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Soil fertility status and nutrient index in soil of research farm Raya, Samba district of Jammu and Kashmir

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ABSTRACT

The study was conducted to evaluate the soil fertility status of Rainfed Research Sub-station for Sub-tropical fruits, Raya district, Samba and their relationship with selected soil properties. Soils of the research farm were found slightly acid to neutral in reaction with low to medium organic carbon and texture was sandy loam to sandy clay loam. The soil of the Raya indicated that the available nitrogen, phosphorus and potassium status was observed to the tune of 98.2%, 6.9% and 89.6 % under low and 1.8 %, 93.1 % and 10.4 % under medium categories, respectively. The available sulphur in soil was 100% under percent deficient. Based on critical limit, all soils were adequately supplied with DTPA-extractable Fe, Zn and Cu content. In respect of zinc and cooper, soils exhibited 94.8 and 91.4 per cent under sufficient, while, 5.2 and 8.6 per cent were found deficient in DTPA -Zn and Cu, respectively. The DTPA –Mn in soil was optimum supplied and 77.6 per cent was found sufficient, while 22.4 per cent was deficient. The soil organic carbon showed significant positive relation with available N, P and K content. Soil pH and EC showed positive correlation with DTPA –Mn, Zn and Cu and negative correlation with DTPA –Fe. The generated nutrient status information can serve as an effective tool for researchers/ scientists in adoption of site specific nutrient management practices.

Key words: orchards, soil properties, primary nutrients, micronutrients, nutrient index

INTRODUCTION

Soil precisely said as “Soul of Infinite life” is one of the most precious and constant natural resource that is found on earth. Without soil, not many lives can be imagined surviving as it forms the *“base”* of life support system of most of terrestrial fauna, biota and thus indirectly that of mankind also. These nutrients are classified into macro and micronutrients based on their amount of requirement by plants. Plant nutrition plays an important role in improving the quantity and quality of horticultural crops and, thus, is essential for successful fruit growing. Evaluation of fertility status of the soils of a region is an important aspect in context of sustainable agricultural production. Soil fertility is one of the important factors controlling yields of crops. Macro and micronutrients are important elements that control soil fertility and yield of crops. The variation in major and micronutrients supply in soil is a natural phenomenon and some of them may be sufficient where others deficient. The decline in soil fertility due to imbalance fertilizer use has been recognized as one of the most important factors limiting crop yield. Sound knowledge about soil fertility is very much relevant for identifying constraint in crop husbandry for attaining sustained productivity and facility agro-technology transfer programme. Information on status of macro-and micronutrients for different soil types, districts and region as well as for the country is highly essential to determine the nature and extent of their deficiencies/toxicities and to formulate strategies for their correction for enhancing crop production.

Hence, the information related to nutrient limitations and their suitable management has better consequence to improved crop production and sustainable development of farming. Soil test based nutrient management, crop rotation, scientific application of chemical and bio-fertilizers are the need of the hour to uphold soil superiority and get better the productivity (Kumar *et al.,* 2014). Evaluation of farm level fertility status of soil provides the necessary information on nutrient status which can help the farmers to apply need based on crop and soil requirement of a particular area. For understanding the reasons of deficiency of available nutrients in soil, correlation of physic-chemical properties with available macro and micronutrients is needed. Therefore, to understand the inherent capacity of soil to supply these nutrients to plants, study on status of macro-and

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micronutrients and their interrelationship with soil characteristics is essential to achieve balance nutrition to overcome soil fertility and improve soil fertility on a sustainable basis. Keeping in view of these aspects a widespread study was undertaken to know the fertility status and nutrient index in soils of different fruit crops of the farm under rainfed condition and presented in this communication.

