Int.J.Curr.Microbiol.App.Sci (2018) *7*(6): 257-277

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 06 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.706.031

Nutrient Status of Apricot (*Prunus armeniaca* L.) Orchards of District Kargil, Ladakh, India

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Keywords

Apricot, Soil, Orchards, District Kargil, available nutrients and micro nutrients

Article Info

Accepted:
02 May 2018
Available Online:
10 June 2018

A B S T R A C T

Apricot (*Prunus armeniaca* L.) is the main fruit in Ladakh region. Soil nutrients play a vital role in the growth, development and yield of apricot tree and the information on the nutritional status of an area can go a long way in planning judicious fertilizers and soil management practices to develop economically viable alternatives for the orchardists. Twenty one orchards with uniform age and vigour were selected and surveyed (simple random survey) for the purpose of collection of soil and leaf samples in District Kargil. The soil samples were collected from the three different depths viz., 0-20 cm, 20-40 cm and 40-60 cm. The soils were mostly sandy loam with sand, silt and clay with neutral to alkaline in reaction. Most of the soil samples were within the safe limit of salinity and were grouped under class A <0.5 dsm^{-1}. Organic carbon is almost low irrespective of all locations. While in available nutrients contents nitrogen is low at all locations, phosphorus is adequate and potassium is varied from medium to high category. The available calcium and magnesium did not reveal a definite pattern along the depth. The available sulphur content in these soils was sufficient and did not exhibit any definite trend in its vertical distribution. The DTPA-extractable zinc was found to be low, copper was found to be optimum in 95.23% soil samples. Iron was found low in 42.85% soil samples and medium to high in 57.14% soil samples. Manganese was found to be low in almost all samples with the surface soils containing higher amount than the sub-surface soils. All the micronutrients cations showed a decreasing trend with the increase in soil depth.

Introduction

Apricot (*Prunus armeniaca* L.) belongs to family Rosaceae. It is grown mostly in the temperate regions of the world e.g. Western and Central Asia, Europe, North Western Himalaya and Western Tibet. It is probably a native of Western China. In India, it is cultivated in Jammu and Kashmir, Himachal Pradesh and hills of Uttar Pradesh. In Jammu and Kashmir State, about 3030 hectare area covered under this fruit. Ladakh is named as

cold arid of North-Western Himalayas in Indian Subcontinent. Apricot being the most dominant fruit crop in the Ladakh region. The market value of the fruit (Apricot) produced from the cold arid areas, is almost double that of the fruit produced from other temperate and sub temperate parts of the country. Seedling originated apricots grow successfully up to an altitude of 3,500 meters a.m.s.l. Ladakh comprises of Kargil and Leh district of Jammu and Kashmir state and is spread over an geographical area of 96,701 km^2 accounting for 43% of the area of the state and 75% of the cold arid region of the India. Fruit crops are raised in 47 villages of Kargil and 54 villages of Leh District, based on the length of the cropping season and elevation Sharma and Mir (1997) identified three climatic divisions (i.e., the upper, middle and lower) within the cold arid region.

The lower belt includes area from Saspol to Batalik, Nubra valley and larger parts of Kargil. Double cropping is practiced in these lower belts and in fruit production, both in terms of variety and quantity is maximum in these areas. The apricot growing areas in District Kargil are Karkitchoo, Hardass, Hunderman, Shilikchey, Poyen, Akchamal, Batalik, Chulichan, Gargardo, Darchiks, Garkhon and Sanjak. These apricot growing areas are situated between 34.5^o to 34.7^o North latitude, 76.2^o to 76.5^o East longitude and at an altitude of 2,500-2,750 meters a.m.s.l.

Generally speaking, the soils in Ladakh show a very wide variation in texture-sandy, loamy, silty loam, etc. and crops perform differently in the different soil types about which there is very little awareness among the local farmers (Singh, 1995). The sand content in the soils of Kargil (Kurbathang plateau) is relatively less (51.29 to 93.00%) with sandy loam as predominant surface texture. The soils in Drass areas are relatively finer with sandy loam to clay loam as the dominant texture while as the soils in the Leh (igoo-phey command area) are coarse textured with sand content of 95.0% and clay content ranging from 1.20 to 2.40%. The percentage of sand in Thicksay is relatively less (50 to 60%) with a clay content varying between 13-22%. Soils are thus loose with good aeration and lack in the capacity to absorb and hold the sufficient moisture and nutrients (Talib 1986). pH and Electrical conductivity of District Kargil ranged between 7.5 to 8.5 in April and 8.0 to 8.7 in September for all locations. While-as in the sub-surface layer the value stood at > 8.0, 0.002 to 0.080 (mmhos/cm) respectively reported in Apricot orchards of district Kargil (Norboo, 1994) and Sanjay *et al.,* (2005) also reported electrical conductivity varied from 0.05 to 1.41 and 0.08 to 1.55 dS m^{-1} respectively in soils of Leh and Kargil District and further confirmed that electrical conductivity were within the safe limits (grouped under class A, <0.5 dS m^{-1}).

Whereas the organic carbon content were ranged between 0.7 to 14.1 and 1.4 to 35.8g kg^{-1} respectively in both districts. Macro-nutrients like Nitrogen, Phosphorus and Potassium were varied from 91.99 to 223.66 kg/ha and phosphorus is within the normal range irrespective of locations and various soil depths (Norboo, 1994). While as potassium varied from 11 to 496 and 103 to 861 kg/ha in soil samples of Leh and Kargil District, respectively (Sanjay *et al.,* (2005). While studying the micro-nutrients (Zn, Cu, Fe and Mn) in the soils of Ladakh it has been reported that Zinc (0.08 to 2.08 mg/kg), copper (0.28 to 1.24 mg/kg), Fe (1.56 to 14.62 mg/kg), Mn (2.12 to 5.92) (Jalali *et al.,* 2000). Soil nutrients play a vital role in the growth, development and yield of plant and the information on the nutritional status of an area can go a long way in planning judicious fertilizers and soil management practices to develop economically viable alternatives for the farming community.

