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Nutrient Status of Pear Orchards of Kashmir and their Relationship with Physico Chemical Properties

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Abstract: A study was conducted in pear orchard soils of Kashmir to find out effect of physico-chemical characteristics on available nutrients. It was found that the texture of soils varied from clay loam to silty clay loam. The soils were normal in calcium carbonate content ranged from 6.4 to 9.8% with normal electrical conductivity. The organic carbon content was medium to high (0.10 to 0.44), while pH was slightly acidic to slightly alkaline (6.10 to 7.76). The pH revealed significantly positive correlation with available calcium and significantly negative relationship with available nitrogen, phosphorus, potassium, sulphur and micronutrient cations. Clay exhibited significantly positive correlation with potassium content and significantly negative with copper, whereas, calcium carbonate indicated significant and positive correlation with exchangeable calcium and magnesium. The organic carbon exhibited significantly positive correlation with available nitrogen, phosphorus, potassium, sulphur and micronutrients.

Key words: *Physico-chemical Characteristics, Available Nutrients, Pear,*

Introduction

The nutrient status survey is a pre-requisite for any agro-based development programme as it provides the information about the fertility status of soils. Balanced nutrition of fruit crops through judicious application of fertilizers is quite essential for improving quantity as well as quality of fruits. Soil and plant analysis are equally important to predict the plant behaviour and its performance in an area and also to know the depth-wise distribution of available nutrients in the soil. Besides it helps in ascertaining the relationship between the available and leaf nutrients and of various physico-chemical characteristics of soil with available nutrients in surface as well as in sub-surface soils. The analysis of soil and plant is a valuable tool for understanding the nutrient supplying capacity of soil, predicting yield levels, and for making fertilizer recommendations. It also helps to determine the influence of various nutrient elements on plant growth and the absorption of various nutrients by plants. Soil tests are of significant value in estimating nutrient availability to the plants and to determine the various physico-chemical characteristics of the soil, which have pronounced influence on the availability of nutrients. On the other hand, leaf analysis reflects the nutritional status of the plants. Therefore, soil and plant analysis are complementary to each other. The diverse agro-climatic zones of the state of Jammu and Kashmir offer the advantage of growing different types of crops, vegetables, fruits *etc*. Among fruits, pear is grown commercially in the state because of its good potential. Pear needs different nutrients in varying quantities to achieve a proper growth and fruiting. According to (Hansein and Ryugo 1979), the production of quality fruit is also influenced by nutritional status of the soil, leaf fruit ratio, fruit mineral composition *etc*. Imbalance of nutrients causes several nutritional disorders through their effect on plant metabolism and consequently impair the quality and yield of fruits. Soil is a natural medium for the growth and nourishment of land plants, which is produced as a result of influence of climate, vegetation and topography on parent material over a period of time. The soil is composed of mineral matter, organic matter, soil water and air. The mineral matter is derived from the disintegration of rocks and minerals, while organic matter is obtained from the decomposition of organic residues and both constitute the solid portion of soil. The

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mineral matter and organic matter is the main storehouse of plant nutrients and possess certain physico-chemical characteristics which include pH, humus content, soil oxygen content, electrical conductivity, soil moisture, ratio of sand, silt, and clay, cation exchange capacity, base saturation, calcium carbonate content *etc*. These properties have significant effect on the availability of the nutrients required by the plants. The texture is important for assessing the nutrient supplying power of soil as well as its potential to supply water and air to plants and also determines the magnitude of surface on which the reaction can occur. pH influences the suitability of soil for crop production, availability of nutrients, microbial activity and soil physical properties like structure, permeability *etc*. Soils generally differ in their salt content which affects their ability to grow crops. Excess salts interfere with water and nutrient uptake. The stability of soil aggregation, release of essential nutrients for plant growth, maintenance of soil microbial dynamics and biochemical changes in soil are attributed to organic matter content of the soils. Besides it serves as an index of soil productivity and accounts for one third of cation exchange capacity of soils. Calcium carbonate in soils affects the soil reaction thereby affecting the availability of plant nutrients. Therefore, a study has been undertaken to find out the effect of physico-chemical characteristics on the available nutrients in pear orchard soils of Kashmir.