MATERIALS AND METHODS

Study area

The Rainfed Research Substation for Subtropical fruits (RRSS) Raya, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (latitude 32^0 39" N, longitude 74^0 53" E and at an average elevation of 332 m above mean sea level), in district Samba, Jammu and Kashmir (UT), India. The total areas of research farm Raya are 8.67 acre and there were grown in different subtropical fruits. The RRSS, Raya is at about 20 km away from Jammu district belongs to Samba district. The soil of Samba district is usually well drained, slightly acid to neutral reaction and classified as alluvial soil. The climate of this area is subtropical with hot and dry in summers and cold in winters, rainfall is moderately mostly during the monsoon seasons. The Samba district is situated in the Shivaliks hills along the banks of Basantar River and topography is differing types i.e. mix plains and slopes. The efficiency of fruit crops depends on many factors such as climate, site, varieties, fertilization, irrigation, soil management practices, pests and diseases management. Among the factors, sufficient supply of nutrients play very crucial role in adaptable cropping and quality of the fruits.

Soil sampling

A total number of 58 composite soil samples were collected from fifteen blocks of fruit plant representing two intercropping , *viz.,* aonla + phalsa, phalsa, kinnow mandarin-A, kagzi lime, citrus collection, mango collection, Eureka lemon, Kinnow mandarin-B, karonda, guava, mango, ber, nursery, aonla + meca ber and malta fruit block from 0-15 cm soil surfaces in the year-2021. The collected soil samples were air dried in shade and after removal of unwanted materials like roots, leaves, pebbles etc. were broken for clods with a wooden mallet. Then the soil samples were passed through 2 mm sieve and were stored in thick-gauge polythene bags after duly labelled for information such as date and place of collection, longitude and latitude of the respective sites etc.

Soil analysis

The soil samples were analysed for pH, EC, organic carbon, available N, P, K and S by adopting standard procedures Jackson (1973). Soil texture was determined according to procedures described by mechanical analysis in hydrometer method (Piper, 1966). The soil textural class was dominant in sandy loam followed by sandy clay loam. Bulk density, porosity and maximum water holding capacity were observed by Keen Roezkowski box method (Chopra and Kanwar, 1991). Available micronutrients (Fe, Cu, Zn and Mn) were extracted by DTPA and measured by atomic absorption spectrophotometer (Lindsay and Norvell, 1978). Soil test rating/critical limits of soil characteristics are presented in Table 1.

Table 1: Soil test rating/critical limits of soil characteristics

Soil characteristics	Low	Medium	High	
Organic carbon (g kg^{-1})	<5.0	5.0-7.5	>7.5	
Available N (kg ha^{-1})	<280	280-560	>560	
Available P (kg ha^{-1})	<10	10-25	>25	
Available K (kg ha^{-1})	<110	110-280	>280	
pH (1:2.5)	Acidic	Normal to alkaline	Slightly alkaline	Alkaline
	6.0	6.0-8.5	8.5-9.0	9.0
EC (dSm^{-1})	Normal	Critical for germination	Critical for growth of sensitive crops	Injurious to most crops
	1.0	1.0-2.0	2.0-4.0	4.0

Source: (Source: (Muhr et. al., 1965)

Soil characteristics	Deficient	Sufficient
Available S (mg kg^{-1})	≤10.0	>10.0
DTPA- Fe (mg kg^{-1})	≤4.5	>4.5
DTPA- Mn (mg kg^{-1})	≤1.0	>1.0
DTPA- Zn (mg kg^{-1})	≤0.6	>0.6
DTPA- Cu (mg kg^{-1})	≤0.2	>0.2

Source: (Tandon, 1989)

Nutrient Index (NI)

Nutrient Index was designed by Parker's index method (Parker *et al.,* 1951) each soil samples were classified as low, medium and high categories based on the critical limits for macro and micro nutrients. Nutrient index was calculated as per the following equation. Nutrient Index = (NL × 1 + NM × 2 + NH × 3) / NT, where, NL, NM and NH are the number of samples in low, medium and high fertility classes of nutrient status, respectively and NT is the total number of samples. The analytical results of each soil samples were categorized as low, medium and high categories based on the critical limits for macro and micro nutrients. The nutrient index and categorization of available nutrients as low (<1.67), medium (1.67-2.33) and high (>2.33) was calculated. Simple correlation coefficients were made to relate physico-chemical properties of soils with macro- and micronutrient by adopting standard statistical procedures.

