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Research Article

# Physico-Chemical Properties of Apple Orchard (Red Delicious) Soils of Ganderbal District

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**Abstract**

The survey was conducted in twenty one (21) orchards of different locations and different altitudes viz. high, mid and low in district Ganderbal, Jammu and Kashmir. The total numbers of soil samples collected were eighty four (84). The soils samples collected were analyzed for various mechanical as well as physico-chemical properties viz. coarse sand, fine sand, silt, clay, pH, organic carbon and electrical conductivity. The mechanical analysis revealed that soils were clay laom, silty loam and loam in texture. The pH was slightly acidic to slightly alkaline. The organic carbon content was high in all the three altitudes under study. There was an erratic distribution of electrical conductivity in all the three altitudes.

**Keywords:** Ganderbal, physico-chemical, altitudes, locations

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## Introduction

Apple (*Malus domestica*) has a diverse climatic adaptation and most of the apple varieties require about 1500 hours of chilling below $7^0$C to break the rest period. Due to its chilling requirements, it grows best in relatively cooler climates than other deciduous fruits. Apple is one of the important fruit of Kashmir valley as all the requirements for its growth and development are met under temperate conditions of Kashmir valley. The average temperature should be around 21 to 24$^o$C during the growing period. The average temperature should be around 21 to $24^0$C during the growing season. Apples endure quite low temperatures, but temperatures of -30$^o$C and rapid fluctuation in winter from relatively warm to extremely cold temperatures are harmful [1]. Nutritional survey of an area is important to evaluate the fertility status of the soils and is a tool in accessing the pre-requisite for any crop research and development programme. The nutritional analysis of soil and plant is a tool for understanding the nutrient supplying power of soils, for predicting the yield levels and for making fertilizer recommendations. Plant growth, yield and fruit quality are directly influenced by many factors related to environmental conditions and orchard management, besides nutritional status. Nutrition plays an important role in maintaining the quality and production of fruits. The nutrition of pome fruits has received a considerable attention in recent years because of their role in high production of quality fruits as well as their relationship to physiological disorders and other effects like reduced respiration, delayed ripening and increasing fruit firmness, thereby extending the storage life of fruits. District Ganderbal is located in the central part of Kashmir division, with a longitudinal depression in greater north western complex of the Himalayan located between $34^0$ 6' to $34^0$ 27' N latitude and $74^0$ 40' to $75^0$ 35' E longitudes covering an area of 1462.8 Km$^2$. The topography of the Ganderbal district varies exhibiting altitudinal range from 1590 to 2810 m above mean sea level [2]. The district is spread across the Sind river. The district is constituted into seven tehsils viz: Ganderbal, Kangan, Lar, Nagbal, Wakura, Tullamulla and Gund. Ganderbal district possesses all the typical characteristics of the climate of Kashmir Valley as a whole. So in order to understand the soils of district Ganderbal and their suitability for growing apple this survey was undertaken.

## Material and Methods

Soil samples were collected from four depths 0-25, 25-50, 50-75 and 75-100 cm from three altitudes high, mid and low. Collected samples were analysed for various physico-chemical properties and mechanical analysis. Soil samples after collection were air dried, crushed, and sieved through 2mm sieve. A portion of soil sample was sieved through 0.5mm mesh size for determination of organic carbon. The processed soil samples were then labelled and stored in cloth bags for analysis of various physico-chemical characteristics**.** Mechanical analysis of the soil samples was carried out by International Pipette Method as described by [3]. The pH of the soil was measured in 1:2.5 soil water suspension with the help of pH meter. The electrical conductivity of the soil water extract was read with the help of conductivity meter. Organic carbon was determined by wet digestion method as outlined by [4].

### *Statistical Analysis*

Mean values were used to obtain estimates of variance components as per the methods suggested by [5].

