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Depth wise distribution of micronutrient of apple (Cv. Red Delicious) orchard soils of Jammu and Kashmir India

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Abstract
A Survey was carried out to study available nutrient status of apple orchard soils of south Kashmir. Twenty orchards 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. The mean available iron, manganese, zinc, copper, content of surface soils was 56.77, 42.43, 1.12, 2.27 ppm, respectively and in sub-surface soils of 51.30, 33.34, 0.89 and 1.48 ppm, respectively. Further it was observed that majority of soils were high in available iron, manganese, low to high in available zinc and medium to high in available copper.

Keywords: apple orchards, micronutrients, fertility status & Kashmir

Introduction
Apple (*Malus domestica* Borkh.) is the fourth most important commercial fruit crop throughout the world following citrus, grapes, and banana. 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.
The fruit industry is the backbone of economy in Jammu and Kashmir and has a great potential to ameliorate the condition of rural people. Kashmiri apple has lived up to its reputation for being one of the choicest fruits as Kashmir has been for long called the home of apples. 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. Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. The requirement of micronutrients (boron, iron, copper, zinc, manganese, molybdenum and chlorine) is only in traces, which is partly met from the soil or through chemical fertilizer or organic sources. Horticultural crops suffer widely by zinc deficiency followed by boron, manganese, copper, iron and Molybdenum deficiencies. Chlorine, copper, iron and manganese are involved in various processes related to photosynthesis and zinc, copper, iron, and manganese are associated with various enzyme systems, molybdenum is specific for nitrate reductase only. Boron is associated with the carbohydrate chemistry and reproductive system of the plant.

Material and Methods
A survey was conducted to study the fertility status of apple orchard soils in south Kashmir (J&K). 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. 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. The available iron, zinc, copper and manganese were determined by atomic absorption spectrophotometer after extracting with DTPA solution as described by Lindsay and Norvell (1978) [8].

Results and Discussions

The data pertaining to available micronutrient status is presented in table and the data regarding fertility status of soils is presented in Table no. 2.

Micronutrient status of soils

Available iron content of surface and sub-surface soils varied from 45.21 to 70.00 and 32.50 to 60.12 ppm with mean values of 56.77 and 51.30 ppm, respectively (Table 1) A perusal of data in Table 2 indicated that all the soils under study were high in available iron content, which may be due to presence high organic matter and due formation of iron chelates. The results are in agreement with those of Dar *et al.* (2015) [4], Masrtat (2015), Bhat *et al* (2017) [2], Nazif *et al.* (2006) [13] and Samiullah *et al.* (2013) [16]. The available iron content varied among different sites due to variation in organic matter, soil pH, elevation and slope. In general surface soils were richer in available iron than sub-surface soils and the content decreased with the depth of soil with unusual trend at few locations. This may be due to sufficient organic matter and low pH of surface soils. The results are in accordance with the observations of Patiram *et al.* (2000) [14], Dar (2009) [4], Fida *et al.* (2011) [6] and Sharma *et al.* (2005).

The data in Table 1 indicated that available manganese content of surface layers ranged from 30.12 to 54.78 ppm with an average value of 42.43 ppm, whereas, in sub-surface soils it varied from 21.50 to 42.17 ppm with a mean value of 33.34 ppm. Apple orchards were sufficiently supplied with available manganese as all the samples fall in the high range (Table 2). The adequacy of available manganese might be attributed to the positive effect of organic matter and suitable soil pH for manganese availability. The results are supported by the observations of Dar *et al.* (2015) [3], Masrat (2015) [9], Zargar (2005) [21] Bhat *et al* (2017) [2] and Nazif *et al.* (2006) [13]. Available manganese content varied among different locations and it was higher in surface soils than sub-surface layers, which may be due to low pH and high organic matter in surface soil layers. The results are in accordance with those of Muftuoglu *et al.* (2004) [10], Dar (2009) [4], Patiram *et al.* (2000) [14] and Demirer *et al.* (2007) [5].

Data presented in the Table 1 showed that available zinc content varied from 0.40 to 1.46 and 0.36 to 1.32 ppm with average values of 1.12 and 0.89 ppm in surface and sub-surface soil layers, respectively. The present study indicated that the available zinc content was low to high, as 10 per cent soils were low and 30 per cent medium and 60 per cent were high in available zinc (Table 2). The results might be attributed to the fact that organic matter to some extent reduces the pH of soils which increases the solubility of zinc besides its effect on weathering of zinc containing minerals and formation of chelated zinc. The results are in accordance with the findings of Khan *et al.* (1997), Muftuoglu *et al.* (2004) [10], Demirer *et al.* (2007) [5] and Samiullah *et al.* (2013) [16] Bhat *et al* (2017) [2]. The variation in amount of zinc might be due to difference in organic carbon, soil pH and other orchard management practices. The surface soils showed higher content of zinc than sub-surface soils and exhibited a decreasing trend with increase in soil depth, which might be due to higher organic carbon at surface soils, as organic carbon is a major contributor of available zinc in soils. The results are in conformity with those of Fida *et al.* (2011) [6], Shah *et al.* (2012) [17], Dar (2009) [4], Sharma and Choudary (2007) [18], Singh and Rathore (2013) [19] and Patiram *et al.* (2000) [14].