Materials and Methods

Survey of study area

Investigations were carried out in 21 orchards of uniform age, vigour and growth selected from main apricot growing areas of District Kargil located at different locations and accordingly soil samples and leaf samples were collected under the standard procedure. A comprehensive survey was conducted in order to evaluate apricot growing orchards at different locations in District Kargil. The design of the survey used in achieving the objectives of the current study was simple random sampling. The Global Positioning System (GPS) co-ordinates (Table 1) were taken along the sampling sites and were used to draw the Arc Map (Map 1) in Arc GIS 10.2.

Climate

Cold arid zone is experienced by harsh climate dryness from extreme heat and cold, excessive dryness and very low rainfall and as such this region is called the cold arid or cold desert zone of the state. Based on the length of the cropping season and elevation Sharma and Mir (1997) identified three climatic divisions (i.e., the upper, middle and lower) within the cold arid region. The lower belt includes area from Saspol to Batalik, Nubra valley and larger parts of Kargil. Double cropping is practiced in this area, both in terms of variety and quantity is maximum in this area.

Soil

The soils are coarse in texture, shallow and sandy derived from weathered debris of rocks. Thee soils falls under the order "Entisols" and sub group Typic-cryoranthents (Gawande *et al.,* 1979). The soils are coarse in texture, low in organic matter and high in calcium carbonate percentage (Takkar and Randhawa, 1978; Katyal and Aggarwal, 1982).

Vegetation

With the changing weather pattern, cropping pattern in the cold desert region is changing rapidly and farmers have shifted from old traditional crops like buckwheat, barley, black peas to low volume high value crops such as peas potato, apple, apricot, almond and seabuckthorn. In fodders alfa alfa is widely grown. Willows (*Salix* species) and Poplars (*Populas* species) are found along the Indus basin.

The soil samples were collected from the drip line of fruit trees from 21 different apricot orchards in different blocks of Kargil at different depths i.e., 0-20 cm, 20-40 cm and 40-60 cm. The soil samples after collection were dried, crushed and sieved through 2 mm sieve and packed for analysis. Mechanical properties (Piper, 1966), pH and electrical conductivity (1:2.5 soil: water ratio), Organic carbon (Walkey and Black, 1934), nitrogen (Subbiah and Asija, 1956), phosphorus (Jackson, 1973). Potassium (Jackson, 1973), sulphur (Chesnin and Yien, 1951) exchangeable calcium and magnesium (Black 1965). The available (DTPA-extractable) micronutrients (Zn, Cu, Fe and Mn) contents of the soil were determined by Lindsay and Norvell (1978). Simple coefficient of correlation 'r' was worked out between various soil properties as per the standard procedures given by Gomez and Gomez (1984). All the data was analyzed and computed with the help of statistical tool SPSS 16.0. Confidence interval (C.I) was also worked out by using the same statistical tool.

Results and Discussion

Soil separates in profile soil samples showed a varied distribution in apricot orchards of District Kargil. The content of sand, silt and clay varied from 55.64 to 60.43, 24.05 to 27.06 and 14.84 to 17.43% respectively with a

mean value of 58.12, 25.66 and 16.12% respectively in surface soils and in sub-surface soils with mean value of 61.40, 23.35 and 15.08% respectively at 95% confidence interval. (C.I) (Table 2). The majority of the soil samples were having sandy loam texture which is in line with the findings of (Norboo, 1994; Jalali, 2000; Sanjay *et al.,* 2005) and geographically the study area comes under the Cold arid region where the soils are mostly sandy in texture.

pH value in surface soils ranged from 7.72 to 8.10 while as in sub-surface layers it varied from 7.78 to 8.15. The pH value obtained at different soil depths showed an increasing trend with the increase in the soil depth exhibiting significant differences among locations (Table 3), similar results were reported by Minhas and Singh (1980), Norboo (1994) and Akhtar (2005). Electrical conductivity varied from 0.50 to 0.68 dsm^{-1} with a mean value of 0.59 dsm^{-1} in surface soils at 95% confidence interval. While as in sub-surface layers, it varied from 0.36 to 0.52 with mean a value of 0.44 dsm^{-1} in surface soils at 95% confidence interval (C.I) and it doesn't show a definite pattern along with the depth of the soil (Table 3).

These results are in conformity with Norboo (1994), Sanjay *et al.,* (2005) and Colak *et al.,* (2010). Organic carbon present in the soil samples varied from 0.15 to 0.20% with a mean value of 0.18% significantly at 95% Confidence interval in surface layer while-as in sub-surface layers it varied from 0.11 to 0.16% with a mean value of 0.13% at 95% C.I. (Table 3). Similar reports were reported in their findings by Norboo (1994), Sanjay *et al.,* (2005) and Colak *et al.,* (2010). Calcium carbonate content varied from 0.28 to 0.56% with a mean value of 0.45% while-as in the sub-surface layers it varied from 0.16 to 0.75% with a mean value of 0.51% statistically at 95% C.I. (Table 3). The available nutrients Nitrogen, Phosphorus and Potassium in the surface soils were varied from 225.28 to 253.79 kg/ha, 21.67 to 26.57 kg/ha, 244.35 to 322.32 kg/ha respectively in the surface soils at 95% C.I. while as in the sub surface soils it varied from 158.57 to 192.42 kg/ha, 20.32 to 24.69 kg/ha, 156.79 to 231.30 kg/ha respectively statistically at 95% C.I. (Table 4).