## Results and Discussion

### *Mechanical analysis*

*Particle size distribution*

The coarse sand content (**Table 1**) in surface soils of high, mid and low altitudes varied from 1.51 to 2.02, 1.38 to 2.04 and 0.83 to 1.87 with the mean values of 1.73, 1.78 and 1.26 respectively. The coarse sand content in sub-surface soils of high, mid and low altitudes varied from1.31-1.60, 1.28 to 1.92 and 1.10 to 1.49 with the mean values of 1.45, 1.60 and 1.29 respectively. The fine sand content varied from 22.85 to 24.67, 25.84 to 43.96 and 32.87 to 45.31 with the mean value of 23.68, 34.95 and 41.36 in surface soils of high, mid and low altitude respectively, whileas it varied from 21.73 to 22.74, 29.43 to 38.47 and 32.35 to 39.19 with the mean value of 22.24, 33.95 and 35.77 in high, mid and low altitude of sub-surface soils respectively. There was an uneven distribution of sand content with the increase in soil depth, which may be due to in-situ weathering of the parent materials. These results are in conformity with the findings of [6] and [7]. The silt content varied from 48.66 to 52.71, 32.13 to 50.30 and 24.48 to 40.51 with the mean value of 50.67, 41.72 and 29.31 respectively in surface soils of high, mid and low altitude respectively, whileas the silt content in sub-surface soils varied from 50.82 to 52.32, 37.61 to 46.92 and 30.32 to 40.52 with the mean values of 51.57, 42.27 and 35.42 in high, mid and low altitudes respectively. There was an erratic distribution of silt content in all the profiles which were in line with the findings of [6], [8] and [9] while working on soils of Kashmir and Punjab respectively. Clay content in surface soils varied from 21.90 to 25.64, 20.45 to 23.86 and 22.06 to 32.03 with the mean value of 23.90, 21.53 and 28.04 in high, mid and low altitudes respectively. The clay content in sub-surface soils varied from 23.91 to 25.51, 21.445 to 22.88 and 24.90 to 30.16 with the mean value of 24.71, 22.16 and 27.53 in high, mid and low altitudes respectively. The distribution of clay was found to be uneven which is in conformity with the findings of [10] and [11]. The highest amount of clay in lower elevations may be due to translocation of clay from surface to sub-surface horizons by illuviation due to high rainfall at higher elevations, which is supported by the findings of [12]. The soils texture ranged from silt loam, clay loam and loam in various profiles under study, which might be due to differences in altitude and relief which have significant bearing on texture of soils. These findings are in agreement with observations of [7], [11] and [13].

### *Physico-chemical properties of apple orchard soils*

*Soil reaction (pH)*

The data in **Table 2** revealed that pH of surface soils ranged from 6.29 to 7.06, 6.02 to 6.44 and 7.19 to 7.34 with the mean values of 6.75, 6.27 and 7.28 in high, mid and low altitudes respectively, whileas, it ranged from 6.80 to 7.09, 6.37 to 6.65 and 7.40 to 7.54 with the mean values of 6.94, 6.51 and 7.47 in sub-surface soils of high, mid and low altitudes respectively. Soil pH was found slightly acidic to slightly alkaline, which increased with the increase in depth at all the locations in all the three altitudes. Increase of pH with increase in depth may be attributed to leaching of bases due to higher precipitation level and organic matter gradient. Similar findings were reported by [14], [15] and [16]. The variation in pH in all the three altitudes may be due to due to leaching of bases due to high rainfall and variation in organic matter as well as temperature, which are in conformity with the reports of [7], [10] and [12].

*Organic Carbon (OC)*

Perusal of data in Table 2 showed that organic carbon ranged from 1.35 to 1.92, 1.24 to 2.08 and 0.80 to 1.50 per cent with the mean values of 1.58, 1.57 and 1.07 per cent in high, mid and low altitudes of surface soils respectively, whileas, it ranged from 1.16 to 1.44, 0.90 to 1.35 and 0.62 to 0.84 per cent with the mean values of 1.30, 1.12 and 0.73 per cent in sub-surface soils of high, mid and low altitudes respectively. Content of soil organic carbon decreased with the increase in soil depths and highest organic carbon was found highest in high altitude followed by mid altitude and then low altitude. The higher content of organic carbon in surface soils may be due to natural vegetation and addition of farm yard manure to these orchards, whileas the highest organic carbon content in high altitudes might be due to low temperature and high rainfall which favours luxurious vegetation and increases soil acidity resulting in low rate of decomposition or mineralization consequently leading to accumulation of organic matter in high altitude soils. These results are in accordance with the findings of [7], [9], [10], [15] and [17].