RESULT AND DISCUSSION

Soil characteristics

Physical properties

The bulk density (BD) of the soils ranged from 1.56-1.71 g cm^{-3} and overall mean 1.64 g cm^{-3} of the research farm (Table 2). The bulk density was highest recorded 1.71 g cm^{-3} in ber block while lowest 1.61 g cm^{-3} in kinnow mandarin - A block. The porosity (P) of the soils ranged from 33.33-41.38 percent. The highest mean value was recorded in eureka lemon block with a mean of 41.03 percent

Table 2: Physical properties of soils of research farm Raya district Samba

Fruit block	Bulk density (g cm^{-3})	Porosity %	MWHC (%)	Sand %	Silt %	Clay %
Aonla + Phalsa	1.58-1.65 (1.61)	35.77-40.96 (37.01)	21.04-33.90 (27.64)	53.03-61.03 (57.03)	23.00-32.00 (26.20)	13.97-15.97 (14.77)
Phalsa	1.65-1.68 (1.67)	38.20-39.49 (38.89)	25.67-32.24 (28.18)	58.03-64.03 (61.28)	21.00-29.00 (25.25)	11.97-14.97 (13.47)
Kinnow mandarin -A	1.58-1.67 (1.63)	38.83-39.64 (39.19)	26.12-37.01 (33.09)	61.03-66.03 (64.28)	21.00-26.00 (23.25)	10.97-13.97 (12.47)
Kagzi lime	1.56-1.66 (1.63)	38.29-40.43 (39.23)	30.62-38.57 (34.25)	55.03-58.03 (57.03)	27.00-32.00 (29.50)	12.97-14.97 (13.47)
Citrus collection	1.58-1.65 (1.62)	35.77-38.88 (37.27)	29.15-37.02 (33.32)	60.03-65.03 (62.53)	20.00-28.00 (24.25)	11.97-14.97 (13.22)
Mango collection	1.61-1.65 (1.63)	36.37-3938 (38.26)	32.12-36.25 (34.99)	60.03-65.03 (62.28)	24.00-26.00 (24.25)	10.97-13.97 (12.97)
Eureka Lemon	1.56-1.67 (1.63)	40.8740.38 (41.03)	33.71-35.02 (34.51)	58.03-66.03 (62.03)	21.00-26.00 (23.25)	12.97-15.97 (14.72)
Kinnow mandarin -B	1.56-1.65 (1.62)	37.31-38.04 (37.60)	28.89-39.35 (34.33)	63.03-66.03 (64.78)	21.00-22.00 (21.50)	12.97-15.97 (13.72)
Karonda	1.65-1.66 (1.66)	38.05-39.47 (38.76)	35.87-36.40 (36.14)	56.03-58.03 (62.03)	19.00-27.00 (23.00)	12.97-16.97 (14.97)
Guava	1.65-1.69 (1.67)	37.55-38.20 (37.84)	28.89-34.67 (30.51)	57.03-63.03 (61.03)	20.00-23.00 (23.75)	12.97-16.97 (15.22)
Mango	1.62-1.72 (1.67)	38.33-40.94 (37.93)	27.11-37.31 (30.50)	57.03-60.03 (58.53)	24.00-28.00 (25.25)	12.97-17.97 (16.22)
Ber	1.68-1.72 (1.71)	37.05-39.50 (38.08)	24.34-32.56 (27.34)	67.03-73.03 (70.03)	15.00-19.00 (17.00)	11.97-13.97 (12.97)
Nursery	1.58-1.65 (1.63)	36.12-38.88 (37.12)	29.15-37.02 (33.62)	58.03-70.03 (66.28)	15.00-28.00 (20.00)	11.97-14.97 (13.72)
Aonla + Meca ber	1.62-1.65 (1.64)	36.12-39.12 (37.34)	28.89-3731 (32.65)	65.03-73.03 (68.03)	15.00-23.00 (19.75)	11.97-12.97 (912.22)
Malta	1.62-1.66 (1.64)	37.05-39.12 (38.05)	28.89-37.31 (32.90)	62.03-73.03 (69.03)	15.00-20.00 (17.50)	10.97-17.97 (13.47)