Available nitrogen may be in low category in soils of apricot orchards of Kargil because of the fact that mineralization of organic matter is very slow in cold arid regions due to low temperature (Sharma and Triparthi, 2002) and loss of nitrogen through leaching under light textured soils (Folh and Turk, 1973) where as results are in accordance with the findings of Norboo (1994) and Sanjay *et al.,* (2005) for available phosphorus and potassium. The Calcium, Magnesium and Sulphur were varied from 218.72 to 236.17 ppm, 15.17 to 21.82 ppm, 11.26 to 11.66 kg/ha respectively in the upper 15 cm or surface soils while as in sub surface it had mean value of 210.29 ppm, 18.77 ppm and 11.39 kg/ha respectively at 95% C.I. (Table 4).

This is in conformity with the findings of Bhandari and Randhawa (1985), Norboo (1994), Dar (1996) and Najar (2002). The data revealed that available sulphur did not exhibited any definite trend in its vertical distribution (Table 4) these results are in agreement with those of Arora *et al.,* (1989), Sharma and Bhandari (1992) and Wani (2001).

DTPA-extractable micro nutrients (Zn, Cu, Fe and Mn) content in the apricot orchard soils of District kargil varied from 0.53 to 0.59 mg/kg, 0.79 to 1.29 mg/kg, 4.76 to 6.97 mg/kg and 1.30 to 2.21 mg/kg respectively in the surface soils. In sub surface soils it varied from 0.57 to 0.70 mg/kg, 0.54 to 0.85 mg/kg, 3.41 to 5.81 mg/kg and 0.79 to 1.21 mg/kg

respectively at 95% C.I. (Table 5). The results were supported by the findings of Jalali *et al.*, (2000) and Sanjay *et al.*, (2005). The amount of available zinc, copper, iron and manganese in the soils under study decreased with an increase in soil depth with maximum amount in surface soils, which can be attributed to the accumulation of high organic matter in surface soils. Similar reports were reported by Sharma *et al.*, (2004), Sharma and Chaudhary (2007) and Dar *et al.*, (2011). The overall manganese content in all samples was below the critical limits as prescribed by Nayyer *et al.*, (1985).

Perusal of the correlation coefficient values between physico-chemical properties with available nutrients in the surface soils revealed that pH of soils had significant negative correlation with phosphorus (r =-0.566), sulphur (r =-0.508) and iron (r =-0.484) (Table 6). A similar relationship between pH and available phosphorus has been reported by the Zaho *et al.*, (2011) and Khokhar *et al.*, (2012). Significant and negative relationship of pH with available sulphur has also been reported by Cheema and Arora (1984), Arora *et al.*, (1989), Pandey *et al.*, (1989) and Dar *et al.*, (2011).

Similar relationship between the pH and available iron has been reported by Chibba and Sekhon (1985), Jalali *et al.*, (1989), Ramesh *et al.*, (1994), Gupta and Srivastava (1990), Mir (1994), Zahoor *et al.*, (2005), Sharma *et al.*, (2005) and Dar *et al.*, (2011). Electrical conductivity showed a significantly negative correlation with nitrogen (r =-0.534) (Table 6). Khokhar *et al.*, (2012) also reported the same.

Soil organic carbon showed positive and significant correlation with nitrogen (r = 0.498) phosphorus (r = 0.508), potassium (r = 0.424), sulphur (r = 0.469) zinc (r = 0.473), copper (r = 0.482), iron (r = 0.497) and manganese (r = 0.432) in surface soils (Table 6). Similar results have been reported by Singh and Ahuja (1990), Mushki (1994), Wani (2001), Akhtar (2005) and Najar *et al.*, (2006). Panday *et al.*, (2000), Wani (2001) and Akhtar (2005). The relationship between organic carbon and available potassium is in conformity with the findings of Chibba and Sekhon (1985), Kumar *et al.*, (1987), Mandal *et al.*, (1990), Mongia and Bandyopadhyay (1991) and Wani (2001). Calcium carbonate revealed a positive and significant correlation with calcium (r = 421), magnesium (428) and Clay (r = 471) (Table 6).

The relationship of calcium carbonate with available calcium and magnesium observed was also supported by the findings of Jassal *et al.*, (2000), Wani (2001) and Dar *et al.*, (2011). The clay content showed significant and positive correlation with nitrogen (r = 0.475) but showed negative but non-significant correlation with potassium (r =-0.254), calcium (r =-0.131), sulphur (r =-0.164), manganese (r =-0.103), zinc (r =-0.117) (Table 6). The results were in line with Mandal *et al.*, (1990), Gupta *et al.*, (1980) and Akhtar (2005).

In sub surface soils pH had significant and negative correlation with phosphorus (r =-0.552), iron (r=-0.620). Electrical conductivity revealed a negative and significant relationship with available nitrogen (r =-0.498). Organic carbon content revealed positive and significant correlation with nitrogen (0.542), phosphorus (r = 0.501), potassium (r = 0.525), sulphur (r = 0.491) and zinc (r = 0.531), copper (r = 0.513), iron (r = 0.493) and manganese (r = 0.471). A negative and significant correlation of calcium carbonate with nitrogen (r =-0.481) and phosphorus (r =-0.537). The clay content of sub-surface soils revealed significant and positive correlation with available nitrogen (r = 0.493), while-as, it showed non-significant correlation with all other nutrients under study.