**Table 1** Particle size distribution of apple orchard soils of Ganderbal

| **HIGH ALTITUDE** | | | | | | |
|---|---|---|---|---|---|---|
| **Orchard Number** | **Depth(cm)** | **Coarse Sand** | **Fine Sand** | **Silt** | **Clay** | **Textural Class** |
| H-1 | 0-25 | 1.97 | 24.25 | 50.78 | 23 | Silt Loam |
| | 25-50 | 1.99 | 23.64 | 50.37 | 24 | Silt Loam |
| | 50-75 | 2.10 | 22.60 | 50.44 | 24.86 | Silt Loam |
| | 75-100 | 2.10 | 22.62 | 50.66 | 24.62 | Silt Loam |
| H-2 | 0-25 | 1.16 | 24.51 | 46.13 | 28.2 | Clay Loam |
| | 25-50 | 1.00 | 21.34 | 47.35 | 30.31 | Clay Loam |
| | 50-75 | 0.92 | 22.10 | 49.98 | 27.00 | Clay Loam |
| | 75-100 | 0.92 | 22.48 | 50.30 | 26.30 | Clay Loam |
| H-3 | 0-25 | 1.90 | 24.51 | 50.80 | 22.79 | Silt Loam |
| | 25-50 | 1.45 | 23.82 | 51.04 | 23.69 | Silt Loam |
| | 50-75 | 1.41 | 23.61 | 51.01 | 23.70 | Silt Loam |
| | 75-100 | 1.27 | 23.50 | 51.00 | 24.23 | Silt Loam |
| H-4 | 0-25 | 1.92 | 24.50 | 50.35 | 23.23 | Silt Loam |
| | 25-50 | 1.44 | 23.20 | 51.07 | 24.29 | Silt Loam |
| | 50-75 | 1.28 | 22.48 | 51.47 | 24.77 | Silt Loam |
| | 75-100 | 1.23 | 23.72 | 51.01 | 24.04 | Silt Loam |
| H-5 | 0-25 | 1.79 | 23.86 | 52.23 | 22.12 | Silt Loam |
| | 25-50 | 1.60 | 22.11 | 54.20 | 22.09 | Silt Loam |
| | 50-75 | 1.52 | 21.58 | 54.11 | 22.79 | Silt Loam |
| | 75-100 | 1.50 | 21.00 | 53.70 | 23.80 | Silt Loam |
| H-6 | 0-25 | 1.83 | 22.44 | 51.86 | 23.87 | Silt Loam |
| | 25-50 | 1.61 | 20.51 | 52.68 | 25.23 | Silt Loam |
| | 50-75 | 1.59 | 20.42 | 53.09 | 24.90 | Silt Loam |
| | 75-100 | 1.54 | 20.32 | 52.82 | 25.32 | Silt Loam |
