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Macronutrients status of apple (cv. red delicious) orchard soils of Jammu and Kashmir India

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Abstract
Fifteen apple (Cv. Red Delicious) orchards of south, Kashmir with uniform age and vigour were selected and surveyed (simple random survey) for the purpose of collection of soil samples. The samples were processed and analyzed for different nutrients. In general the soils were medium in available nitrogen, medium to high in available phosphorus and high in available potassium with mean values of 354.0, 29.14 and 468.27 kg/ha, respectively in surface soils (0-25 cm) and mean values of 247.37, 24.97 and 419.85 kg/ha, respectively in sub-surface soils (25-75 cm). All the soils under investigation were high in available, calcium and magnesium showing average values of, 1993.0, 353.2 ppm and, 2017.0 and 365.3 ppm in surface and sub-soils, respectively. The soils were medium in sulpher content with surface and sub-surface sulpher content of 11.2 and 9.7 respectively.

Keywords: apple orchards, macronutrients, fertility status & Kashmir

Introduction
Apple is thought to have originated in the Caucasus region of southeastern Europe and possibly southwestern Siberia, from where, man widened its sphere of cultivation to almost every corner of the world. In India cultivation of apple is confined to the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and to the limited extent to the states of Arunachal Pradesh, Sikkim, Nagaland, Meghalaya and Manipur. It is a typical temperate fruit primarily growing in USA, China, France, Italy, Turkey, Argentina, Germany, Spain, Japan and USSR. Present world production of apples is close to 60 million tones (Anonymous, 2012) [3] with China producing almost half of the total and United States is the second-leading producer. The area under apple cultivation in Jammu and Kashmir is 163432 hectares including Kashmir 144733 hectares and Jammu 18699 hectares. The production of apple in the state is 1170306 metric tons with 1139180 metric tons in Kashmir and 31126 metric tons in Jammu region (Anonymous, 2015). The leading districts of Kashmir in production and area are Shopian, Baramulla, Kulgam, Anatnag and Pulwama, however Shopian and Pulwama districts of south Kashmir are well known for quality and production.
\Nutrition plays an important role in determining the quality and yield of fruit crops. The major nutrients (Nitrogen, phosphorus, potassium and calcium) has a major effect on fruit quality. Neilsen and Neilsen (2009) [23] reported that increased phosphorus applied through fertigation increased yield and decreased watercore and browning. Potassium fertilization increased fruit colour and quality without increasing bitter pit. Calcium reduced bitter pit, while nitrogen fertilization increased yield but reduced fruit colour and quality.

Material and Methods
Soil samples from 20 orchards of uniform age and vigour were collected depth wise with an increment of 25 cm to a depth of 75 cm following simple random sampling from different apple orchards of south Kashmir. The collected soil samples were air-dried in shade. The air dried samples were ground with wooden pestle and mortar and passed through 2 mm sieve to separate the coarse fragments (>2 mm). The soil sample were analyzed for various physical and chemical parameters. Available nitrogen was determined by alkaline potassium permanganate distillation method as described by Subbiah and Asija (1956) [32]. Available phosphorus content of the soil was extracted by 0.5 N sodium bicarbonate at pH 8.5 (Olesen *et al*. 1954) [24] and was estimated by ammonium molybdate method as outlined by Jackson (1973) [15].

Available potassium was extracted with neutral normal ammonium acetate at 1:5 soil to extract ratio and the content of potassium was estimated by flame photometer. Available sulphur in soil was determined by Chesnin and Yien (1951) [8] method after extracting the soil with Morgan's reagent having pH 4.8. Calcium and magnesium content in the soil samples were determined by versenate titration method (Jackson, 1973) [15].

Results and Discussions

The data pertaining to available macronutrient status of soils is presented in Table no. 1 and 2 and the data regarding fertility status of soils is presented in Table no 3.

Macronutrients Status of Soils

Primary nutrients

Available nitrogen content of surface and sub-surface soils varied from 219.96 to 595.84 and 153.66 to 364.67 kg/ha with mean values of 354.00 and 247 kg/ha, respectively (Table 1). A perusal of Table-3 showed that 75 per cent samples have medium status, 15 per cent have low status and 10 per cent have high status of available nitrogen. It may be due to slower decomposition of organic matter under temperate conditions and removal of mineralized nitrogen by intensive cropping. The results are in accordance with the findings of Akther (2005) [2], Masrat (2015) [15] Bhat *et al* (2017) [7] Wani *et al* (2017) and Zargar (2005) [36]. The variation in nitrogen content is due to variation in climatic and physiographic conditions, variation in organic matter content, difference in natural fertility and variation in use of nitrogenous fertilizers. Nitrogen content of surface soils was higher than sub-soils and showed a decreasing trend with depth of soil profile. The decrease in available nitrogen with increase in soil depth may be due to presence of higher organic matter content and favourable environmental conditions for mineralization at surface than sub-surface layers. The results are in agreement with the findings of Ranjha *et al.* (2002) [26], Dar (2009) [10] and Singh and Rathore (2013) [31].

