guava crop in semi-arid regions of Haryana which could be worth making a thoughtful fertilizer schedule for profitable & enhanced production and longer orchard life. Due to paltry information on the available nutrient status of guava orchards in Haryana, it is therefore, needed to assess the soil and leaf nutrient status of soils and study their relationship with other soil attributes. Thus, the study was undertaken to investigate the physio-chemical properties and nutrient status of guava orchards of Rewari district in order to correct their deficiencies.

MATERIALS AND METHODS

Twelve guava orchards were selected for survey work from five blocks of Rewari district which lies between 27.95 ^{o} N to 28.47 ^{o} N latitude and 76.28 ^{o} E to 76.85 ^{o} E longitude in south-west Haryana. Rewari is a part of the Indo Gangetic alluvial plain of Yamuna sub-basin having alluvial and sandy soils with interspersed strike ridges covered by windblown sand. Nearly 80-85 % of annual rainfall is received in the monsoon season extending from July to September. Mean annual rainfall in Rewari district is 569.6 mm and the climate is semi-arid which is characterized by hot and dry summer and cold winter. The average minimum and maximum temperature vary from 6 to 41° C during winter (January) and summer (May-June), respectively.



UNDER PEER REVIEW

Fig 1. Metrological data of Rewari district

Guava cultivation is adapted in southern parts of Haryana having light-textured sandy loam to loamy sand soils with poor fertility and high pH. To characterize the nutrient status of 12 guava orchards in Rewari district, orchards having at least a 3-acre area were selected. The soil sample from all representative depths (0-15, 15-30, 30-60 cm) was taken from each acre. If the area of the orchard was more than 3 acres, then randomly 3 sites were selected for sampling. The soil sample from all representative depths was taken from a nearby non-orchard area also. A composite sample of leaves was taken from every orchard during August 2019 and their locations were recorded in the form of latitudes and longitudes by using handheld GPS. Samples were collected in thoroughly cleaned plastic bags which were properly and carefully labeled, then brought to the laboratory for chemical analysis.