| H-7 | 0-25 | 1.80 | 22.30 | 52.70 | 23.20 | Silt Loam |
| | 25-50 | 1.60 | 22.50 | 51.78 | 24.12 | Silt Loam |
| | 50-75 | 1.54 | 22.50 | 52.04 | 23.92 | Silt Loam |
| | 75-100 | 1.54 | 22.40 | 51.78 | 24.28 | Silt Loam |
| Surface Mean | | 1.73 | 23.68 | 50.67 | 23.90 | |
| 95 % CI | | 1.51-2.02 | 22.85-24.67 | 48.66-52.71 | 21.90-25.64 | |
| Subsurface Mean | | 1.45 | 22.24 | 51.57 | 24.71 | |
| 95% CI | | 1.31-1.60 | 21.73-22.74 | 50.82-52.32 | 23.91-25.51 | |
| **MID ALTITUDE** | | | | | | |
| **Orchard Number** | **Depth(cm)** | **Coarse Sand** | **Fine Sand** | **Silt** | **Clay** | **Textural Class** |
| M-1 | 0-25 | 1.34 | 34.58 | 38.19 | 25.89 | Clay Loam |
| | 25-50 | 0.99 | 32.12 | 40.78 | 26.11 | Clay Loam |
| | 50-75 | 0.86 | 30.29 | 42.84 | 26.01 | Clay Loam |
| | 75-100 | 0.84 | 30.20 | 42.75 | 26.21 | Clay Loam |
| M-2 | 0-25 | 1.41 | 40.28 | 35.81 | 22.50 | Loam |
| | 25-50 | 1.24 | 41.52 | 34.12 | 23.12 | Loam |
| | 50-75 | 0.98 | 41.32 | 35.21 | 22.49 | Loam |
| | 75-100 | 0.93 | 40.70 | 35.70 | 22.67 | Loam |
| M-3 | 0-25 | 1.91 | 26.87 | 50.22 | 21.00 | Silt Loam |
| | 25-50 | 1.54 | 24.31 | 51.48 | 22.67 | Silt Loam |
| | 50-75 | 1.45 | 24.36 | 51.48 | 22.71 | Silt Loam |
| | 75-100 | 1.31 | 25.63 | 51.86 | 21.20 | Silt Loam |
| M-4 | 0-25 | 2.22 | 46.78 | 29.37 | 21.63 | Loam |
| | 25-50 | 2.00 | 44.93 | 31.95 | 21.12 | Loam |
| | 50-75 | 3.20 | 45.30 | 30.57 | 20.93 | Loam |
| | 75-100 | 3.22 | 43.62 | 31.73 | 21.43 | Loam |
| M-5 | 0-25 | 2.00 | 46.16 | 31.49 | 20.35 | Loam |
| | 25-50 | 1.97 | 47.00 | 29.40 | 21.63 | Loam |
| | 50-75 | 1.94 | 45.71 | 30.45 | 21.90 | Loam |