Perusal of data in the Table 1 revealed that available phosphorus content of surface soils varied from 20.16 to 38.52 kg/ha, whereas, in sub-surface soils it varied from 17.47 to 36.73 kg/ha, with an average values of 29.14 and 24.96 kg/ha, respectively. In general available phosphorus showed a decreasing trend with increase in soil depth. The higher amount of organic matter in surface soils might be the reason for greater amount of available phosphorus in surface layers. The present findings are in line with the results obtained by Dar (2009) [10], Fida *et al.* (2011) [13], Deepika and Srivastava (2013) [11], Kumar *et al.* (2014) [17], Bhat *et al* (2017) [7] and Wani *et al* (2017). The available phosphorus status of soils under study area ranged from medium to high (Table 3). It was recorded that 30 per cent orchards were medium and 70 per cent were high in available phosphorus content. This is in accordance with the results observed by Mushki (1994) [20] and Wani (2001) [34]. The available phosphorus content in soils of different altitudes varied significantly with higher content in high altitude soils followed by low altitude soils, which could be attributed to favorable soils reaction and high organic matter leading to the formation of organophosphate complexes and coating of iron and aluminium particles by humus. This is supported by the research work of Singh and Bhandari (1992) [30] and Akhter (2005) [27].

Data in the table 1 showed that available potassium content varied from 434.56 to 508.48 and 362.88 to 463.68 kg/ha with mean values of 468.27 and 419.85 kg/ha in surface and sub-surface soils, respectively. Available potassium content was in high range (Table 3). It might be due to prevalence of potassium rich clay minerals like illite, application of potassium fertilizers and manures. This is in agreement with the findings of Dar *et al.* (2015) [9], Bhat *et al* (2017) [7] Wani *et al* (2017) Najar (2002) [21], Ahlawat and Sindhu (1990) [1] and Patil *et al.* (2015) [15]. The data indicated that available potassium content did not reveal any specific trend with the depth. However, higher content of available potassium was found in surface soils than sub-surface soils, which may be attributed to higher weathering of potassium bearing minerals in surface soils, due to greater exposure of these minerals to weathering agencies at surface than sub-soils and also due to fertilizer and manure additions to surface soils. The results are supported by the findings of Akther (2005) [2], Dar (2009) [10], Fida *et al.* (2011) [13], Demirer *et al.* (2007) [12] and Negroo (2001) [22].

Secondary nutrients

An examination of data in the Table 2 indicated that soil available calcium content of surface soils ranged from 1800.0 to 2220.0 ppm with an average value of 1993.0 ppm, whileas, in sub-surface soils it showed a variation of 1800.0 to 2360.0 ppm with an average value of 2017.0 ppm. The variation of available calcium content among different locations may be due to difference in amount of calcium bearing minerals, difference in pH of soils and difference in elevation and slope of different locations. In general calcium content of sub-surface layers was higher than the surface layers, which might be due leaching of calcium from surface to sub-surface layers. The results are in agreement with those of Ahmad (2003), Wani (2001) [34], Dar (2009) [10], Bhat *et al* (2017) [7] and Wani *et al* (2017). Soils under apple orchards in south Kashmir were sufficiently supplied with available calcium and it was high in all the soils (Table 3). The reason may be due to presence of thick uniform layer of limestone with substantial quantities of dolomite and shale, which encircle whole valley of Kashmir in the form of cliffs (Wadia, 1981) [33]. The calcareous nature of parental material as reported by Handoo (1983) [14] may also be a responsible for high available calcium content of these soils. The observations are supported by the findings of Dar *et al.* (2015) [9], Masrat (2015) [19], Shaaban and El-Fouly (2012) [28], Yogeeshappa *et al.* (2008) [35] and Bhargava and Raghupathi (2001).

The data presented in the Table 2 revealed that available magnesium content of surface and sub-surface soils varied statistically from 276.0 to 466.0 and 296.0 to 512.0 ppm with average values of 353.2 and 365.3, respectively and showed an inconsistent trend with soil depth. Similar results were observed by Verma *et al.* (1990), Talib (1984), Singh *et al.* (1990) and Dar (2009) [10] who also didn't observe any definite relationship of exchangeable magnesium with soil depth. Available magnesium content was high (Table 3), which may be due to presence of illite and chlorite type of minerals in Kashmir as reported by Najar (2002) [21]. The results are further supported by the findings of Akther (2005) [2], Dar *et al.* (2015) [9], Masrat (2015) [19] and Shah (2004) Bhat *et al* (2017) [7], Wani *et al* (2017) showed an inconsistent trend with soil depth. Similar results were observed by Verma *et al.* (1990), Talib (1984), Singh *et al.* (1990) and Dar (2009) [10] who also didn't observe any definite relationship of exchangeable magnesium with soil depth.