Table 1 revealed that available copper content varied from 1.79 to 2.43 ppm with mean value of 2.27 ppm in surface soils, whileas, it varied from 1.11 to 1.96 ppm with mean value of 1.48 ppm in sub-surface soils. The available copper status has been found as medium in 35 per cent samples and high in 65 per cent samples (Table-2). These results are in conformity with those of Mushki (1994) [11], Yeresheemi *et al.* (1998); Najar (2002) [12] and Sharma *et al.* (2005). The variation of soil available copper content among different locations might be due to variation in soil pH, organic matter, clay and calcium carbonate content. A decreasing trend of available copper content was observed with increase in depth and surface soils were richer in copper content, which might be due to higher organic matter and regular addition of fertilizers and manures to surface soils. The results are in agreement with findings of Dar (2009) [4], Ranjha *et al.* (2002) [15], Khokhar *et al.* (2012) [7], Najar (2002) [12] and Shah *et al.* (2012) [17].

Table 1: Available micronutrient cation status of apple orchard soils of south Kashmir

Location	Depth (cm)	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Keller	0-25	70.00	54.78	1.46	2.43
	25-50	57.84	42.17	1.32	1.89
	50-75	49.80	30.00	1.12	1.50
Hurpora	0-25	67.78	51.46	1.39	2.32
	25-50	60.12	41.00	1.22	1.96
	50-75	50.00	37.60	1.08	1.42
Killora	0-25	62.25	49.95	1.37	2.20
	25-50	49.63	40.00	1.20	1.69
	50-75	38.58	34.12	1.10	1.21
Loosdanan	0-25	60.00	48.00	1.30	2.18
	25-50	57.33	40.12	1.18	1.41
	50-75	41.00	36.14	1.08	1.20
Kachdoora	0-25	64.59	47.00	1.31	2.18
	25-50	50.00	38.91	1.18	1.49
	50-75	41.20	33.56	1.10	1.21
Harmain	0-25	56.20	46.00	1.26	2.14
	25-50	55.00	36.65	1.15	1.41
	50-75	44.40	38.00	0.83	1.23
Imamshab	0-25	59.90	49.00	1.21	2.10
	25-50	48.20	38.75	1.10	2.60
	50-75	41.00	33.11	0.78	1.68
Kapran	0-25	57.60	46.50	1.18	2.12

	25-50	49.00	40.00	1.08	1.58
	50-75	37.26	33.30	0.72	1.40
Reish Nagri	0-25	55.00	45.63	1.22	2.00
	25-50	43.65	38.00	1.09	1.56
	50-75	45.67	29.20	0.72	1.23
Zainpora	0-25	51.30	37.34	1.15	2.13
	25-50	47.65	31.45	1.06	1.52
	50-75	42.29	30.00	0.71	1.11
Kamrizipora	0-25	60.59	45.21	1.24	2.13
	25-50	50.12	40.10	1.10	1.52
	50-75	43.00	40.01	0.81	1.20
Drubugam	0-25	59.88	43.20	1.21	2.10
	25-50	51.20	35.50	1.08	1.71
	50-75	41.22	29.98	0.78	1.60
Bandzoo	0-25	59.68	42.16	1.16	2.06
	25-50	48.69	33.54	1.04	1.69
	50-75	49.00	26.59	0.73	1.33
Rahmo	0-25	57.22	39.55	1.10	2.02
	25-50	49.00	35.30	1.02	1.67
	50-75	37.00	36.00	0.71	1.41
Gossu	0-25	50.12	35.00	1.13	1.96
	25-50	40.30	29.54	1.03	1.56
	50-75	36.00	25.88	0.73	1.29
Rajpora	0-25	47.88	33.66	1.0	1.90
	25-50	40.00	29.52	0.89	1.63
	50-75	38.32	27.56	0.72	1.27
Arihal	0-25	54.50	39.78	0.97	1.79
	25-50	43.45	33.00	0.82	1.46
	50-75	46.20	33.78	0.73	1.23
Ashmander	0-25	49.56	32.12	0.88	1.86
	25-50	43.52	26.21	0.78	1.52
	50-75	36.70	21.50	0.68	1.29
Tahab	0-25	45.21	32.15	0.50	1.92
	25-50	42.31	29.55	0.46	1.60
	50-75	37.21	25.00	0.38	1.30
Dalipora	0-25	46.20	30.12	0.40	1.79
	25-50	39.12	26.00	0.36	1.45
	50-75	32.50	27.21	0.29	1.30
Surface Range		45.21-70.00	30.12-54.78	0.40-1.46	1.79-2.43
Mean		56.77	42.43	1.12	2.27
Sub-surface		32.50-60.12	21.50-42.17	0.36-1.32	1.11-1.96
Mean		51.30	33.34	0.8990	1.4832
Surface C.D ($P\leq 0.5$)		51.59	23.59	0.89	
Sub-surface C.D ($P\leq 0.5$)		61.08	27.19	0.62	

Table 2: Soil fertility status of apple orchard soils of south Kashmir

Nutrient element	Concentration (ppm)		Fertility class (% samples)		
	Range	Mean	Low	Medium	High
Fe	45.21-70	56.77	-	-	100
Mn	30.12-54.78	42.43	-	-	100
Zn	0.40-1.46	1.12	10	30	60
Cu	1.79-2.43	0.27	-	35	65

Conclusions

The apple orchards of south were adequately supplied with iron, manganese. Further soil analysis revealed that available zinc was low medium and high in 10, 30, and 60 per cent apple orchards, respectively. Copper was medium in and high in 35and 65 percent samples respectively. The present investigation though first of its kind is expected to be quite useful for horticulturists for formulation of further research and development programmes for increasing apple production.

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