| Orchard Number | Depth(cm) | Coarse Sand | Fine Sand | Silt | Clay | Textural Class |
|---|---|---|---|---|---|---|
| | 75-100 | 1.93 | 45.88 | 30.30 | 21.89 | Loam |
| M-6 | 0-25 | 1.32 | 27.23 | 50.38 | 21.07 | Silt Loam |
| | 25-50 | 1.21 | 27.13 | 50.84 | 20.82 | Silt Loam |
| | 50-75 | 1.10 | 26.90 | 51.10 | 20.90 | Silt Loam |
| | 75-100 | 1.00 | 26.90 | 51.17 | 20.93 | Silt Loam |
| M-7 | 0-25 | 1.82 | 22.43 | 53.08 | 22.67 | Silt Loam |
| | 25-50 | 1.80 | 22.44 | 54.76 | 21.00 | Silt Loam |
| | 50-75 | 1.80 | 22.44 | 53.83 | 21.93 | Silt Loam |
| | 75-100 | 1.80 | 22.53 | 53.87 | 21.8 | Silt Loam |
| Surface Mean | | 1.78 | 34.95 | 41.72 | 21.53 | |
| 95 % CI | | 1.38-2.04 | 25.84-43.96 | 32.13-50.30 | 20.45-23.86 | |
| Subsurface Mean | | 1.60 | 33.95 | 42.27 | 22.16 | |
| 95 % CI | | 1.28-1.92 | 29.43-38.47 | 37.61-46.92 | 21.45-22.88 | |
| **LOW ALTITUDE** | | | | | | |
| **Orchard Number** | **Depth(cm)** | **Coarse Sand** | **Fine Sand** | **Silt** | **Clay** | **Textural Class** |
| L-1 | 0-25 | 1.90 | 25.43 | 51.60 | 21.07 | Silt Loam |
| | 25-50 | 1.60 | 24.60 | 52.57 | 21.23 | Silt Loam |
| | 50-75 | 1.60 | 24.50 | 52.60 | 21.30 | Silt Loam |
| | 75-100 | 1.60 | 24.50 | 52.20 | 21.70 | Silt Loam |
| L-2 | 0-25 | 1.04 | 38.94 | 29.02 | 31.00 | Clay Loam |
| | 25-50 | 0.90 | 39.10 | 27.80 | 32.20 | Clay Loam |
| | 50-75 | 1.40 | 37.47 | 28.70 | 32.43 | Clay Loam |
| | 75-100 | 1.70 | 37.36 | 28.94 | 32.00 | Clay Loam |
| L-3 | 0-25 | 1.12 | 39.10 | 28.35 | 31.43 | Clay Loam |
| | 25-50 | 1.00 | 38.12 | 32.41 | 28.47 | Clay Loam |
| | 50-75 | 1.10 | 39.00 | 28.10 | 31.80 | Clay Loam |
| | 75-100 | 1.04 | 38.94 | 29.02 | 31.00 | Clay Loam |
| L-4 | 0-25 | 1.00 | 40.28 | 26.72 | 32.00 | Silt Loam |
| | 25-50 | 0.92 | 26.98 | 51.03 | 21.07 | Silt Loam |
| | 50-75 | 0.90 | 26.36 | 50.13 | 22.61 | Silt Loam |
| | 75-100 | 0.90 | 26.77 | 50.91 | 21.42 | Silt Loam |
| L-5 | 0-25 | 1.01 | 44.50 | 33.42 | 21.07 | Clay Loam |
| | 25-50 | 1.20 | 36.71 | 29.80 | 33.01 | Clay Loam |
| | 50-75 | 1.20 | 38.41 | 26.27 | 34.12 | Clay Loam |
| | 75-100 | 1.20 | 38.41 | 25.79 | 34.60 | Clay Loam |
| L-6 | 0-25 | 2.40 | 46.45 | 29.37 | 21.78 | Loam |
| | 25-50 | 2.30 | 46.24 | 28.90 | 22.56 | Loam |
| | 50-75 | 2.00 | 46.62 | 29.93 | 21.45 | Loam |
| | 75-100 | 2.00 | 46.60 | 29.98 | 21.42 | Loam |
| L-7 | 0-25 | 1.04 | 38.94 | 29.02 | 31.00 | Clay Loam |
| | 25-50 | 1.03 | 38.32 | 29.63 | 31.02 | Clay Loam |
| | 50-75 | 1.00 | 37.90 | 28.70 | 32.40 | Clay Loam |
| | 75-100 | 1.00 | 39.23 | 27.67 | 32.10 | Clay Loam |
| Surface Mean | | 1.26 | 41.36 | 29.31 | 28.04 | |
| 95 % CI | | 0.83-1.87 | 32.87-45.31 | 24.48-40.51 | 22.06-32.03 | |
| Subsurface Mean | | 1.29 | 35.77 | 35.42 | 27.53 | |
| 95 % CI | | 1.10-1.49 | 32.35-39.19 | 30.32-40.52 | 24.90-30.16 | |