Perusal of data in Table 2 indicated that available sulphur content varied from 9.2 to 12.2 ppm with mean value of 11.2 ppm in surface soils, whereas, in sub-soils varied from 8.7 to

11.0 ppm with mean value of 9.7 ppm. The soils were low to medium in available sulphur content, as 5 per cent orchards were low and 95 per cent were medium in available sulphur content (Table 3). The results might be attributed to the temperate environmental conditions resulting in low mineralization of organic matter, thus lower release of available sulphur. The results are in conformity with the findings of Antoo (2000) [4], Masrat (2015) [19], Bhat *et al* (2017) [7], Wani *et al* (2017) [9], Sharma and Bhandari (1992) [30] and Arora *et al.* (1989) [5]. The variation in organic matter content among different locations may be responsible for difference in available sulphur content among different locations. In general surface soils were higher in available sulphur but no specific trend was observed with the increase in soil depth. The results are supported by the findings of Aora *et al.* (1989), Dar (1996) and Wani (2001) [9].

Table 1: Available primary nutrient status of apple orchard soils of south Kashmir

Location	Depth (cm)	N (Kg ha^{-1})	P (Kg ha^{-1})	K (Kg ha^{-1})
Keller	0-25	595.84	38.52	499.52
	25-50	364.67	35.84	445.76
	50-75	254.01	34.04	432.32
Hurpora	0-25	579.26	38.08	508.48
	25-50	349.88	36.73	452.48
	50-75	266.11	30.91	439.04
Killora	0-25	444.41	34.04	468.16
	25-50	296.12	30.46	445.76
	50-75	243.26	26.43	452.48
Loosdanan	0-25	422.91	33.60	470.40
	25-50	334.20	29.56	441.28
	50-75	251.77	27.77	421.12
Kachdoora	0-25	405.44	34.94	497.28
	25-50	289.85	27.77	430.8
	50-75	207.87	24.19	418.88
Harmain	0-25	328.38	30.91	490.56
	25-50	286.12	26.88	450.24
	50-75	230.27	22.40	405.44
Imamshab	0-25	374.52	32.70	472.64
	25-50	320.32	30.91	423.36
	50-75	220.41	26.88	400.96
Kapran	0-25	359.29	26.88	441.28
	25-50	342.36	25.08	383.04
	50-75	176.06	21.95	362.88
Reish Nagri	0-25	349.88	29.12	472.64
	25-50	258.49	27.77	454.72
	50-75	197.56	24.64	439.04
Zainpora	0-25	319.42	25.08	456.96
	25-50	240.57	22.84	432.32
	50-75	181.88	21.95	441.28
Kamrizipora	0-25	336.89	32.25	479.36
	25-50	275.96	28.22	423.36
	50-75	234.75	22.84	371.84
Drubugam	0-25	330.17	30.91	465.92
	25-50	283.58	27.32	463.68
	50-75	219.96	24.64	430.08
Bandzoo	0-25	310.01	28.67	483.84
	25-50	231.16	26.88	443.52
	50-75	203.39	25.08	409.92
Rahmo	0-25	287.61	29.56	461.44
	25-50	300.60	26.88	427.84
	50-75	256.70	24.64	398.72
Gossu	0-25	292.99	24.19	468.16
	25-50	253.56	21.95	439.04
	50-75	207.42	19.26	407.68
Rajpora	0-25	340.92	23.74	450.24
	25-50	251.77	21.05	405.44
	50-75	224.48	18.36	385.28
Arihal	0-25	283.58	23.29	445.76
	25-50	266.11	21.95	383.04
	50-75	193.53	19.26	392.00
Ashmander	0-25	274.17	20.16	459.20
	25-50	254.01	17.92	432.32
	50-75	211.90	17.47	430.08
Tahab	0-25	224.44	23.74	439.04
	25-50	175.16	21.05	407.68
	50-75	168.44	17.92	362.88

Dalipora	0-25	219.96	22.4	434.56
	25-50	216.83	20.60	398.72
	50-75	153.66	20.16	407.68
Surface Range		219.96-595.84	20.16-38.52	434.56-508.48
Mean		354.00	29.14	468.27
Sub-surface		153.66-364.67	17.47-36.73	362.88-463.68
Mean		247.37	24.96	419.85
Surface C.D (P≤ 0.5)		46.88	5.48	16.18
Sub-surface C.D (P≤ 0.5)		28.46	3.51	11.06