Table.1 Soil and plant sampling sites (District Kargil)

Soil sample	Plant sample	Location	Latitude (North-south)	Longitude (East-West)	Altitude (meter, amsl)
S1	P1	Karkichu	34.63	76.25	2840
S2	P2	Hardas	34.61	76.25	2665
S3	P3	Hunderman	34.61	76.24	2661
S4	P4	Shiliksay	34.82	76.09	2680
S5	P5	Akchmal	34.59	76.23	2871
S6	P6	Poyen	34.74	76.08	2710
S7	P7	Gongma Kargil	34.79	76.23	2920
S8	P8	Chulichan	34.85	76.53	2700
S9	P9	Batalik	34.76	76.40	2803
S10	P10	Darchik	34.63	76.15	2675
S11	P11	Gargardo	34.84	76.46	2695
S12	P12	Garkhon	34.63	76.62	2724
S13	P13	Sanjak	34.80	76.69	2784
S14	P14	Menji	34.53	76.00	2778
S15	P15	Titichumik	34.57	76.00	2780
S16	P16	Hotriculture orchard	34.51	76.13	2816
S17	P17	kurbathang orchard	34.70	76.22	2824
S18	P18	KVK Orchard	34.70	76.16	2818
S19	P19	MARES Kargil	34.71	76.18	2816
S20	P20	Aba Grong	34.71	76.22	2874
S21	P21	Pishu	34.59	76.23	2868

Table.2 Mechanical properties of soils of apricot orchards of District Kargil

Sites	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
Karkichu	0-20	55.80	29.32	14.88	Sandy loam
	20-40	59.25	27.29	13.46	Sandy loam
	40-60	60.75	25.37	13.88	Sandy loam
Hardas	0-20	55.29	29.36	15.35	Sandy loam
	20-40	57.39	28.45	14.16	Sandy loam
	40-60	59.29	27.37	13.34	Sandy loam
Hunderman	0-20	64.03	20.05	15.92	Sandy loam
	20-40	66.37	18.36	15.27	Sandy loam
	40-60	69.47	17.43	13.10	Sandy loam
Shiliksay	0-20	56.16	25.03	18.81	Sandy loam
	20-40	58.92	24.02	17.06	Sandy loam
	40-60	59.47	23.45	17.08	Sandy loam
Akchmal	0-20	54.37	29.67	15.96	Sandy loam
	20-40	58.45	28.36	13.19	Sandy loam
	40-60	59.95	27.45	12.60	Sandy loam
Poyen	0-20	54.45	28.45	17.10	Sandy loam
	20-40	55.35	27.05	17.60	Sandy loam
	40-60	57.17	25.35	17.48	Sandy loam
Gongma Kargil	0-20	61.37	28.37	10.26	Sandy loam
	20-40	62.04	25.39	12.57	Sandy loam
	40-60	63.95	24.71	11.34	Sandy loam

Contd…

Sites	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
Chulichan	0-20	59.45	28.95	11.60	Sandy loam
	20-40	62.42	26.45	11.13	Sandy loam
	40-60	63.92	24.36	11.72	Sandy loam
Batalik	0-20	65.41	19.27	15.32	Sandy loam
	20-40	67.02	18.42	14.56	Sandy loam
	40-60	68.92	17.56	13.52	Sandy loam
Darchik	0-20	54.08	28.42	17.50	Sandy loam
	20-40	58.25	26.16	15.59	Sandy loam
	40-60	69.49	24.21	6.30	Sandy loam
Gargardo	0-20	56.31	28.21	15.48	Sandy loam
	20-40	57.21	26.12	16.67	Sandy loam
	40-60	60.32	25.01	14.67	Sandy loam
Garkhon	0-20	63.42	21.01	15.57	Sandy loam
	20-40	64.92	19.02	16.06	Sandy loam
	40-60	66.42	17.95	15.63	Sandy loam
Sanjak	0-20	57.32	26.32	16.36	Sandy loam
	20-40	59.72	25.11	15.17	Sandy loam
	40-60	62.31	23.56	14.13	Sandy loam
Menji	0-20	57.76	26.31	15.93	Sandy loam
	20-40	59.42	24.67	15.91	Sandy loam
	40-60	63.23	23.01	13.76	Sandy loam

Contd…

Sites	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Textural class
Titichumik	0-20	65.11	19.42	15.47	Sandy loam
	20-40	67.23	17.33	15.44	Sandy loam
	40-60	69.41	16.23	14.36	Sandy loam
Horticulture orchard	0-20	52.31	28.13	19.56	Sandy loam
	20-40	54.42	27.04	18.54	Sandy loam
	40-60	56.33	25.45	18.22	Sandy loam
kurbathang orchard	0-20	64.32	23.42	12.26	Sandy loam
	20-40	66.42	22.22	11.36	Sandy loam
	40-60	69.81	21.32	8.87	Sandy loam
Kvk Orchard	0-20	51.42	29.12	19.46	Sandy loam
	20-40	53.92	27.11	18.97	Sandy loam
	40-60	55.22	25.27	19.51	Sandy loam
MARES, Kargil	0-20	50.13	28.14	21.73	Sandy loam
	20-40	52.75	26.24	21.01	Sandy loam
	40-60	54.12	25.27	20.61	Sandy loam
Aba Grong	0-20	67.95	18.21	13.84	Sandy loam
	20-40	68.08	16.31	15.61	Sandy loam
	40-60	69.02	14.21	16.77	Sandy loam
Pishu	0-20	52.32	27.18	20.50	Sandy loam
	20-40	54.52	25.12	20.36	Sandy loam
	40-60	56.32	24.02	19.66	Sandy loam
Mean (Surface)		**58.12**	**25.66**	**16.12**	
95% C.I		**55.64-60.43**	**24.05-27.60**	**14.84-17.43**	
Mean (Sub-surface)		**61.40**	**23.35**	**15.08**	
95% C.I		**59.14-63.67**	**21.71-25.19**	**13.81-16.49**	