Values in parenthesis indicates the mean value while the lowest mean value of 37.01 per cent was recorded in Aonla + phalsa block. The high bulk density of soil of research farm may be due to low clay content and organic matter and high sand content. Similar results are reported by Kumar *et.al*. (2018). The Maximum water holding capacity (MWHC) in soil ranged from 21.04 – 39.35 per cent. The highest mean value was recorded in mango collection block with a mean of 34.99 per cent while the lowest mean value of 27.34 per cent was recorded in ber block. The variation in maximum water holding capacity due to clay, organic carbon content and heterogeneity of parent material similar results were also reported by Sathyavathi and Reddy (2004).The sand content ranged from 53.03-73.03 per cent and overall mean 63.18 per cent of research farm. The highest sand content recorded in ber block with a mean of 70.03 per cent while the lowest mean value of 57.03 per cent was recorded in Aonla+ phalsa block. The silt content ranged from 15.00-32.00 percent and overall mean 23.02 per cent of research farm. The highest sand content recorded in kagzi lime block with a mean of 29.50 per cent while the lowest mean value of 17.00 percent was recorded in ber block. The high sand content depends on richness of parent material along with its fraction. The dominant textural class was sandy loam followed by sandy clay loam. The similar results are reported by Gupta (1994).

Chemical properties

The pH of the soils of the research farm was slightly acid to neutral (pH 6.41 – 7.66) in reaction (Table 3). The highest mean value was recorded in ber block with a mean of 7.56 while the lowest mean value of 6.50 was recorded in karonda block. The electrical conductivity (EC) of the studied soils was low (0.03-0.05 dSm^{-1}). This low value in all the orchards uses might due

Table 3: Chemical properties of soils of research farm Raya district Samba

Fruit block	Soil pH (1:2.5)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)
Aonla + Phalsa	6.66-7.21 (6.98)	0.03-0.06 (0.04)	2.10-3.60 (2.60)
Phalsa	6.67-6.88 (6.78)	0.06-0.09 (0.07)	2.40-3.40 (2.80)
Kinnow mandarin -A	6.70-6.86 (6.76)	0.03-0.05 (0.04)	5.40-6.40 (5.81)
Kagzi lime	6.72-6.87 (6.78)	0.02-0.06 (0.0375)	3.01-3.08 (3.45)
Citrus collection	6.51-6.74 (6.58)	0.03-0.06 (0.04)	4.50-6.15 (5.51)
Mango collection	6.41-6.85 (6.57)	0.04-0.07 (0.06)	2.83-4.40 (3.51)
Eureka Lemon	6.58-7.05 (6.85)	0.04-0.07 (0.06)	2.82-4.20 (3.48)
Kinnow mandarin -B	6.68-6.89 (6.81)	0.05-0.07 (0.06)	4.50-5.60 (4.98)
Karonda	6.48-6.52 (6.50)	0.04-0.07 (0.06)	2.60-2.80 (2.70)
Guava	7.10-7.36 (7.20)	0.13-0.18 (0.15)	3.80-4.80 (3.38)
Mango	7.34-7.64 (7.46)	0.12-0.17 (0.14)	3.30-4.80 (4.00)
Ber	6.59-7.19 (6.90)	0.03-0.06 (0.04)	2.28-3.20 (2.72)
Nursery	6.90-7.12 (7.02)	0.05-0.09 (0.07)	3.50-4.20 (3.83)
Aonla + Meca ber	6.87-7.12 (7.00)	0.08-0.14 (0.11)	4.40-5.40 (5.84)
Malta	7.50-7.66 (7.56)	0.03-0.06 (0.05)	3.20-4.10 (3.60)