*Electrical Conductivity (EC)*

Electrical conductivity in surface soils of high, mid and low altitudes was found out to be in the range of 0.13 to 0.23, 0.20 to 0.26 and 0.16 to 0.76 $dSm^{-1}$with the mean values of 0.19, 0.23 and 0.49 $dSm^{-1}$ respectively (Table 2), whileas, it ranged from 0.71 to 0.80, 0.22 to 0.31 and 0.29 to 0.48 $dSm^{-1}$ with the mean values of 1.04, 0.26 and 0.39 $dSm^{-1}$ in sub-surface soils of high, mid and low altitudes respectively. Electrical conductivity showed an erratic trend within the soil depths. This is in conformity with the findings of [10], [18] and [19].

**Table 2** Physico-chemical properties of apple orchard soils of Ganderbal

| Orchard Number | Depth (cm) | pH (1:2.5) | Organic Carbon(%) | EC ($dSm^{-1}$) |
|---|---|---|---|---|
| **HIGH ALTITUDE** | | | | |
| H-1 | 0-25 | 6.23 | 1.96 | 0.29 |
| | 25-50 | 6.28 | 1.63 | 0.41 |
| | 50-75 | 6.49 | 1.24 | 0.11 |
| | 75-100 | 6.67 | 1.01 | 0.31 |
| H-2 | 0-25 | 6.28 | 1.95 | 0.40 |
| | 25-50 | 6.34 | 1.56 | 0.19 |
| | 50-75 | 6.99 | 1.12 | 0.25 |
| | 75-100 | 7.01 | 1.11 | 0.21 |
| H-3 | 0-25 | 6.42 | 1.76 | 0.22 |
| | 25-50 | 6.50 | 1.65 | 0.25 |
| | 50-75 | 6.61 | 1.57 | 0.37 |
| | 75-100 | 6.73 | 1.68 | 0.28 |
| H-4 | 0-25 | 6.51 | 1.84 | 0.31 |
| | 25-50 | 6.72 | 1.82 | 0.37 |
| | 50-75 | 6.93 | 1.78 | 0.32 |
| | 75-100 | 6.93 | 1.69 | 0.36 |
| H-5 | 0-25 | 7.01 | 1.37 | 0.16 |
| | 25-50 | 7.14 | 1.28 | 0.28 |
| | 50-75 | 7.20 | 1.17 | 0.32 |
| | 75-100 | 7.22 | 1.03 | 0.38 |
| H-6 | 0-25 | 7.12 | 1.28 | 0.93 |
| | 25-50 | 7.17 | 1.12 | 0.87 |
| | 50-75 | 7.19 | 1.09 | 0.45 |
| | 75-100 | 7.23 | 0.91 | 0.42 |
| H-7 | 0-25 | 7.20 | 1.32 | 0.92 |
| | 25-50 | 7.24 | 1.17 | 0.84 |
| | 50-75 | 7.31 | 1.09 | 0.62 |
| | 75-100 | 7.35 | 1.00 | 0.60 |
| Surface Mean | | 6.75 | 1.58 | 0.19 |
| 95 % CI | | 6.29-7.06 | 1.35-1.92 | 0.13-0.23 |
| Subsurface Mean | | 6.94 | 1.30 | 1.04 |
| 95 % CI | | 6.80-7.09 | 1.16-1.44 | 0.71-0.80 |
| **MID ALTITUDE** | | | | |
| **Orchard Number** | **Depth (cm)** | **pH (1:2.5)** | **Organic Carbon(%)** | **EC ($dSm^{-1}$)** |
| M-1 | 0-25 | 6.01 | 2.21 | 0.11 |
| | 25-50 | 6.23 | 1.98 | 0.12 |
| | 50-75 | 6.94 | 1.83 | 0.14 |
| | 75-100 | 7.10 | 1.72 | 0.17 |
| M-2 | 0-25 | 6.04 | 1.09 | 0.16 |
| | 25-50 | 6.09 | 1.00 | 0.14 |
| | 50-75 | 6.23 | 0.91 | 0.13 |
| | 75-100 | 6.98 | 0.75 | 0.18 |
| M-3 | 0-25 | 6.13 | 1.92 | 0.12 |
| | 25-50 | 6.24 | 1.74 | 0.13 |
| | 50-75 | 6.28 | 1.30 | 0.16 |
| | 75-100 | 6.30 | 1.02 | 0.20 |
| M-4 | 0-25 | 6.15 | 1.93 | 0.24 |
| | 25-50 | 6.23 | 1.24 | 0.18 |
| | 50-75 | 6.40 | 0.43 | 0.25 |
| | 75-100 | 6.42 | 0.40 | 0.32 |
| M-5 | 0-25 | 6.19 | 1.84 | 0.21 |
| | 25-50 | 6.24 | 1.78 | 0.17 |
| | 50-75 | 6.28 | 1.72 | 0.24 |