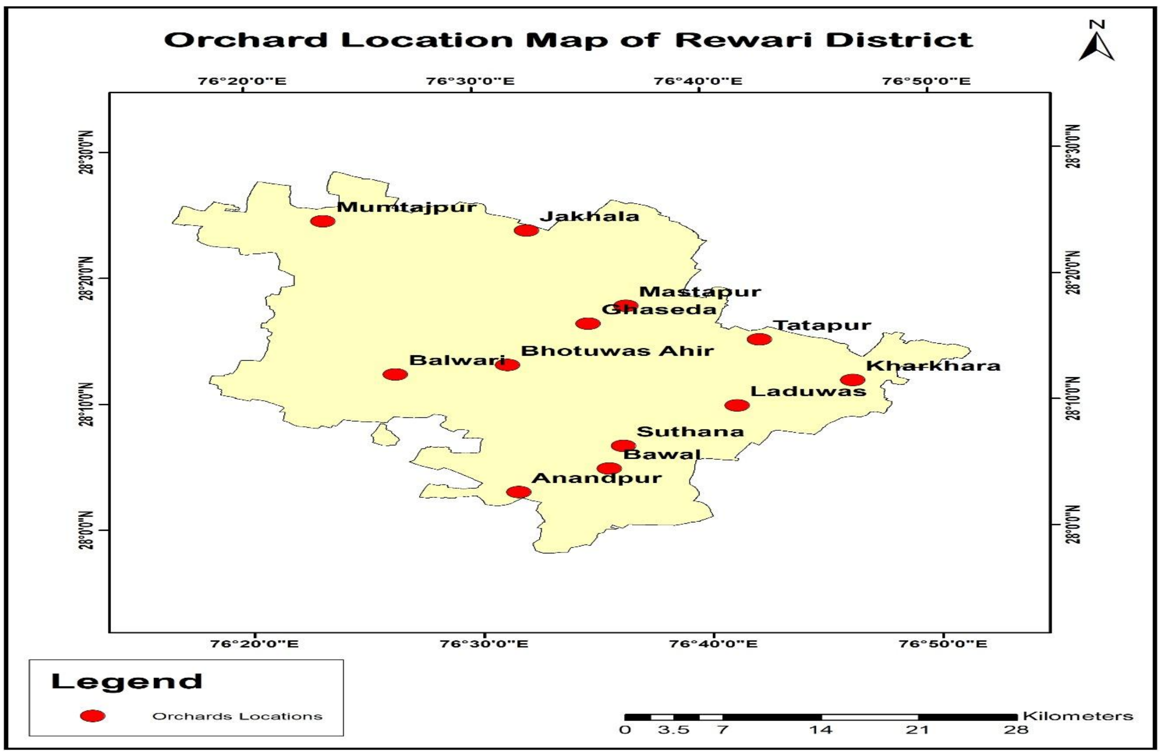


Fig. 2. Location Map of Rewari district

Mechanical analysis of soil samples was done by the international pipette method (Piper, 1950). The soil pH (1:2 soil:water suspension) and the electrical conductivity of the supernatant liquid were estimated as per the method detailed by Richards (1954), organic carbon (Walkley and Black (1934). The soil samples were analyzed in the laboratory for nitrogen, phosphorus and potassium. Available nitrogen was calculated by the alkaline potassium permanganate method as per the procedure outlined by Asija *et al.* (1956). Available phosphorus was estimated by standard procedures given by Olsen (1954) and available potassium by neutral normal ammonium acetate using the procedure of Hanway and Heidal (1952). In leaves, nutrients (N, P and K) were analyzed taking 0.5 g of dried plant sample digested with 10 ml of diacid mixture (1 perchloric + 4 nitric acid) on a hot plate till the residual solution became colorless. The final digestate volume was made 50 ml. Analysis of guava leaf samples for nitrogen, phosphorus and potassium was done as per procedure suggested by Lindner (1944), Koenig and Johnson (1942) and Bhargava and Raghupati (1993), respectively. The nutrient index was calculated by using the method as used by Baloda *et al.* (2014).

$$\textbf{Nutrient Index} = \frac{\textbf{No. of samples in low X 1 + No. of samples in medium X 2+ No. of samples in high X 3}}{\textbf{Total no. of samples}}$$

Data analysis: The data was statistically analyzed using EXCEL, OPSTAT statistical software developed by the Department of Statistics, CCSHAU, Hisar (Sheoran *et al.*, 1998) at the probability ($p = 0.05$) to drive ANOVA. However, the correlation was computed using SPSS software.

RESULTS AND DISCUSSION

Data pertaining to soil texture (Table 1) showed that the sand content in orchard soils varied from 76.3 to 82.9 percent. The minimum and maximum sand content were in S_9 and S_6 soils, respectively. The minimum (8.2 %) and maximum (12.4 %) silt content were found in soils of orchards S_6 and S_9, respectively. Clay content in these soils varied between 8.7 and 12.0 percent. Moreover, data indicated that minimum and maximum sand, silt and clay content in non-orchard soil samples varied from 76.1 to 82.5 %, 8.6 to 12.5 % and 8.6 to 11.8 % in S_9 and S_6 soils, S_4 and S_9 soils, S_{11} and S_8 soils, respectively. The texture ranged from sandy loam to loamy sand. Sand had highly significant and inverse relationships with silt ($r = -0.889^{**}$) and clay ($r = -0.911^{**}$) while clay has been found significantly and positively correlated with silt ($r = 0.620^{*}$) (Table 4). In general, soils of the study area (Rewari) are sandy in nature, which manifests low moisture, poor structural development and low nutrient retention capacity while high infiltration rates and susceptibility to wind erosion (Bangroo *et al.*, 2018).

Table 1: Variation in soil texture with depth of sampling in the orchard and non-orchard soils of Rewari

Sample No.	Orchard				Non orchard				Name of village and block
	Sand (%)	Silt (%)	Clay (%)	Textural class	Sand (%)	Silt (%)	Clay (%)	Textural class	
S_1	78.5	10.1	11.4	Sandy loam	78.6	10.2	11.2	Sandy loam	Anandpur, Bawal
S_2	81.2	9.9	8.9	Loamy Sand	81.4	9.9	8.7	Loamy sand	Suthana, Bawal
S_3	78.9	9.8	11.3	Sandy loam	79.1	9.5	11.4	Sandy loam	College of Agriculture, Bawal
S_4	81.1	8.9	10	Sandy loam	81.3	8.6	10.1	Sandy loam	Kharkhara,

UNDER PEER REVIEW

									Rewari
S_5	81.5	9.3	9.2	Sandy loam	81.6	9.1	9.3	Sandy loam	Tatapur, Rewari
S_6	82.9	8.2	8.9	Loamy sand	82.5	8.7	8.8	Loamy sand	Laduwas, Rewari
S_7	77.2	10.8	12	Sandy loam	77.4	10.9	11.7	Sandy loam	Mastapur, Jatusana
S_8	76.3	12	11.7	Sandy loam	76.4	11.8	11.8	Sandy loam	Ghaseda, Jatusana
S_9	76.3	12.4	11.3	Sandy loam	76.1	12.5	11.4	Sandy loam	Jakhala, Nahar
S_{10}	77.1	11.3	11.6	Sandy loam	77.5	10.8	11.7	Sandy loam	Mumtajpur, Nahar
S_{11}	81.1	10.2	8.7	Loamy sand	81.4	10	8.6	Loamy sand	Bhotuwas Ahir, Khol
S_{12}	80.8	10.4	8.8	Loamy sand	80.7	10.5	8.8	Loamy sand	Balwari, Khol
Mean	79.40	10.27	10.31		79.5	10.20	10.29		
Range	76.3-82.9	8.2-12.4	8.7-12.0		76.1-82.5	8.6-12.5	8.6-11.8		