Values in parenthesis indicates the mean value to loss of soluble salts from the soils under high rainfall condition. High ions content under acidic condition might be the cause of lower pH value. Bhuyan *et al.* (2014) and Basumatary *et al.* (2019) also reported the acidic condition in soils of Assam. The organic carbon (OC) content of the soil ranged from 2.10- 6.40 g kg^{-1} with an overall mean of 3.94 g kg^{-1}. The lowest (2.60 gkg-1) organic carbon content was found in soils of Aonla + phalsa orchard while the highest value (5.84 g kg-1) was found in soils from Aonla + Meca ber block. The differences in the amount of soil organic carbon might be due to the differences in biomass addition and differential rate of decomposition in the vicinity under different fruit crops, as the degradation of organic matter depends on nature of the plant materials and soil microbes.

Macronutrient status in soils

Available nitrogen: Available nitrogen status in the soil ranged from 120.00- 290.00 kg ha^{-1} having a mean value of 205.55 kg ha^{-1} (Table 4). The highest mean value of 262.50 kg ha^{-1} was observed in Kinnow mandarin-A block while, the lowest mean value of 127.0kg ha^{-1} was recorded in soils from Karonda block. The difference of available nitrogen content in the soils might be due to diverse amount of organic carbon present in the soils which released different amounts of nitrogen into the soils. This was evident from significant positive correlation in between organic carbon (r= 0.874**) with available nitrogen (Table 6). Similar results were also observed by Kumar *et al.* (2010) and Maqbool *et al.* (2017). Result (Table 4) indicated that about 98.2 per cent of soils of the research farm were categorized as low and 1.8 per cent of the soils were reported as medium. The overall nutrient index of the district was found as 1.01 and fertility rating was low.

Available phosphorus: Results (Table 4) that available phosphorus content in soil ranged from 10.2-19.2 kg ha^{-1} with a mean of 14.4 kg ha^{-1}. Among the blocks, the highest mean value of 17.3 kg ha^{-1} was observed in kinnow mandarin-A block. This higher value might be due to higher content of organic carbon present in soils. Significant positive correlation with organic carbon (r= 0.734**) also indicated that organic carbon is a major source of available P in soils (Table 6). These results are comparable with the findings of Kumar and Sohan (2012) and Maqbool *et al.* (2017). The soil of the research station indicated that the available phosphorus status was observed to the tune of 6.9% and 93.1 % under low and medium categories, respectively (Table 4). Overall nutrient index value was 1.93 and overall fertility rating was medium.

Available potassium: Status of available potassium in the soil varied from 125.0-164.0 kg ha^{-1} with a mean value of 139 kg ha^{-1} (Table 4). Among the blocks, maximum content was observed in guava block which varied from 142.0- 152.0 kg ha^{-1} with a mean value of 147.5 kg ha^{-1}. This higher content might be due to might be due to creation of favorable soil environment with presence of higher content of organic carbon as compare to other blocks. Correlation study also reported that available potassium showed a significant and positive correlation (r= 0.545**) with OC (Table 6). Similar relation was also reported by Basumatary *et al.* (2014). The soil of the research farm exhibited that 89.6 per cent of the soils were categorized as low and 10.4 per cent of the soils were reported as medium (Table 4). The overall nutrient index of the research station was found as 1.10 and fertility rating was low.

Available sulphur: Available sulphur status in the soil ranged from 0.71- 4.32 mg kg^{-1} having a mean value of 2.16 mg kg^{-1} (Table 4). The highest mean value of 3.20 mg kg^{-1} was observed in kinnow mandarin-B block while, the lowest mean value of 0.98 mg kg^{-1} was recorded in soils from karonda block. This difference could be due to dissimilarity in content of organic carbon content in soils. The poor availability of sulphur was due to low organic carbon and adsorption by calcium carbonate (Kumar *et al.,* 2014).Correlation study also reported that available sulphur showed a significant and positive correlation with pH, OC, BD, Porosity sand per cent (Table 6). The results resemble to the Basumatary *et al.* (2021) in soils of Assam. Consequence indicated that about 100.0 per cent of soils of the research station was categorized as low (Table 4). The overall nutrient index of the district was found as 1.00 and fertility rating was low.