Table.3 Physico-chemical properties of soils of apricot orchards of District Kargil

Location site	Depth (cm)	pH (1:2.5)	EC (dsm^{-1})	OC (%)	$CaCO_3$ (%)
Karkichu	0-20	8.25	0.34	0.10	0.31
	20-40	8.34	0.28	0.08	0.25
	40-60	8.67	0.25	0.08	0.26
Hardas	0-20	7.60	0.76	0.23	0.25
	20-40	7.07	0.28	0.08	0.21
	40-60	7.68	0.33	0.10	0.22
Hunderman	0-20	7.65	0.25	0.08	0.31
	20-40	7.68	0.34	0.10	0.24
	40-60	7.71	0.39	0.12	0.26
Shiliksay	0-20	8.20	0.34	0.10	0.31
	20-40	8.24	0.37	0.11	0.42
	40-60	8.42	0.41	0.12	0.42
Akchmal	0-20	8.48	0.64	0.19	0.33
	20-40	8.50	0.59	0.18	0.34
	40-60	8.53	0.52	0.16	0.33
Poyen	0-20	8.45	0.54	0.16	0.34
	20-40	8.29	0.57	0.17	0.26
	40-60	8.24	0.65	0.20	0.25
Gongma Kargil	0-20	7.92	0.98	0.29	0.34
	20-40	8.01	0.88	0.26	0.29
	40-60	8.04	0.62	0.19	0.28
Chulichan	0-20	7.25	0.69	0.21	0.25
	20-40	7.32	0.24	0.07	0.24
	40-60	7.29	0.25	0.08	0.25
Batalik	0-20	8.29	0.48	0.14	0.26
	20-40	8.56	0.34	0.10	0.23
	40-60	8.40	0.37	0.11	0.21
Darchik	0-20	7.39	0.42	0.13	0.37
	20-40	7.23	0.33	0.10	0.34
	40-60	8.02	0.11	0.03	0.34
Gargardo	0-20	7.14	0.58	0.17	0.27
	20-40	7.31	0.31	0.09	0.25
	40-60	7.29	0.26	0.08	0.27

Contd…

Location site	Depth (cm)	pH (1:2.5)	EC (dsm^{-1})	OC (%)	$CaCO_3$ (%)
Garkhon	0-20	8.45	0.48	0.14	0.26
	20-40	8.42	0.43	0.13	0.24
	40-60	8.40	0.41	0.12	0.21
Sanjak	0-20	8.35	0.62	0.19	0.31
	20-40	8.34	0.49	0.15	0.28
	40-60	8.55	0.50	0.15	0.29
Menji	0-20	7.68	0.72	0.22	0.27
	20-40	7.52	0.35	0.11	0.24
	40-60	7.54	0.62	0.19	0.25
Titichumik	0-20	7.91	0.51	0.15	0.21
	20-40	7.93	0.45	0.14	0.15
	40-60	7.95	0.16	0.05	0.11
Horticulture orchard	0-20	7.97	0.96	0.29	1.41
	20-40	7.81	0.82	0.25	3.11
	40-60	7.76	0.76	0.23	3.26
Kurbathang orchard	0-20	7.52	0.64	0.19	0.41
	20-40	7.60	0.29	0.09	0.36
	40-60	8.42	0.40	0.12	0.32
KVK Orchard	0-20	7.53	0.82	0.25	1.21
	20-40	7.62	0.76	0.23	0.75
	40-60	7.64	0.74	0.22	0.72
MARES Kargil	0-20	7.78	0.65	0.20	0.65
	20-40	7.80	0.59	0.18	0.61
	40-60	7.79	0.57	0.17	0.58
Aba Grong	0-20	8.20	0.54	0.16	0.45
	20-40	8.30	0.46	0.14	0.37
	40-60	8.31	0.42	0.13	0.38
Pishu	0-20	8.10	0.46	0.14	0.31
	20-40	7.96	0.32	0.10	0.32
	40-60	7.84	0.29	0.09	0.28
Mean (Surface)		**7.90**	**0.59**	**0.18**	**0.45**
95% C.I		**7.72-8.10**	**0.50-0.68**	**0.15-0.20**	**0.28-0.56**
Mean (Sub-surface)		**7.96**	**0.44**	**0.13**	**0.51**
95% C.I		**7.78-8.15**	**0.36-0.52**	**0.11-0.16**	**0.16-0.75**

Table.4 Available Macronutrients in soil samples of apricot orchards of District Kargil

Location site	Depth (cm)	N	P	K	Ca	Mg	S
		kg/ha			Ppm		kg/ha
Karkichu	0-20	248.37	21.63	350	248.30	23.07	11.36
	20-40	223.28	19.86	225	229.70	22.39	11.42
	40-60	200.70	18.26	180	232.50	0.56	10.84
Hardas	0-20	210.74	25.25	370	251.20	21.12	11.11
	20-40	173.11	21.96	290	250.70	18.26	10.84
	40-60	160.56	19.86	220	246.80	23.74	10.98
Hunderman	0-20	250.88	22.96	335	226.10	21.62	11.61
	20-40	193.18	22.22	270	224.50	23.15	11.89
	40-60	179.38	21.80	210	221.00	21.36	11.84
Shiliksay	0-20	248.37	23.08	190	220.80	2.475	10.87
	20-40	223.28	22.39	180	243.80	23.91	11.22
	40-60	148.02	22.13	160	227.60	23.62	11.44
Akchmal	0-20	223.28	18.30	355	230.30	14.99	11.00
	20-40	185.65	21.70	335	234.10	15.63	10.95
	40-60	135.48	22.13	210	249.50	25.09	10.84
Poyen	0-20	235.83	25.89	175	239.90	6.75	11.06
	20-40	173.11	23.90	105	222.30	3.79	11.25
	40-60	148.02	22.48	80	224.10	4.94	11.69
Gongma Kargil	0-20	160.56	19.92	475	223.30	23.54	11.50
	20-40	135.48	18.50	435	148.60	22.56	11.53
	40-60	112.90	17.50	415	145.00	22.48	11.14
Chulichan	0-20	260.92	31.40	240	229.30	16.38	12.06
	20-40	223.28	29.49	110	258.40	17.64	11.17
	40-60	210.74	27.45	70	143.40	24.54	10.87