The data (Table 2) indicated that $CaCO_3$ content of guava orchard soils at 0-15 cm depth varied from traces to 1.30 percent, while in the case of non-orchard soils, it ranged from traces to 1.20 percent. Similarly, the $CaCO_3$ content in both (orchard and non-orchard) soils at 15-30 cm depth ranged between traces (S_1, S_4, S_7, S_8, S_{10}) - 2.80 percent (S_2) and traces (S_1, S_4, S_7, S_8, S_{10}) - 3.10 percent (S_2) with a mean value of 0.72 and 0.80 percent, respectively. The $CaCO_3$ content at 30-60 cm depth in the orchard and non-orchard soils varied from traces - 3.20 percent and traces - 3.50 percent with a mean value of 0.73 and 0.71 percent, correspondingly. $CaCO_3$ showed an increasing trend with depth. An increase in the $CaCO_3$ content with depth indicated leaching of calcium from surface soil to sub-surface soils and accumulated in form of calcium carbonate. Comparative high calcium carbonate content of soil might be attributed due to the dominance of the alkaline earth carbonates which are not only high in the soils (Jitendra and Raj, 2012) but also in the water used for irrigation purposes in arid and semi-arid regions (Mediratta *et al.*, 1985). Calcium carbonate had significant and positive correlation with sand ($r = 0.723^{**}$) and pH ($r = 0.588^{*}$). On the other hand, it had significant and negative correlation with silt ($r = -0.610^{*}$), clay ($r = -0.689^{*}$), organic carbon ($r = -0.578^{*}$), available nitrogen ($r = -0.682^{*}$), available phosphorus ($r = -0.673^{*}$) and available potassium ($r = -0.687^{*}$) (Table 4). It is obvious from the data (Table 2) that the minimum organic carbon content in orchard soils (0.21 percent) at depth 0-15 cm, was recorded under S_5, while the maximum (0.49 percent) was under S_7 with a mean value of 0.36 percent. On the other hand, the organic carbon at depth 15-30 cm varied from 0.16 to 0.45 percent. The organic carbon content in soils of the lowest depth (30-60 cm) varied from 0.13 to 0.38 percent. In the case of non-orchard soils, organic carbon values at 0-15, 15-30 and 30-60 cm depth, ranged from 0.21-0.49, 0.17-0.42 and 0.14-0.35 percent, respectively. Organic carbon progressively decreased with increasing depth irrespective of orchard and non-orchard soil. The organic carbon in non-orchard soils was low compared to orchard soils. As per the rating given by Muhr (1963), the soils having < 0.5 % OC have been categorized in low

UNDER PEER REVIEW

organic carbon. All the soil samples of the present study were categorized in the low organic carbon category. The extremely low organic carbon content of these soils could be attributed to the occasional addition of organic matters, lack of natural vegetation and enhanced oxidation of organic matter content due to high temperature (Baloda *et al.*, 2014).

Table 2: Variation in $CaCO_3$ (%) and OC (%) of orchard and non-orchard soils at different locations

Sample No.	Depths (cm)											
	0-15				15-30				30-60			
	$CaCO_3$		OC		$CaCO_3$		OC		$CaCO_3$		OC	
	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard
S1	Tr	Tr	0.41	0.39	Tr	Tr	0.35	0.34	Tr	Tr	0.30	0.29
S2	1.30	1.20	0.31	0.28	2.80	3.10	0.28	0.26	3.20	3.50	0.25	0.24
S3	0.22	0.24	0.42	0.39	0.66	0.70	0.40	0.37	1.18	1.22	0.36	0.32
S4	Tr	Tr	0.28	0.25	Tr	Tr	0.24	0.22	Tr	Tr	0.19	0.18
S5	0.95	0.78	0.21	0.26	1.76	1.77	0.16	0.23	0.98	0.90	0.13	0.16
S6	0.80	0.70	0.22	0.21	1.00	1.10	0.19	0.17	1.80	1.10	0.16	0.14
S7	Tr	Tr	0.49	0.49	Tr	Tr	0.45	0.42	Tr	Tr	0.36	0.33
S8	Tr	Tr	0.45	0.41	Tr	Tr	0.40	0.38	Tr	Tr	0.38	0.35
S9	0.30	0.29	0.44	0.44	0.74	0.74	0.39	0.35	0.38	0.38	0.31	0.29
S10	Tr	Tr	0.42	0.39	Tr	Tr	0.38	0.36	Tr	Tr	0.36	0.33
S11	0.84	0.68	0.33	0.31	1.21	1.27	0.28	0.25	0.70	0.83	0.25	0.24
S12	0.40	0.37	0.39	0.38	0.51	0.95	0.35	0.33	0.53	0.60	0.31	0.29
Mean	0.40	0.36	0.36	0.35	0.72	0.80	0.32	0.30	0.73	0.71	0.28	0.26
Range	Tr -1.30	Tr -1.20	0.21-0.49	0.21-0.49	Tr -2.80	Tr -3.10	0.16-0.45	0.17-0.42	Tr -3.20	Tr -3.50	0.13-0.38	0.14-0.35

A review of data given in fig 3 indicated that the minimum (6.78 and 6.80) and maximum (8.12 and 8.12) pH were reported at 0-15 cm depth in the orchard and non-orchard samples of Mastapur (S_7) and Bhotuwas Ahir (S_{11}), respectively. On the other hand, minimum and maximum pH values of orchard and non-orchard soils at 15-30 cm depth varied statistically from 7.37 to 7.97 and 7.39 to 7.96, respectively. The pH in soils of 30-60 cm depth varied statistically from 7.49 to 8.06 and 7.56 to 8.11 in the orchard and non-orchard soils, respectively. The pH of different depths of sampling under orchards and non-orchard soils showed an irregular trend with increasing depth. The pH of soils increased significantly with increase in sand ($r = 0.913^{**}$) and $CaCO_3$ ($r = 0.588^{*}$) while, it decreased significantly with increase in silt ($r = -0.693^{*}$), clay ($r = -0.939^{**}$), organic carbon ($r = -0.757^{**}$), available nitrogen ($r = -0.701^{*}$), available phosphorus ($r = -0.667^{*}$) and available potassium ($r = -0.671^{*}$) (Table 4). It is evident from the data (fig 4) that the electrical conductivity of orchard soils varied statistically from 2.31 to 4.16 dS m^{-1} while in non-orchard soils it ranged statistically from 2.28-4.11 dS m^{-1}. Electrical conductivity was found to decrease with increasing soil depth. A critical examination of the data showed that soils samples