Materials and Methods

For the study, twenty one pear orchards of uniform age group (15-20 years) were selected from pear growing areas of the valley located at different altitudes and soil samples were collected up to a depth of 100 cm with an increment of 25 cm (Table 1). The samples were air dried and crushed with a wooden pestle and mortar followed by sieving through a sieve of 2 mm size and stored in polythene bags for analysis. A portion of crushed soil was passed through a sieve of 0.5 mm and stored separately for estimation of organic carbon. The pH and electrical conductivity were estimated in 1:2.5 (soil : water) suspension by standard procedures given by Jackson (1973). Organic carbon was determined by the method outlined by (Walkley and Black 1934) and calcium carbonate was estimated by the method prescribed by (Piper 1966). The available nitrogen was determined by alkaline permanganate method given by (Subbiah and Asija 1956), while, available phosphorus and potassium were estimated by the methods given by (Jackson 1973). The exchangeable calcium and magnesium were determined by versenate titration method outlined by (Black 1965). Available sulphur extracted by method given by (Williams and Steinsbergs 1959) and estimated by method outlined by (Chesnin and Yien 1951). The available micronutrient cations in soils were determined using atomic absorption spectrometer after extraction with diethelenetriamine penta acetic acid (DTPA) (Lindsay and Norvell 1978).

The study area *i.e.* Kashmir valley is spread over latitude of 32° 17' to 37° 50' N and longitude of 72° 17' to 80° 30' E. The state of Jammu and Kashmir has an area of 14, 904 ha under pear cultivation with a production of 73,515 tonnes (Annonymous 2014). Pear cultivation is affected by the various problems like russeting, corky spot, blackening of leaves, black spot, pearsolla, sanjose scale. In addition to this, no attention is paid to use of balanced fertilizers, insufficient application of manures, pruning and training, disease/pest control measures.

Table 1. Location of pear orchards for collection of soil samples in Kashmir valley.

S. No.	Location	District	Altitude (m a.m.s.l)
1	Chararsharief	Budgam	2100
2	Pakherpora	Budgam	2020
3	Footlipra	Budgam	2000
4	Kamrazipora	Pulwama	1920
5	Kanigam	Pulwama	1880
6	Tujan	Pulwama	1850
7	Adijan	Kulgam	1840
8	Drabagam	Pulwama	1800

9	Pombay	Kulgam	1800
10	Astanpora	Srinagar	1790
11	Rajpora	Pulwama	1780
12	Tral	Pulwama	1760
13	Nawpora	Budgam	1750
14	Pirpora	Pulwama	1730l
15	Wakura	Ganderbal	1690
16	Zazna	Ganderbal	1640
17	New Thead	Srinagar	1620
18	Manzgam	Srinagar	1580
19	Khanda	Budgam	1580
20	Handwara	Kupwara	1560
21	Pohru	Budgam	1520

Results and Discussion

Physico-chemical characteristics of soils

The most reactive fraction of various textural separates of soil is clay, which influences most of the physical and chemical activities of soil. Clay content varied from 18.20 to 38.00% with a mean value of 28.97% in surface soils, whereas, it ranged from 19.10 to 39.70% with mean value of 30.40 in sub-surface soils (Table 2). The distribution of the clay content was erratic with depth. The texture of soils ranged from clay loam to silty clay loam. The pH in surface soils was found in the range of 6.10 to 7.76 with mean value of 6.75, while, it varied from 6.20 to 7.94 with mean value of 7.00 in sub-surface soils. The pH of the soils was slightly acidic to slightly alkaline and it increases with increase in soil depth. The electrical conductivity of surface soils and sub-surface soils ranged from 0.10 to 0.44 and 0.06 to 0.38 dSm^{-1} with mean value of 0.26 and 0.23dSm^{-1}, respectively. The electrical conductivity was normal and it showed an irregular trend with an increase in soil depth. The calcium carbonate was found normal and increased with increase in soil depth generally. It varied from 6.40 to 9.80 and 7.00 to 10.80% with mean value of 7.90 and 8.77% in surface and sub-surface soils, respectively. The organic carbon content was found in the range of 0.66 to 2.36 % with a mean value of 1.54% in surface soils, whereas, it varied from 0.37 to 1.56% with a mean value of 0.88% in sub-surface soils and it decreased with soil depth. This is due to addition of organic manures, more mineralization and decomposition and high microbial population in surface soils. The soils were medium to high in organic carbon content.