Contd…

Location site	Depth (cm)	N	P	K	Ca	Mg	S
		kg/ha			Ppm		kg/ha
Batalik	0-20	273.46	18.44	240	226.60	21.99	11.14
	20-40	223.28	16.49	175	242.30	13.16	11.47
	40-60	135.48	16.28	145	253.50	1.88	11.17
Darchik	0-20	223.28	32.57	195	220.30	14.60	11.00
	20-40	185.65	30.83	145	196.60	20.40	10.76
	40-60	148.02	29.80	110	219.60	23.97	10.60
Gargardo	0-20	260.92	34.55	260	221.56	16.46	12.12
	20-40	229.56	32.42	230	220.12	17.36	12.46
	40-60	210.74	31.57	210	184.30	23.45	12.49
Garkhon	0-20	273.46	28.10	335	230.50	23.66	10.89
	20-40	260.92	26.92	175	91.05	18.17	11.25
	40-60	223.28	26.18	140	99.05	23.42	11.89
Sanjak	0-20	273.46	17.50	130	167.00	24.72	12.00
	20-40	235.83	16.66	70	158.60	22.41	11.31
	40-60	210.74	15.51	60	238.30	20.76	11.28
Menji	0-20	260.92	30.44	250	198.40	16.74	11.31
	20-40	173.11	28.89	165	256.10	22.04	11.17
	40-60	110.39	26.73	110	241.60	12.13	11.31
Titichumik	0-20	185.65	18.41	160	246.40	16.86	11.39
	20-40	85.30	19.68	115	250.80	24.06	11.03
	40-60	122.93	20.30	105	156.10	23.60	10.87

Contd…

Location site	Depth (cm)	N	P	K	Ca	Mg	S
		kg/ha			Ppm		kg/ha
Horticulture orchard	0-20	260.92	31.79	360	236.40	25.00	11.55
	20-40	198.20	30.07	215	274.10	22.19	11.31
	40-60	160.56	29.53	175	243.10	0.03	11.03
Kurbathang orchard	0-20	210.74	23.56	365	236.60	0.93	11.72
	20-40	173.11	22.13	190	223.30	13.38	11.44
	40-60	97.84	21.35	150	156.10	24.08	11.14
KKk Orchard	0-20	260.92	20.12	320	221.36	25.36	12.43
	20-40	210.74	18.75	280	222.15	22.17	12.20
	40-60	135.48	18.06	240	210.45	21.86	12.00
MARES, Kargil	0-20	248.37	23.19	305	210.35	24.16	11.53
	20-40	185.65	21.59	270	164.36	23.56	11.42
	40-60	148.02	20.54	245	156.32	22.15	11.36
Aba Grong	0-20	198.20	19.08	255	245.60	23.45	11.86
	20-40	148.02	18.35	230	231.60	21.56	12.18
	40-60	97.84	17.50	215	231.80	22.01	12.00
Pishu	0-20	260.92	20.29	285	246.10	24.48	11.14
	20-40	235.83	18.81	255	236.12	23.84	11.47
	40-60	198.20	18.50	235	228.16	23.54	11.64
Mean (surface)		**237.57**	**24.28**	**285.00**	**217.13**	**18.03**	**11.48**
95% C.I		**225.28-253.79**	**21.67-26.57**	**244.35-322.32**	**218.72-236.17**	**15.17-21.82**	**11.26-11.66**
Mean (sub-surface)		**175.39**	**22.57**	**196.48**	**210.29**	**18.77**	**11.39**
95% C.I		**158.57-192.42**	**20.32-24.69**	**156.79-231.30**	**193.79-229.42**	**16.53-21.61**	**11.19-11.59**

Table.5 Micro-nutrient status in soils of apricot orchards of District Kargil (mg/kg)

Location site	Depth(cm)	Zn	Cu	Fe	Mn
Karkichu	0-20	0.61	0.57	2.82	1.19
	20-40	0.34	0.55	2.32	0.99
	40-60	0.32	0.44	2.23	0.83
Hardas	0-20	0.54	2.78	11.99	1.23
	20-40	0.43	2.06	10.46	0.92
	40-60	0.41	1.24	5.69	0.39
Hunderman	0-20	0.58	1.15	4.36	2.14
	20-40	0.57	0.81	4.01	1.78
	40-60	0.41	0.74	3.98	0.86
Shiliksay	0-20	0.57	1.53	4.35	2.51
	20-40	0.56	1.10	3.90	1.34
	40-60	0.46	0.96	2.68	0.55
Akchmal	0-20	0.65	1.39	4.39	1.69
	20-40	0.54	0.98	2.19	1.49
	40-60	0.52	0.92	1.51	1.36
Poyen	0-20	0.55	0.57	7.22	1.41
	20-40	0.54	0.42	5.51	0.48
	40-60	0.46	0.30	3.54	0.39
Gongma Kargil	0-20	0.71	0.34	4.21	1.03
	20-40	0.49	0.24	3.26	0.79
	40-60	0.43	0.23	3.20	0.64
Chulichan	0-20	0.57	1.20	7.67	1.49
	20-40	0.56	0.77	7.09	1.38
	40-60	0.55	0.69	6.41	0.50
Batalik	0-20	0.58	0.71	4.35	2.22
	20-40	0.57	0.53	3.31	1.41
	40-60	0.56	0.44	2.73	1.25
Darchik	0-20	0.50	0.55	10.12	2.22
	20-40	0.31	0.47	14.37	1.41
	40-60	0.29	0.20	12.84	1.37
Gargardo	0-20	0.51	1.24	7.25	1.56
	20-40	0.48	0.30	6.68	1.31
	40-60	0.39	0.22	6.02	1.01