UNDER PEER REVIEW

range from normal to saline in nature. The value of electrical conductivity indicates that the accumulations of the salts in these soils might be due to the light texture of soils, poor rainfall and application of poor quality water. The results of the investigation are in close proximity with the findings of Jitendra and Raj (2012) and Salehin *et al.* (2020). Moreover, the EC of soils has a non-significant relationship with sand, silt, clay, $CaCO_3$ and OC content of soils (Table 4).

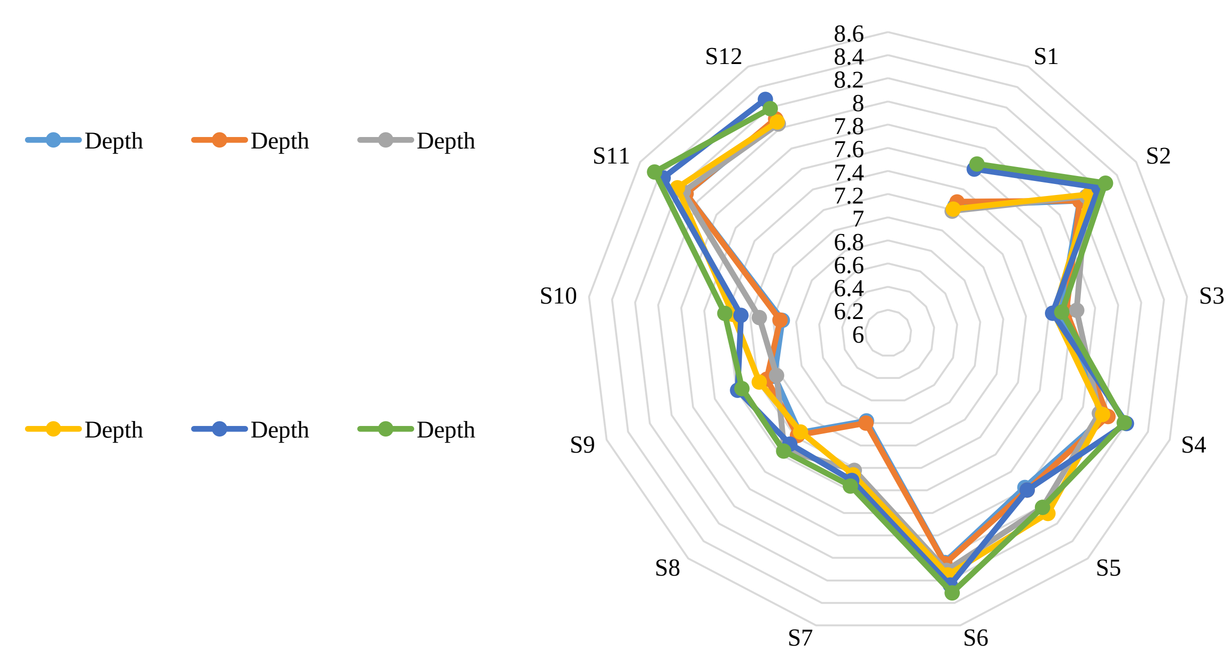


Fig. 3. pH of orchard and non orchard soils of Rewari

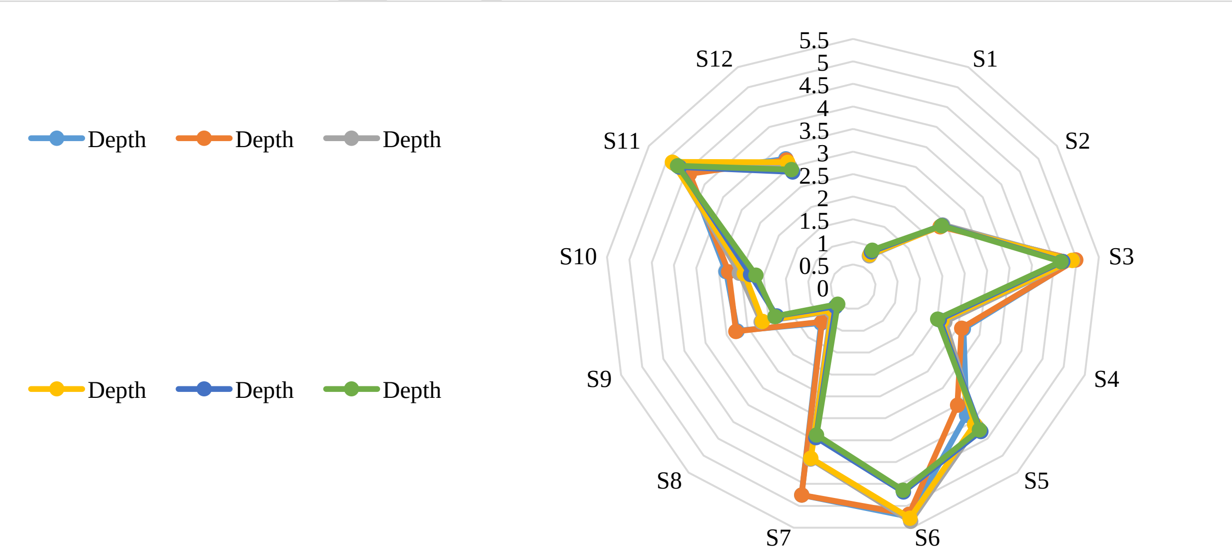


Fig. 4. EC_e of orchard and non orchard soils of Rewari as influenced by depth of sampling

Nitrogen is an essential macronutrient for the plant. It influences vegetative growth directly. Data (Table 3) elucidate that the available nitrogen content of surface soil (0-15 cm) of orchard and non-orchard were found to vary statistically between 124.32 to 149.18 kg ha^{-1} and 122.95 to 147.74 kg ha^{-1} with a mean value of 136.75 and 135.35 kg ha^{-1}, respectively. Nutrient index of surface soils (0-15 cm) was found 1. The data relating to the available nitrogen content of soil depths (15-30 cm and 30-60 cm) revealed that available nitrogen content of orchard soils ranged statistically from 121.11 to 145.51 kg ha^{-1} and 108.85 to 127.80 kg ha^{-1} with an average value of 133.31 and 118.32 Kg ha^{-1} whereas in case of non-orchard soils at the same depth it varied from 119.73 to 144.27 kg ha^{-1} and 109.23 to 129.86 kg ha^{-1} with an average of 132.00 and 119.55 kg ha^{-1}, respectively. All the samples were drawn from the surface and sub-surface soil depth of orchards and non-orchards were found low (100 %) in available nitrogen content in the present investigation. The reasons for low available nitrogen in soils under study might be due to less natural vegetation, low amount of organic carbon (Jat *et., al* 2012) and sandy texture (Ganai A. Q., 2018). Available nitrogen had significant positive correlations with silt (r = 0.605*), clay (r = 0.677*), organic carbon (r = 0.681*) and phosphorus (r = 0.593*) whereas it was found to be significantly and negatively correlated with sand (r = -0.714**), calcium carbonate (r = -682*) and pH (r = -701*) (Table 4). Phosphorus is essential for energy and boosts drought resistance. Available phosphorus content in orchard and non orchard soils (0-15, 15-30 and 30-60 cm) varied statistically from 13.46-19.34, 12.14-16.75, 10.14-13.19 kg ha^{-1} and 12.87-17.59, 11.57-15.81, 10.08-12.98 kg ha^{-1}, respectively. The available phosphorus was observed to decrease with depth in most of the soils. The reason might be low mobility (Gathala, 2004; Ganai *et al.