Table 2. Physico-chemical characteristics of pear orchard soils

Parameter	Surface soils (0 -25 cm)		Sub-surface soils (25 -100 cm)	
	Range	Mean	Range	Mean
pH	6.10 – 7.76	6.75	6.20 – 7.94	7.00
EC (dSm^{-1})	0.10 – 0.44	0.26	0.06 – 0.38	0.23
$CaCO_3$ (%)	6.40 – 9.80	7.90	7.00 – 10.80	8.77
Organic Carbon (%)	0.66 – 2.36	1.54	0.37 – 1.56	0.88
Clay (%)	18.20 – 38.00	28.97	19.10 – 39.70	30.40

Available nutrient status of soils

Available nitrogen was low to medium and ranged from 207.87 to 439.49 and 69.89 to 400.06 kg ha^{-1} with mean value 353.25 and 225.16 kg ha^{-1} in surface and sub-surface soils, respectively (Table 3). In surface and sub-surface soils, the available phosphorus varied from 21.06 to 41.66 and 16.13 to 37.18 kg ha^{-1} with mean value of 34.25 and 23.36 kg ha^{-1}, respectively and it was medium to high. The available potassium was high in study soils and varied from 318.08 to 474.88 kg ha^{-1} with mean value of 401.70 kg ha^{-1}in surface layers and from 154.56 to 407.68 kg ha^{-1} with mean value of 276.06 kg ha^{-1} in sub-surface layers, respectively. The exchangeable calcium ranged from 4390.40 to 4995.20 and 4569.60 to 5308.80 kg ha^{-1} with mean value of 4766.92 and 4950.76 kg ha^{-1} in surface and sub-surface sols, respectively, whereas, exchangeable magnesium ranged from 586.88 to 676.48 and 416.64 to 725.76 kg ha^{-1} with mean value of 638.51 and 587.44 kg ha^{-1} in surface and sub-surface soils, respectively. Both calcium and magnesium were found high in soils. The available sulphur was found to range from 22.40 to 26.88 kg ha^{-1} with mean value of 24.51 kg ha^{-1} in surface soils, whereas, it ranged from 16.35 to 27.78 kg ha^{-1} with mean value of 21.57 kg ha^{-1} in sub-surface soils and the soils were medium in available sulphur. The DTPA extractable micronutrients *i.e.* zinc, copper, iron and manganese ranged from 0.54 to 1.82, 1.14 to 2.80, 29.60 to 76.00 and 25.40 to 54.40 mg kg^{-1} with mean value of 1.28, 2.00, 48.50 and 43.06 mg kg^{-1} in surface soils, respectively, while as, in sub-surface soils, they varied from 0.19 to 1.08, 0.55 to 2.56, 11.50 to 56.00 and 14.20 to 49.30 mg kg^{-1} with mean value of 0.59, 1.27, 27.49 and 25.16 mg kg^{-1}, respectively. The available zinc was low to high, available copper medium to high, while, available iron and manganese were high in the study soils. The nitrogen, phosphorus, potassium, sulphur, zinc, iron decreased while calcium and magnesium increased with depth.

Table 3. Available nutrient concentration in orchard soils.

Parameter	Surface soils (0-25 cm)		Sub-surface soils (25-100 cm)	
	Range	Mean	Range	Mean
Nitrogen (kg/ha)	207.87 – 439.49	353.25	69.89 – 400.06	225.16
Phosphorus (kg/ha)	21.06 – 41.66	34.25	16.13 – 37.18	23.36
Potassium (kg/ha)	318.08 – 474.88	401.70	154.56 – 407.68	276.06
Calcium (kg/ha)	4390.40 – 4995.20	4766.92	4569.60 – 5308.80	4950.76
Magnesium (kg/ha)	586.88 – 676.48	638.51	416.64 – 725.76	587.44
Sulphur (kg/ha)	22.40 – 26.88	24.51	16.35 – 27.78	21.57
Zinc (mg/kg)	0.54 – 1.82	1.28	0.19 – 1.08	0.59
Copper (mg/kg)	1.14 – 2.80	2.00	0.55 – 2.56	1.27
Iron (mg/kg)	29.60 – 76.00	48.50	11.50 – 56.00	27.49
Manganese (mg/kg)	25.40 – 54.40	43.06	14.20 – 49.30	25.16

Effect of physico-chemical characteristics of soil on available nutrients

Organic carbon exhibited significant and positive relationship with available nitrogen, phosphorus, potassium, sulphur, zinc, copper, iron and manganese in surface soils, while, similar relationship was observed with available nitrogen, phosphorus, potassium, zinc, copper, iron and manganese in sub-surface soils (Table 4).