Contd…

Location site	Depth(cm)	Zn	Cu	Fe	Mn
Garkhon	0-20	0.50	0.38	5.02	5.45
	20-40	0.33	0.30	2.41	2.86
	40-60	0.31	0.22	1.83	2.07
Sanjak	0-20	0.54	1.22	5.78	1.12
	20-40	0.50	0.77	5.47	1.03
	40-60	0.49	0.53	4.80	0.35
Menji	0-20	0.51	1.16	9.79	1.10
	20-40	0.40	0.98	7.58	0.79
	40-60	0.36	0.90	4.62	0.63
Titichumik	0-20	0.48	1.51	5.47	1.85
	20-40	0.40	1.41	4.89	0.94
	40-60	0.37	0.63	3.18	0.75
Horticulture orchard	0-20	0.69	0.79	6.37	0.94
	20-40	0.46	0.77	4.75	0.37
	40-60	0.39	0.71	4.39	0.26
Kurbathang orchard	0-20	0.56	1.02	4.17	2.68
	20-40	0.49	0.83	3.85	1.98
	40-60	0.48	0.81	1.96	0.57
KVK Orchard	0-20	0.64	1.56	6.48	1.56
	20-40	0.41	1.02	5.64	1.04
	40-60	0.36	0.94	5.03	0.86
MARES, Kargil	0-20	0.53	0.64	3.56	1.06
	20-40	0.50	0.58	3.38	0.92
	40-60	0.48	0.56	2.86	0.61
Aba Grong	0-20	0.53	0.81	4.58	1.21
	20-40	0.50	0.78	3.87	0.86
	40-60	0.48	0.73	3.16	0.61
Pishu	0-20	0.55	0.71	3.24	1.16
	20-40	0.43	0.64	3.14	1.06
	40-60	0.31	0.61	2.89	0.96
Mean (surface)		**0.56**	**1.09**	**4.41**	**1.88**
95% C.I		**0.53-0.59**	**0.79-1.29**	**4.76-6.97**	**1.30-2.21**
Mean (Sub-surface)		**0.63**	**0.72**	**4.76**	**1.02**
95% C.I		**0.57-0.70**	**0.54-0.85**	**3.41-5.81**	**0.79-1.21**

Table.6 Relationship between the physico-chemical characteristics and available soil nutrients in surface soils of apricot orchard of District Kargil

	pH	EC	OC	$CaCO_3$	Clay	N	P	K	Ca	Mg	S	Zn	Cu	Fe	Mn
pH	1														
EC	-0.213	1													
OC	-0.234	0.998**	1												
$CaCO_3$	-0.105	0.528*	0.544*	1											
Clay	0.137	-0.141	-0.113	0.471*	1										
N	0.054	-0.534*	0.498*	-0.479*	0.475*	1									
P	-0.566*	0.121	0.508*	-0.417*	0.023	0.284	1								
K	-0.097	0.434*	0.424*	0.261	-0.254	-0.290	-0.030	1							
Ca	0.033	-0.123	-0.147	0.421*	-0.131	-0.386	0.017	0.341	1						
Mg	0.095	0.239	0.253	0.428*	0.169	0.187	-0.190	0.271	-0.094	1					
S	-0.508*	0.356	0.469*	0.380	-0.164	0.098	0.015	0.015	-0.273	0.264	1				
Zn	-0.015	0.131	0.473*	0.001	-0.117	-0.048	-0.170	0.005	0.059	0.167	-0.125	1			
Cu	-0.299	0.127	0.482*	-0.046	0.023	-0.077	-0.057	-0.064	-0.059	-0.132	0.124	0.075	1		
Fe	-0.484*	0.287	0.497*	-0.023	0.048	-0.009	0.588*	-0.194	-0.094	-0.099	-0.016	0.124	0.497	1	
Mn	0.180	-0.382	0.432*	-0.231	-0.103	0.192	0.128	0.011	0.077	-0.210	-0.355	-0.012	-0.178	-0.120	1

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table.7 Relationship between the physico-chemical characteristics and available soil nutrients in sub-surface soils of apricot orchard of District Kargil

	pH	EC	OC	$CaCO_3$	Clay	N	P	K	Ca	Mg	S	Zn	Cu	Fe	Mn
pH	1														
EC	0.139	1													
OC	0.140	0.997**	1												
$CaCO_3$	-0.110	0.551*	0.553*	1											
Clay	0.013	0.498*	0.422	0.348	1										
N	0.019	-0.498*	0.542*	-0.481*	0.493*	1									
P	-0.552*	-0.150	0.501*	-0.537*	-0.122	0.229	1								
K	-0.071	0.395	0.525*	0.477*	0.100	-0.230	-0.262	1							
Ca	-0.084	-0.067	-0.069	0.257*	0.068	0.065	0.049	-0.121	1						
Mg	-0.304	-0.187	-0.173	0.537*	-0.023	-0.039	-0.043	0.280	-0.341	1					
S	-0.532*	0.161	0.491*	-0.043	.0447*	0.195	-0.042	0.248	-0.127	0.094	1				
Zn	-0.202	0.310	0.531*	0.070	0.264	-0.419	-0.306	0.276	-0.029	0.220	0.342	1			
Cu	-0.237	-0.052	0.513*	0.045	0.006	-0.305	-0.194	0.005	0.423	0.256	-0.259	0.074	1		
Fe	-0.620*	-0.289	0.493*	-0.009	-0.286	-0.010	0.505*	-0.275	0.197	0.138	-0.251	-0.092	0.068	1	
Mn	0.212	-0.364	0.471*	-0.361	-0.262	0.377	0.157	-0.031	-0.418	0.223	0.076	-0.277	-0.292	-0.113	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table.8 Nutrient status of apricot orchard of District Kargil (%)