*, 2020). Both, orchard and non-orchard soil samples were low to medium in available phosphorus. The correlation coefficient were determined between the available phosphorus and other nutrients for orchards soils and it was concluded that available phosphorus had significant positive correlations with silt (r = 0.665*), clay (r = 0.652*), organic carbon (r = 615*) and nitrogen (r = 0.593*) whereas it had significant negative correlation with sand (r = -0.731**), calcium carbonate (r = -0.673*) and pH (r = -0.667*). While it had a non-significant relationship with EC and potassium. Potassium provides disease resistance to crops. Data (Table 3) revealed that the minimum and maximum available potassium content of orchard soils at 0-15, 15-30, 30-60 cm depths was 216.78 and 454.16, 200.65 and 450.05, 194.52 and 344.03 kg ha^{-1} with a mean of 381.09, 353.98 and 249.15 kg ha^{-1} while in case of non-orchard soils at the same depths lowest and highest value of available potassium was 206.39 and 455.83, 202.83 and 451.09, 191.07 and 348.15 kg ha^{-1} with an average of 372.02, 354.92 and 248.21 kg ha^{-1}, respectively. The minimum and maximum value of available potassium at all depths (0-15, 15-30 and 30-60 cm) were recorded in Laduwas (S_6) and Mumtajpur (S_{10}) in orchard soils whereas in non-orchard soils these values lied in Laduwas (S_6) and Jakhala (S_9), respectively. A critical analysis of data revealed that most of the surface (0-15 cm) soil samples were high in available potassium with a nutrient index value of 2.91. This might be due to the presence of potash-bearing minerals (Muscovites, biotite and feldspar), which weather slowly and keep on releasing potash. Available potassium content of orchards soils had significant positive correlations with silt (r = 0.767**), clay (r = 0.718**) and organic carbon (r = 0.641*) while it had

UNDER PEER REVIEW

significant and negative correlation with sand (r = -0.823**), calcium carbonate (r = -0.687**) and pH (r = -0.671*) potassium contents found to have non-significant relationship with nitrogen and phosphorus (Table 4). Similar results were observed by Ganai *et al.* (2020).