Table 2: Available secondary nutrient status of apple orchard soils of south Kashmir

Location	**Depth (cm)**	**Ca (mg kg^{-1})**	**Mg (mg kg^{-1})**	**S (mg kg^{-1})**
Keller	0-25	1810.0	459.0	12.2
	25-50	1820.0	396.0	11.0
	50-75	1900.0	433.0	10.2
Hurpora	0-25	1800.0	474.0	12.0
	25-50	1830.0	445.0	10.9
	50-75	1880.0	496.0	10.0
Killora	0-25	1930.0	516.0	11.6
	25-50	1910c	530.0	10.1
	50-75	1980.0	540.0	9.7
Loosdanan	0-25	1960.0	476.0	11.2
	25-50	1980.0	507.0	10.4
	50-75	2030.0	522.0	9.5
Kachdoora	0-25	1830.0	496.0	11.9
	25-50	1800.0	514.0	10.1
	50-75	1880.0	522.0	9.7
Harmain	0-25	1806.0	496.0	11.1
	25-50	1810.0	521.0	9.1
	50-75	1830.0	538.0	8.9
Imamshab	0-25	2000.0	521.0	11.4
	25-50	2010.0	476.0	9.8
	50-75	2030.0	504.0	10.1
Kapran	0-25	1840.0	512.0	10.9
	25-50	1880.0	486.0	9.8
	50-75	1870.0	500.0	9.8
Reish Nagri	0-25	2000.0	502.0	9.8
	25-50	2010.0	522.0	10.0
	50-75	2030.0	533.0	9.5
Zainpora	0-25	2060.0	566.0	11.0
	25-50	2010.0	557.0	10.2
	50-75	2030.0	612.0	11.0
Kamrizipora	0-25	2020.0	382.0	11.8
	25-50	2050.0	419.0	10.0
	50-75	2040.0	457.0	9.1
Drubugam	0-25	1990.0	376.0	11.6
	25-50	1960.0	412.0	10.2
	50-75	2000.0	427.0	9.9
Bandzoo	0-25	2040.0	441.0	11.7
	25-50	2020.0	405.0	9.6
	50-75	2090.0	459.0	9.9
Rahmo	0-25	2060.0	448.0	11.0
	25-50	2080.0	457.0	9.6
	50-75	2030.0	476.0	10.2
Gossu	0-25	2090.0	427.0	11.4
	25-50	2110.0	409.0	9.4
	50-75	2180.0	449.0	10.1
Rajpora	0-25	2120.0	468.0	11.1
	25-50	2100.0	439.0	8.9
	50-75	2160.0	503.0	9.1
Arihal	0-25	2010.0	452.0	11.1
	25-50	2030.0	472.0	10.1
	50-75	2060.0	488.0	9.7
Ashmander	0-25	2150.0	459.0	10.7

	25-50	2170.0	466.0	8.7
	50-75	2190.0	521.0	9.2
Tahab	0-25	2130.0	509.0	10.9
	25-50	2080.0	499.0	9.7
	50-75	2170.0	505.0	9.9
Dalipora	0-25	2220.0	501.0	10.3
	25-50	2290.0	471.0	9.6
	50-75	2360 .0	521.0	8.9
Surface Range		1800.0-2220.0	276.0-466.0	9.2-12.2
Mean		1993.0	353.2	11.2
Sub-surface		1800.0-2360.0	296.0-512.0	8.7-11.0
Mean		2017.0	365.3	9.7
Surface C.D (P≤ 0.5)		51.59	276.0-466.0	0.89
Sub-surface C.D (P≤ 0.5)		61.08	353.2	0.62

Table 3: Soil fertility status of apple orchard soils of south Kashmir

Nutrient element	Concentration (Kg ha^{-1})		Fertility class (% samples)		
	Range	Mean	Low	Medium	High
N	219.96-595.84	159.4	15	75	10
P	20.16-38.52	13.01	-	30	70
K	434.56-508.48	159.05	-	-	100
	Concentration (ppm)				
Ca	1800-2220	1993	-	-	100
Mg	376-566	474.0	-	-	100
S	9.2-12.2	11.2	5	95	-

Conclusions

The apple orchards of south were adequately supplied with, potassium, calcium, magnesium, iron, manganese. Further soil analysis revealed that available nitrogen and sulphur were low in 15 and 5 per cent apple orchards, respectively. The Study may be useful to researchers for formulating further research and developmental programmes.

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