Nutrients	Low	Medium	High
Nitrogen (N)	100	-	-
Phosphorus (P)	-	61.90	38.09
Potassium (K)		47.61	52.38
Zinc (Zn)	76.19	23.80	
Copper (Cu)	-	95.23	4.76
Iron (Fe)	42.85		57.14
Manganese (Mn)	100		

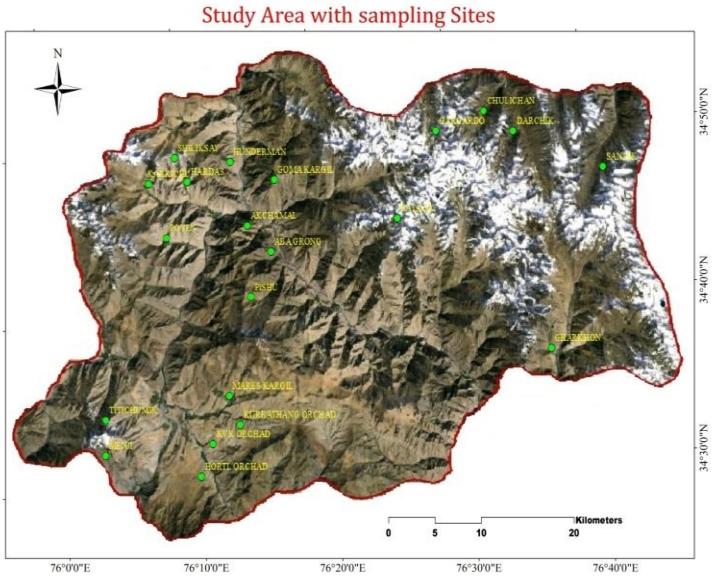
Table.9 Critical limits of available macro-nutrients in soil (Tandon, 1989)

Nutrients	Low	Normal	High
N	<280 kg/ha	280-560 kg/ha	>560 kg/ha
P	<10 kg/ha	10-25 kg/ha	>25 kg/ha
K	<110 kg/ha	110-280 kg/ha	>280 kg/ha
O.C	<0.50%	0.50-0.75%	>0.75%

Table.10 Critical limits of available micro-nutrients in soil

Nutrients	Low	Normal	High	References
Zn (mg/kg)	<0.6	0.6-1.2	> 1.2	Takkar and Mann (1975)
Cu (mg/kg)	<0.2	0.2-2.0	> 2.0	Follet and Lindsay(1970)
Fe (mg/kg)	< 4.5	-	-	Follet and Lindsay(1970)
Mn (mg/kg)	< 3.74	-	-	Nayyar *et al.*, (1985)

Map.1 GIS Arc map of sampling sites (District Kargil)



The overall soil nutrient status of apricot orchards of District Kargil was summarized in Table 8 based on different categorization limits prescribed by different researchers (Follet and Lindsay, 1970; Takkar and Mann, 1975; Nayyar *et al.,* 1985 and Tandon, 1989) (Table 9 and 10). The overall nitrogen content in apricot orchards of District Kargil falls under low category while in case of phosphorus content 61.90% of soil samples fall under the medium category and 38.09% of the soil samples fall under the high category. In respect of potassium content in orchard soils 47.61% of soil samples falls under medium category and 52.38% falls under the high category. While observing the micronutrient status of apricot orchards of District Kargil available zinc content ranged from low category to medium category i.e., 76.19% soil samples were categorized under low category while 23.80% of soil samples fall under medium category. Similarly in case of copper content in the orchard soils of District Kargil 95.23% soil samples were categorized into medium category and 4.76% soil samples were categorized into the high status. While in case of iron content 42.85% soil samples falls under the low category and 57.14% soil samples were under medium to high category. Manganese content in all orchard soils falls within the low category.

From the summarized result of the present investigation it can be concluded that soils of apricot orchards of district Kargil were low in organic carbon and available nitrogen content but by and large adequately supplied with phosphorus, potassium, calcium, magnesium and sulhpur. Micronutrients like zinc, and manganese were low in these orchard soils. Iron content in these soils was low to adequate while as copper content of these orchard soils was sufficient. Poor nitrogen status of the orchard soils was matter of concern but it does not necessarily mean additional requirements as such until optimum values are determined with a deeper understanding of overall status for more seasons. Awareness campaigns should be conducted along with trainings by trained professionals to the farmers for better management of orchards. There is need to sort out the huge variations between soil and leaf analysis by way of standardizing the methods of nutrient extraction besides calculating the critical limits befitting environmental conditions of cold arid zones. Further and time to time surveys should be carried out in order to assess the nutrient status of soil, plant and its impact on quality of fruit. Microbiological parameters are also needed to study for the deeper understanding of microbial interactions in soil.

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How to cite this article:

Mansoor Ali, M.A. Malik, Tsering Dolkar and Ahmad Ali. 2018. Nutrient Status of Aprioct (Prunus armeniaca L.) Orchards of District Kargil, Ladakh, India. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 257-277. doi: https://doi.org/10.20546/ijcmas.2018.706.031