UNDER PEER REVIEW

Table 3: Available primary macronutrients status in the orchard and non-orchard soils of Rewari

Sample No.	Depths (cm)																	
	0-15						15-30						30-60					
	N (kg/ha)		P_2O_5 (kg/ha)		K_2O (Kg/ha)		N (kg/ha)		P_2O_5 (kg/ha)		K_2O (Kg/ha)		N (kg/ha)		P_2O_5 (kg/ha)		K_2O (Kg/ha)	
	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non Orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard	Orchard	Non orchard
S1	144.45	143.51	21.88	20.15	424.01	413.45	140.53	139.44	19.15	18.53	380.78	379.16	116.13	115.51	14.44	14.62	303.82	300.34
S2	115.24	114.73	10.71	10.03	295.11	298.52	113.32	113.17	9.58	9.17	281.09	281.58	101.84	102.87	8.37	8.33	227.01	219.85
S3	130.16	128.22	19.99	20.22	395.42	399.33	125.85	124.83	18.97	18.79	376.67	382.62	111.91	112.51	14.89	14.87	292.52	289.47
S4	152.23	150.78	13.43	13.71	294.41	296.82	150.11	147.93	12.66	13.13	282.06	283.06	126.34	123.68	11.41	11.64	241.68	245.89
S5	106.52	104.96	16.29	16.52	387.33	381.88	105.14	102.18	14.92	14.01	344.54	343.45	101.06	100.33	10.25	10.76	297.91	288.12
S6	119.94	118.17	9.95	9.87	216.78	206.39	116.69	114.62	9.14	9.01	200.65	202.83	103.82	101.46	8.01	7.97	194.52	191.07
S7	153.57	151.63	18.32	16.16	452.03	431.41	148.63	148.13	15.66	13.59	429.11	429.01	136.89	135.24	11.51	11.22	212.02	214.73
S8	148.99	146.24	18.21	17.93	443.25	341.94	146.84	144.97	17.02	16.64	367.72	356.36	123.72	141.73	13.24	13.53	204.73	202.59
S9	163.41	162.35	24.16	16.55	395.66	399.57	159.15	158.22	18.51	15.67	392.54	394.26	144.34	142.14	14.78	13.37	216.67	218.94
S10	152.93	151.91	14.61	13.82	454.16	455.83	146.41	145.35	12.84	11.71	450.05	451.09	133.58	131.85	10.49	10.04	344.03	348.15
S11	109.42	108.25	10.59	10.24	416.33	427.86	104.24	103.57	10.03	9.96	381.72	383.48	101.86	100.02	9.72	9.81	249.19	251.88
S12	144.17	143.48	18.74	17.63	398.68	411.31	142.87	141.66	14.94	14.12	360.93	372.18	118.45	127.27	12.97	12.26	205.74	207.51
Mean	136.75	135.35	16.40	15.23	381.09	372.02	133.31	132.00	14.45	13.69	353.98	354.92	118.32	119.55	11.67	11.53	249.15	248.21
CI (95%)	124.32-149.18	122.95-147.74	13.46-19.34	12.87-17.59	334.17-428.01	325.91-418.13	121.11-145.51	119.73-144.27	12.14-16.75	11.57-15.81	310.01-397.96	311.00-398.84	108.85-127.80	109.23-129.86	10.14-13.19	10.08-12.98	218.22-280.08	217.43-278.98
CV (%)	14.30	14.41	28.20	24.35	19.37	19.50	14.39	14.62	25.10	24.40	19.55	19.47	12.59	13.57	20.58	19.81	19.53	19.51

UNDER PEER REVIEW

It is obvious from the data (fig. 5) that minimum (0.45 percent) nitrogen content of guava leaf was observed with the orchard S_{11}, whereas, maximum (1.46 percent) was found under orchard S_{10}. The low concentration of nitrogen in guava trees might be due to the low nitrogen status of soils (Bhatnagar *et al.*, 2001), poor organic carbon content, high pH and inadequate application of nitrogen (Sharma and Kumawat, 2019). Besides this, soils of Rewari district are sandy in nature and hence higher leaching losses of nitrogen might be an important reason for reduced uptake. The phosphorus content of guava leaf varied statistically from 0.29 to 0.40 percent with an average of 0.34 percent. The highest value of phosphorus content was obtained in leaves of guava plants of orchard Anandpur (S_1), while its lowest content was recorded for orchard Laduwas (S_6). Medium (33.3 %) to low (66.7 %) phosphorus status of orchard soils and its poor uptake & utilization by plants and due to fixation of available phosphorus content by free oxides might be the possible reason. The nutrient index value for phosphorus was 1.33. The potassium content of guava leaf ranged statistically from 0.98 to 1.24 percent with a mean value of 1.11 percent. The leaf samples which were found sufficient in potassium; might have been due to the sufficient availability of potassium in soils of Rewari district and the presence of micaceous minerals (Sharma and Kumawat, 2019). These results are in conformity with Oliveira *et al.* (2020). Half of the leaf samples were deficient in potassium. Nitrogen content of guava leaves was found significantly and positively correlated with phosphorus ($r = 0.716^{**}$) and potassium ($r = 0.854^{**}$) (Table 5).