| | | | | |
|---|---|---|---|---|
| | 75-100 | 6.29 | 1.41 | 0.30 |
| M-6 | 0-25 | 6.51 | 1.68 | 0.25 |
| | 25-50 | 6.59 | 1.59 | 0.13 |
| | 50-75 | 6.72 | 1.03 | 0.31 |
| | 75-100 | 6.84 | 0.81 | 0.33 |
| M-7 | 0-25 | 6.60 | 0.99 | 0.18 |
| | 25-50 | 6.63 | 0.82 | 0.19 |
| | 50-75 | 6.70 | 0.57 | 0.20 |
| | 75-100 | 6.71 | 0.52 | 0.22 |
| Surface Mean | | 6.27 | 1.57 | 0.23 |
| 95 % CI | | 6.02-6.44 | 1.24-2.08 | 0.20-0.26 |
| Subsurface Mean | | 6.51 | 1.12 | 0.26 |
| 95 % CI | | 6.37-6.65 | 0.90-1.35 | 0.22-0.31 |
| **LOW ALTITUDE** | | | | |
| **Orchard Number** | **Depth (cm)** | **pH (1:2.5)** | **Organic Carbon (%)** | **EC ($dSm^{-1}$)** |
| L-1 | 0-25 | 7.17 | 1.61 | 0.25 |
| | 25-50 | 7.45 | 1.38 | 0.23 |
| | 50-75 | 7.57 | 1.21 | 0.28 |
| | 75-100 | 7.78 | 0.98 | 0.35 |
| L-2 | 0-25 | 7.20 | 1.72 | 0.19 |
| | 25-50 | 7.28 | 1.21 | 0.27 |
| | 50-75 | 7.30 | 0.98 | 0.21 |
| | 75-100 | 7.51 | 0.62 | 0.35 |
| L-3 | 0-25 | 7.22 | 0.76 | 0.27 |
| | 25-50 | 7.27 | 0.59 | 0.42 |
| | 50-75 | 7.32 | 0.44 | 0.15 |
| | 75-100 | 7.38 | 0.37 | 0.24 |
| L-4 | 0-25 | 7.24 | 1.07 | 0.22 |
| | 25-50 | 7.38 | 0.93 | 0.25 |
| | 50-75 | 7.51 | 0.74 | 0.16 |
| | 75-100 | 7.57 | 0.50 | 0.37 |
| L-5 | 0-25 | 7.34 | 1.20 | 0.25 |
| | 25-50 | 7.39 | 0.84 | 0.47 |
| | 50-75 | 7.43 | 0.74 | 0.38 |
| | 75-100 | 7.45 | 0.62 | 0.31 |
| L-6 | 0-25 | 7.36 | 0.84 | 0.25 |
| | 25-50 | 7.40 | 0.78 | 0.18 |
| | 50-75 | 7.54 | 0.65 | 0.23 |
| | 75-100 | 7.68 | 0.40 | 0.28 |
| L-7 | 0-25 | 7.36 | 0.87 | 0.12 |
| | 25-50 | 7.45 | 0.75 | 0.11 |
| | 50-75 | 7.57 | 0.72 | 0.14 |
| | 75-100 | 7.68 | 0.68 | 0.19 |
| Surface Mean | | 7.28 | 1.07 | 0.49 |
| 95 % CI | | 7.19-7.34 | 0.80-1.50 | 0.16-0.76 |
| Subsurface Mean | | 7.47 | 0.73 | 0.39 |
| 95 % CI | | 7.40-7.54 | 0.62-0.84 | 0.29-0.48 |
| Surface Mean | | 6.72 | 1.48 | 0.28 |
| 95 % CI | | 6.49-6.95 | 1.29-1.68 | 0.18-0.38 |
| Subsurface Mean | | 6.96 | 1.08 | 0.28 |
| 95 % CI | | 6.84-7.08 | 0.97-1.19 | 0.24-0.32 |

## Conclusion

The results reveal that the soils had silt loam, clay loam and loam texture. The soils were slightly acidic to slightly alkaline. Organic matter was sufficient in the soils under study. There was a definite variation among all the three altitudes and the physico chemical properties varied depth wise as well. The programme can be very useful for farmers in accessing the need of fertilizers as to when and what quantity is to be applied for improving the yield of their orchards and also is very important for further research and developmental programmes.

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