Table 4: Available macro-nutrient status of soils of research farm Raya district Samba

Fruit block	Available macronutrients			
	Avail. N (kg ha^{-1})	Avail. P (kg ha^{-1})	Avail. K (kg ha^{-1})	Avail. S (mg kg^{-1})
Aonla + Phalsa	160.0.-190.0. (175.00)	10.40-11.60 (11.00)	142.0.-150.0 (146.25)	0.71-1.96 (1.28)
Phalsa	170.0.-200.0 (183.75)	10.94-12.84 (12.02)	126.0-142.0 (133.26)	1.16-1.70 (1.52)
Kinnow mandarin -A	240.0-290.0 (262.50)	16.10-19.20 (17.35)	152.0-164.0 (158.25)	1.96-2.86 (2.43)
Kagzi lime	188.0-220.0 (205.75)	12.24-14.47 (13.48)	132.0-148.0 (138.75)	1.34-1.88 (1.61)
Citrus collection	248.0-262.0 (255)	14.60-16.70 (15.67)	136.0-148.0 (142.75)	2.86-2.32 (3.56)
Mango collection	180.0-210.0 (193.75)	11.80-14.50 (13.15)	136.0-142 (138.75)	0.98-1.43 (1.21)
Eureka Lemon	185.0-215.0 (204.25)	14.51-17.42 (15.73)	132.0-146.0 (139.25)	2.23-3.39 (2.81)
Kinnow mandarin -B	122.0-145.0 (136.25)	10.20-13.86 (12.34)	126.0-138.0 (131.25)	2.68-3.57 (3.20)
Karonda	120.0-134.0 (127.0)	11.20-12.20 (11.70)	125.0-132.0 (128.50)	0.71-1.25 (0.98)
Guava	230.0-243.0 (236.25)	15.17-18.57 (17.27)	142.0-152.0 (147.50)	2.50-3.21 (2.83)
Mango	224.0-240.0 (231.75)	14.27-16.17 (15.50)	134.0-142.0 (136.50)	0.98-1.88 (1.26)
Ber	205.0-225.0 (217.25)	13.45-15.12 (14.55)	128.0-135.0 (131.11)	2.14-3.39 (2.81)
Nursery	162.0-188.0 (173.0)	14.50-16.45 (15.59)	141.0-148.0 (144.75)	1.34-2.34 (1.77)
Aonla + Meca ber	245.0-265.0 (249.0)	13.20-15.42 (14.17)	138.0-144.0 (140.75)	1.07-2.59 (1.76)
Malta	180.0-216.0 (193.50)	14.18-17.42 (16.05)	125.0-135.0 (131.50)	2.14-3.48 (2.78)
Overall low (%)	98.2	6.9	89.6	100
Overall medium (%)	1.8	93.1	10.4	0
Overall high (%)	0	0	0	0
Overall nutrient index	1.01	1.93	1.10	1.00

Micronutrient Status in soils

DTPA-Fe: The DTPA-Fe indicate that overall, Fe content of the research station ranged from 9.26 -28.29 mg $kg^{-1}$with a mean value of 17.19 mg kg^{-1} (Table 5). The highest Fe content was found in nursery block which varied from 18.95- 28.95 mg kg^{-1} with mean value of 24.37 mg kg^{-1}. The higher concentration in this block could be due to the higher organic carbon content because it acts as chelating agent. Fe reacts with certain organic molecules to form organo metallic complexes as chelates and the soluble chelates can increase the availability of the micronutrient and protect it from precipitation reactions. These chelates may also be synthesized by plant roots and released to the surrounding soil or may be present in soil humus. These are positively correlation obtained between DTPA-Fe with organic carbon and silt content. The increase in DTPA-Fe content with increase in soil organic carbon also reported by various workers (Behera and Shukla, 2013; Basumatary *et al.* 2019). The overall nutrient index mean value of 3.00 indicated that soils were sufficiently high in iron content (Table 5).The sufficiency of DTPA-Fe may also be due to lower pH of the studied soils. This is sustained by the overall negative significant correlation obtained between DTPA-Fe with pH, EC, BD, P, MWHC and sand content (Table 6). The results are in conformity with Rai *et al.* (2018).