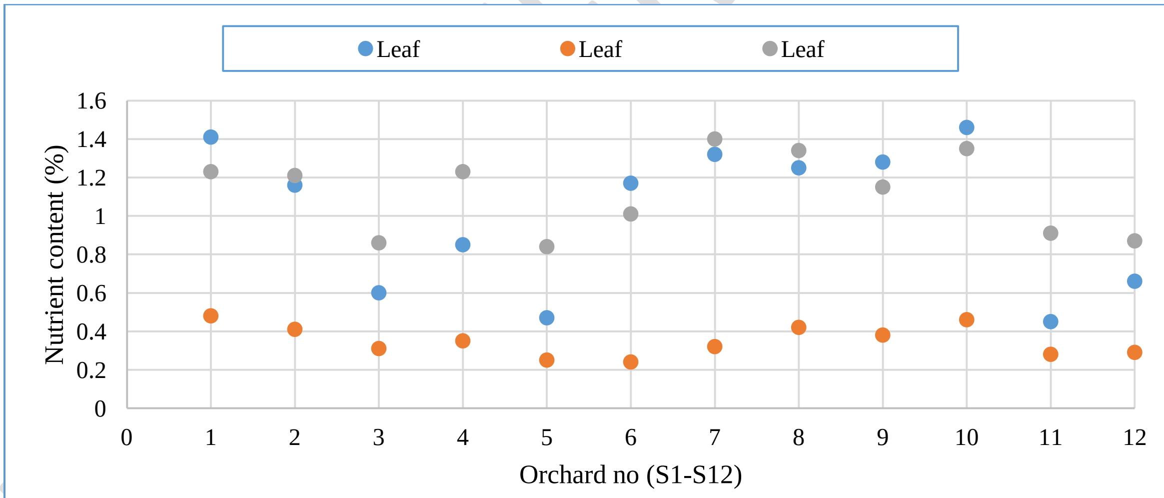


Fig. 5. Guava orchards leaf macronutrient status

Table 4: Correlation matrix between various soil properties

	Sand	Silt	Clay	$CaCO_3$	OC	pH	EC	N	P_2O_5	K_2O
Sand	1	-0.889**	-0.911**	0.723**	-0.871**	0.913**	0.457^{NS}	-0.714**	-0.731**	-0.823**
Silt		1	0.620*	-0.610*	0.708*	-0.693*	-0.571^{NS}	0.605*	0.665*	0.767**
Clay			1	-0.689*	0.852**	-0.939**	-0.270^{NS}	0.677*	0.652*	0.718**
$CaCO_3$				1	-0.578*	0.588*	0.336^{NS}	-0.682*	-0.673*	-0.687*
OC					1	-0.757**	-0.340^{NS}	0.681*	0.615*	0.641*
pH						1	0.397^{NS}	-0.701*	-0.667*	-0.671*
EC							1	-0.530^{NS}	-0.400^{NS}	-0.223^{NS}
N								1	0.593*	0.338^{NS}
P_2O_5									1	0.534^{NS}
K_2O										1

(** 1% signigicant; * 5% significant)

Table 5: Correlation matrix between different leaf nutrients

	N	P	K
N	1	0.716**	0.854**
P		1	0.720**
K			1

(** 1% signigicant; * 5% significant)

Table 6: Nutritional status of soils under guava cultivation in Rewari district of Haryana

	At 0-15 cm depth				At 15-30 cm depth				At 30-60 cm depth			
Nutrient	**Deficient (%)**	**Adequate (%)**	**High (%)**	**Index value**	**Deficient (%)**	**Adequate (%)**	**High (%)**	**Index value**	**Deficient (%)**	**Adequate (%)**	**High (%)**	**Index value**
N	100	-	-	1	100	-	-	1	100	-	-	1
P_2O_5	25	66.7	8.3	1.83	25	75	-	1.75	41.7	58.3	-	1.58
K_2O	-	8.3	91.7	2.91	-	8.3	91.7	2.91	-	66.7	33.3	2.33

CONCLUSION

The texture of soils under study was found to vary from sandy loam to loamy sand. The organic carbon status was low in all samples. The maximum calcium carbonate content in both orchard and non-orchard soil samples was observed in Suthana (S_2). The electrical conductivity of 75% of soil samples was found normal while pH ranged from normal to alkaline. All orchard and non-orchard soil samples were low in nitrogen, however, phosphorus was in deficient to sufficient range. Potassium was sufficient in almost all samples. Leaf samples of guava were deficient in nitrogen and phosphorus while only 50 percent of samples were low in potassium. The results of the present investigation suggest that balanced fertilizer applications should be recommended for optimizing the productivity of guava orchards.

UNDER PEER REVIEW

REFERENCES

AICRP. (1989). Progress Report 1988-89, AICRP on management of salt affected soil and use of saline water. CSSRI, Karnal.

Anonymous (2018). Horticulture Statistics at a glance. Horticulture Statistical Division, Department of Agriculture, Cooperation and Farmer's Welfare. Report, pp 1-3.

Anonymous (2018a). Horticulture Statistics at a glance. Horticulture Statistical Division, Department of Agriculture, Cooperation and Farmer's Welfare. Report, pp 179.

Asija, S., Subbiah, B. V. and Asija, G. L. (1956). Rapid procedure for the estimation of the available nitrogen in soils. *Current Science*, **25**: 259-260.