Table 4. Correlation coefficients (r) of physico-chemical characteristics with available nutrient elements in pear orchard soils of Kashmir**.**

Soil Properties	Available nutrients									
	N	P	K	Ca	Mg	S	Zn	Cu	Fe	Mn
	Surface soils (0 – 25 cm)									
pH	-0.74*	-0.78*	-0.29	0.65*	-0.01	-0.29	-0.82*	-0.89*	-0.70*	-0.42
Organic carbon	0.80*	0.70*	0.55*	-0.42	-0.14	0.55*	0.74*	0.73*	0.75*	0.64*
$CaCO_3$	-0.41	-0.08	-0.51*	0.72*	0.60*	-0.69*	-0.17	-0.01	-0.28	-0.36
Clay	0.11	-0.34	0.51*	0.04	0.25	0.26	-0.36	-0.48*	-0.34	-0.07
	Sub-surface soils (25 – 100 cm)									
pH	-0.79*	-0.52*	-0.88*	0.29	-0.01	0.42	-0.39	-0.79*	-0.45*	-0.32
Organic carbon	0.58*	0.58*	0.61*	-0.28	0.32	0.40	0.68*	0.75*	0.63*	0.64*
$CaCO_3$	-0.08	-0.11	0.09	0.77*	0.46*	-0.19	-0.16	0.09	-0.28	-0.20
Clay	-0.22	-0.25	0.39	-0.09	-0.11	0.45*	-0.04	-0.03	-0.14	0.01

* Significant at 5% Level.

The increase in availability of nutrients may be attributed to the release of these elements from organic complexes as well as from the weathering of minerals due to acidulating action of organic matter. This is supported by the findings of Mandal *et al.* (1990), Tripathi *et al.* (1997), Wani (2001), Najar (2002), Farida (2005) and Sharma *et al*. (2005). The surface soil pH revealed significant and positive relationship with exchangeable calcium, but indicated significant and negative relationship with available nitrogen, phosphorus, zinc, copper and iron, while sub-surface soil pH showed significant and negative relationship with available nitrogen, phosphorus, potassium, copper and iron. The increase in pH with the increase in calcium is quite obvious, because of basic nature of calcium cation, while as, decrease in availability of nitrogen, phosphorus, potassium, zinc, copper and iron may be attributed to dominance of calcium with an increase in pH. Similar findings are reported by Jalali *et al.* (1989), Mandal *et al.* (1990), Mahapatra *et al.* (1996), Wani (2001), Farida (2005) and Sharma *et al.* (2005). Calcium carbonate exhibited significantly negative relationship with available potassium and sulphur in surface soils, whereas, it exhibited significant and positive relationship with available calcium and magnesium in both surface as well as sub-surface soils. This could be attributed to release of basic ions (calcium and magnesium) because of favourable pH. The findings are in agreement with the results of Panday *et al.* (1989), Balanagoudar and Satyanarayana (1990) and Wani (2001). The clay content in surface soils indicated significant and positive correlation with available potassium only, whereas, it showed significantly negative relationship with available copper. A positive and significant relationship was also observed between clay content and available sulphur in sub-surface soils. These are in conformity with the findings of Mandal *et al.* (1990), Panday *et al.* (2000) and Sharma *et al.* (2005).

Conclusions

In pear growing soils of Kashmir, the pH revealed significantly positive correlation with available calcium and significantly negative relationship with available nitrogen, phosphorus, potassium, sulphur and micronutrient cations. Clay exhibited significantly positive correlation with potassium content and significantly negative with copper, whereas, calcium carbonate indicated significant and positive correlation with exchangeable calcium and magnesium. The organic carbon exhibited significantly

positive correlation with available nitrogen, phosphorus, potassium, sulphur and micronutrients

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