DTPA-Mn: Result (Table 5) revealed that DTPA-Mn content ranged between 0.48-4.21 mg kg^{-1} with a mean value of 1.95 mg kg^{-1}. Among the blocks, the highest and the lowest average Mn were found in soils from mango collection block (3.60 mg kg^{-1}) and Aonla+ phalsa block (0.53 mg kg^{-1}). Based on the critical limit (1.0 mg kg^{-1}), of the research station indicated that the DTPA-Mn status was observed up to the tune of 22.4%, 22.4% and 55.2 % under low, medium and high categories, respectively (Table 5). The overall nutrient index was found as 2.32 indicated that soils were suitably medium. This competence may also be due to the fact that decrease in soil pH increased the solubility of DTPA-Mn while increase in organic matter and the exchange capacity of the soil leading to more retention of DTPA-Mn resulting in increased availability of DTPA-Mn. These findings were supported by a negative correlation between DTPA-Mn and bulk density and a positive correlation between DTPA-Mn with pH, EC, OC, P, MWHC and sand content (Table 6). Similar results were reported by Bhuyan *et al.* (2014) and Basumatary *et al.* (2014).

Table 5: Available micro-nutrient status of soils of Research farm, Raya district Samba

Fruit block	Available micronutrients (mg/kg)			
	Fe	Mn	Zn	Cu
Aonla + Phalsa	15.22-20.68 (17.83)	048-0.58 (0.53)	3.50-5.07 (4.45)	0.49-0.60 (0.55)
Phalsa	14.95-16.65 (15.95)	0.95-1.24 (1.10)	4.41-7.83 (6.27)	0.16-0.54 (0.51)
Kinnow mandarin -A	17.95-22.57 (21.09)	0.71-1.17 (0.91)	1.02-1.93 (1.55)	0.50-0.60 (0.55)
Kagzi lime	15.78-20.40 (18.09)	1.63-2.00 (1.75)	2.50-3.13 (2.74)	0.56-0.61 (0.59)
Citrus collection	17.42-23.60 (21.59)	2.39-3.53 (2.91)	2.02-2.93 (2.52)	0.51-0.62 (0.59)
Mango collection	16.72-21.34 (19.03)	2.79-4.21 (3.60)	3.20-3.80 (3.46)	0.87-0.91 (0.89)
Eureka Lemon	12.86-14.45 (13.66)	2.65-3.03 (2.85)	2.75-2.43 (3.07)	0.57-0.62 (0.60)
Kinnow mandarin- B	17.22-21.72 (20.20)	1.17-2.19 (1.45)	0.46-1.32 (0.84)	0.84-0.99 (0.92)
Karonda	9.26-10.80 (10.03)	0.82-0.96 (0.89)	1.01-1.42 (1.22)	0.48-0.52 (0.50)
Guava	10.43-13.42 (11.93)	0.93-1.61 (1.28)	3.58-4.10 (3.81)	0.59-0.63 (0.61)
Mango	18.21-21.34 (19.85)	2.52-3.81 (3.27)	3.35-4.12 (4.76)	0.91-1.03 (0.96)
Ber	11.72-13.26 (12.65)	0.82-1.82 (1.25)	2.02-2.47 (2.17)	0.14-0.39 (0.36)
Nursery	18.95-28.29 (24.37)	2.18-3.53 (2.71)	2.52-3.43 (3.01)	0.69-0.83 (0.76)
Aonla + Meca ber	13.97-15.51 (14.61)	2.28-3.00 (2.75)	1.73-2.18 (1.98)	0.50-0.59 (0.54)
Malta	11.88-15.05 (13.48)	1.16-2.18 (1.50)	0.47-0.92 (0.68)	0.49-0.69 (0.61)
Overall low (%)	0	22.4	5.2	8.6
Overall medium (%)	0	0	0	0
Overall high (%)	100	77.6	94.8	91.4
Overall nutrient index	3.00	2.32	2.86	2.82