Baloda, S., Phogat, V., Bhatia, S. K. and Sharma, J. R. (2014). Nutrient indexing of guava orchards in Hisar district of Haryana, India. *Indian Journal of Agricultural Research,* **48**(3): 211-216.

Bangroo, S. A., Dar, S. B., Itoo, H., Mubarak, T. and Malik, A. R. (2018). Effect of physico-chemical properties of soil on available soil nutrients in apple orchards of district Kulgam. *Current World Environment*, **13**(2).

Bhargava, B. S. and Raghupati, H. B. (1993). In methods of analysis of soils, plants, waters and fertilizers. H.L.S. Tandon (Ed.) F.D.C.O, New Delhi, pp 41.

Bhatnagar, P. and Sharma, M. K. (2018). Soil nutrient dynamics of guava (*Psidium guajava* L.) cv. L-49 orchards in vertisols of Jhalawar district. *HortFlora Research Spectrum,* **7**(3): 210-216.

Bhatnagar, P., Chandra, A. and Gupta, P.K. (2001). Nutritional survey of Aonla orchards in Bikaner district of Rajasthan. *Journal of Eco-Physiology,* **4**(3-4): 127-131

Dhillon, W.S. (2013). Fruit production in India. Narendra Publishing House, Delhi, pp: 263-278.

Du Plessis, S.F., Smart, G. and Koen, T.J. 1973. A few aspects of fertilizing guavas. *The Citrus and Subtropical Fruit Journal*, **478**:18-19.

Ganai, A. Q. (2018). Macronutrients status of apple (cv. red delicious) orchard soils of Jammu and Kashmir India. *International Journal of Chemical Studies,* **6**(2): 3314-3319.

Ganai, A. Q., Dar, M. A., Chesti, M. H. and Dar, N. A. (2020). Correlation of physico-chemical characteristic with available nutrients and leaf nutrient content in apple (Cv. Red Delicious) orchard of Jammu and Kashmir (India). *Current Journal of Applied Science and Technology*, 42-52.

Gathala, M.K., Yadav, B.L. and Singh, S.D. (2004). Mineral nutrient status of pomegranate orchards in Jaipur district of Rajsthan. *Journal of the Indian Society of Soil Science*, **52**: 206-208.

Hanway, J.J. and Heidel, H.H. (1952). Soil analysis methods as used in Iowa State College, Soil Testing Laboratory. *Iowa State College Bulletin*, **57**: 1-131.

Jat, M. K., Choudhary, S. K. and Purohit, H. S. (2012). Status of micronutrients in aonla (*Emblica officinalis*) orchards in semi-arid eastern plain of Rajasthan. *Asian Journal of Soil Science,* **7**(1): 47-49.

Jitendra, S. and Raj, K. (2012). Influence of soil nutrient status on yield and qualitative attributes of pomegranate (*Punica granatum* L.) and ber (*Zizyphus mauritiana* Lamk.). *HortFlora Research Spectrum,* **1**(1): 5-12.

Koenig, R. and Johnson, C. (1942). Colorimetric determination of phosphorus in biological materials. *Industrial & Engineering Chemistry Analytical Edition,* **14**(2): 155-156.

UNDER PEER REVIEW

Lindner, R.C. (1944). Rapid analytical method for some of the more common inorganic constituents of plant tissues. *Plant physiology*, **19**(1): 76-89.

Manchanda, H.R. (1976). Quality of ground water in Haryana, HAU, Hisar. pp. 160.

Mediratta, J.C., Bansal, K.N. and Gupta, G.P. (1985). Characterization of some salt affected soils of Harsi command area of M.P. *Journal of the Indian Society of Soil Science,* 214-217.

Muhr, G.R., Datta, N.P., Sankarasubramoney, H., Dever, R.F., Leley, V.K. and Donahue, R.L. (1963). Soil testing in India. United States Agency for International Development Mission of India: Delhi.

Oliveira, C. T. D., Rozane, D. E., Amorim, D. A. D., Souza, H. A. D., Fernandes, B. S. and Natale, W. (2020). Diagnosis of the nutritional status of 'Paluma'guava trees using leaf and flower analysis. *Revista Brasileira de Fruticultura*, **42**(3).

Olsen, S. R. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture.

Piper, C. S. (1950). Soil and Plant Analysis. The University of Adelaide, Australia, 286-287.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. U.S.D.A., Handbook, **78**(2): 154.

Salehin, S. M., Mohsin, G., ferdous, T., Zaman, J. R., Uddin, M. J. and Rahman, M. K. (2020). Soil fertility and leaf nutrient status of mango orchard sites. *Dhaka University Journal of Biological Sciences*, **29**(2): 155-163.

Sharma, S. and Kumawat, B. L. (2019). Effect of leaf nutrient content at various age groups of guava (*Psidium guajava* L.) on fruit yield and quality in semi-arid region of Rajasthan. *Indian Journal of Agricultural Research*, **53**(2): 237-240.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C. and Pannu, R. S. (1998). Statistical software package for agricultural research workers. *Recent advances in information theory, statistics & computer applications by DS Hooda & RC Hasija Department of Mathematics Statistics, CCS HAU, Hisar*, 139-143.

Walkley, A.J. and Black, C.A. (1934). Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*, **37**: 29-38.

UNDER PEER REVIEW