DTPA-Zn: The DTPA-Zn content ranged between 0.46- 7.83 mg kg^{-1} (Table 5). Maximum content was recorded in phalsa block, which varied from 4.41- 7.83 mg kg^{-1} with a mean of 6.27 mg kg^{-1} while, the minimum was recorded in malta block which ranged from 0.47-0.92 mg kg^{-1} with a mean of 0.68 mg kg^{-1}. Based on the critical limit (0.6 mg kg^{-1}), of the research station indicated that the DTPA-Zn status was observed up to the tune of 5.2 %, 3.4 % and 91.4 % under low, medium and high categories, respectively (Table 5). The overall nutrient index of the research station was found as 2.86 and fertility rating was high. Correlation study indicated that the availability of Zn significant and positive correlation with silt (Table 6). This positive correlation might be due to the formation of organic complexes between pH, EC and porosity that protect it from leaching (Shah *et al.,* 2018).The available Zn was negatively correlated with soil MWHC (r= -0.406) and Sand (r= -0.526) which is in line with the earlier finding of Sidhu and Sharma (2010).

DTPA -Cu: The Cu content ranged from 0.34-1.03 mg $kg^{-1}$with a mean value of 0.64 mg kg^{-1} (Table 5). Among the blocks, the highest average Cu was found in mango block (0.96 mg kg^{-1}) and the lowest was recorded in ber block (0.36 mg kg^{-1}). Based on critical limit, the soils of the research station indicated that about 8.6 per cent were categorized as low and 91.4 per cent of the soils were reported as high (Table 5). The nutrient index of the research station was reported as 2.82 and fertility rating was high. The sufficiency of DTPA-Cu might be due to the higher organic carbon content and chelating effect. Correlation studies (Table 6) revealed positive correlation obtained between DTPA-Cu with pH, EC, BD and silt content. This might be due to the formation of soluble Cu-organic complexes on the clay surfaces. On the other hand, Cu was negatively correlated with OC, P, MWHC and sand content. The similar results were also reported by Basumatary *et al.* (2021) in Assam soils.

Table 6: Correlation coefficient (r) among soil properties and available nutrients

Parameters	pH	EC	OC	BD	Porosity %	MWHC (%)	Sand %	Silt %
N	0.198	0.254	0.874**	-0.372	-0.001	0.140	0.078	0.024
P	0.408	0.304	0.734**	-0.144	0.143	0.287	0.306	-0.285
K	-0.021	0.043	0.545*	-0.400	-0.038	-0.048	-0.203	0.260
S	0.070	-0.145	0.457	0.066	0.002	-0.064	0.430	-0.398
Fe	-0.087	-0.176	0.193	-0.098	-0.301	-0.200	-0.149	0.237
Mn	0.026	0.282	0.210	-0.117	0.003	0.340	0.032	0.028
Zn	0.001	0.268	-0.235	0.060	0.038	-0.406	-0.526	0.528*
Cu	0.201	0.347	-0.248	0.459	-0.190	-0.240	-0.225	0.191

**Significant at 5%level; **Significant at 1% level*

CONCLUSION

The study indicated that the soils of Raya orchard are slightly acid to neutral reaction with safe limit of soluble salt content. The OC was low to medium and low to medium in available N. The area showed low to medium in available P and K and low in available S content. The DTPA extractable Fe was sufficient and Mn, Zn and Cu were deficient to sufficient in the research farm Raya. The NIV for macronutrients N, K and S were low and medium for P. The NIV for micronutrients contents DTPA–Mn was medium and DTPA– Fe, DTPA– Zn and DTPA–Cu were high. This information can be useful in developing management practices and site specific nutrient management practices for fruit crops in research farm Raya soil of Samba district.

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