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Research Article

STUDIES ON SOIL NUTRIENT STATUS IN RELATION TO YIELD ATTRIBUTES OF SWEET ORANGE (*Citrus sinensis* L.) *CV.* NUCELLAR

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Abstract- An experiment was carried out at College of Agriculture, Latur, M.S. India during s*ummer* and *kharif* season of 2014-2015 to study the nutrient status of soils of sweet orange orchards of Jalna district. In order to know the soil nutrient status, ten sweet orange orchards located in ten different talukas of Jalna district were randomly selected. Soil samples were collected in May 2014 at a depth of 0-30 cm, 30-60 cm and 60-90 cm. Soil samples were analysed to find out soil nutrient status. Results showed that all the soils samples were neutral to alkaline in reaction (pH). All soil samples were in safe limit for electrical conductivity (EC). All soils samples were low to medium in organic carbon content (OC), nitrogen content (N), available phosphorus (P), sulphur content (S) and Manganese content (Mn).All soils samples were high in calcium content (Ca), available magnesium content (Mg). The soils were sufficient in available copper content (Cu). Results also showed that the fruit yield had significant and positive correlation with soil OC, N, P, K and Cu.

Keywords- Soil, Nutrient Status, Yield, Sweet Orange.

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Introduction

Sweet orange (*Citrus sinensis* L.) belongs to the family *Rutaceae* and originated in China. It is grown in tropical and subtropical climate in the world for their sweet fruits, which can be eaten fresh or processed to obtain juice. In world the global production of oranges record 48.8 MMT [1]. In India citrus grown in area of 846 thousand ha and the production of 7464 thousand MT with the productivity of 8.80MT/ha [2]. Maharashtra is the largest producer of sweet orange in the country and contributes to about 49% of the total production. Sweet orange is given widely in different districts of Maharashtra but Jalna, Aurangabad, Nanded and Parbhani are the major area in production, among them Jalna is dominant in area and production .One of the main reasons for low sweet orange productivity in the soils of Marathwada region is multiple nutrient deficiencies. The soils of this region are derived from basaltic parent material and are deficient in nutrients including N,P, Fe, Mn and Zn. Therefore, above facts are essential to create information about nutrient status of orchard soil so as to develop fertilizer schedule for sweet orange orchards of Jalna district. Considering the above facts the present investigation was made to study soil nutrients status in relation to yield of sweet orange to find out the relation between nutrient status and yield.

Materials and Methods

An experiment was carried out during summer 2014-15 at ten sweet orange orchards located in different talukas of Jalna district during year 2014-2015. Soils of Jalna district ranges from deep black shallow and light textured. Majority of soil are medium to deep black and categorized under order vertisols and inceptisols. In order to know the soil and leaf nutrient status, ten sweet orange orchards located in ten different talukas of Jalna district were randomly selected. The soil samples were collected in May 2014. The details of selected sweet orange orchards of Jalna district are given in [Table-1].

Table-1 *Details of selected sweet orange orchards of Jalna district.*

Sr. No.	Sample No.	Name of Cultivator	Name of Tahsil	Name of Village
1.	JS001	Laxman T. kachare	Jalna	Kacharewadi
2.	JS002	Balaji N. Kachare	Jalna	Kacharewadi
3.	JS003	Sandeep T. Kolhe	Badnapur	Deogaon
4.	JS004	Haribhau B. Ghate	Jalna	Dukri Pimpri
5.	JS005	Abhay A. Shendre	Ambad	Pimpalgaon
6.	JS006	Vilas B. Kharat	Ambad	Dhangar Pimpari
7.	JS007	Bhimrao R. Pund	Ambad	Pimpalgaon
8.	JS008	Sanjay S. Shere	Mantha	Waturphata
9.	JS009	Dnyaneshwar B. Dahatonde	Ghansawangi	Talegaon
10.	JS010	Vinod B. Mahajan	Ghansawangi	Talegaon

Three soil samples were collected from each orchard during May 2014 below the tree canopy at 0-30, 30-60 and 60-90 cm depth. So in all 30 samples were collected within tree canopy at 0.5 m away from the tree trunk. Collected soil samples were brought to laboratory and dried under shade. After drying a part of each sample was ground by wooden mortar and pestle and stored in polythene bags with proper labelling for subsequent estimation of physiochemical characteristics, macronutrients and micronutrient. Soil pH was determined from (1:2:5) soil water suspension ratios using digital pH meter [4]. Organic carbon was determined by modified method of Walkley and Black [4].

Electrical conductivity (EC) was determined in supernatant solution of soil water suspension (1:2:5) using digital direct read conductivity bridge [4] and expressed in dsm^{-1}. Available nitrogen was determined by Alkaline Permangnate method as described by [21]. Available phosphorus was determined using double beam US-VIS Spectrophotometer with [13]. Available K was determined using Flame Photometer [5]. Exchangeable Ca & Mg were determined by Versanate Titration method [6].

Available sulphur was determined by using 1:5 soil and extracted 0.15% $CaCl_2$ solution on UV- Spectrophotometer at 340nm wavelength [23]. Available micronutrients such as Mn, Zn and Cu were measured using atomic absorption spectrophotometer fro Perkins Elmer as described by [12]. The twelve uniform matured fruits were collected from each orchard during November-December 2014. Washed 2-3 times with fresh water and brought to laboratory for analysis. The total yield of harvested fruit was weighed from each tree on a pan balance.

The data of yield per tree was recorded and from that yield per hectare was calculated. Seeds from fruits of single orchard separated from fruit and weighed on digital balance and averages were worked out and recorded as weight of seed. The juice was extracted from five fruits weighed on digital balance and average were worked out and recorded as weight of peel. The juice and seed was separately weight on digital balance and the ratio was calculated by dividing the juice weight by weight of the seed. Total soluble solids (TSS) in the terms of percent of juice were recorded by using Erma hand refractometer. The total titrable acidity was determined by titrating fruit juice against 0.1 NaOH in the presence of phenolphthalein indicator (A.O.A.C., 1975) and by using formula Total Sugar = Reducing Sugar (%) + Non reducing sugar (%). The Titrimetric method of Lane and Eynon as described by [17] was followed for estimation of reducing sugar. The correlation between nutrient status, yield and quality parameters of soil worked out as per the standard given by [15].

Result and Discussion

Physicochemical properties

Soil reaction (pH)

Data from [Table-2] clearly indicates that at 60-90 cm depth, the pH of soils was varied from 7.14 – 8.0 with an average value of 7.55. The lowest value (7.14) was observed in sample JS006. Whereas, higher value (8.0) was observed in sample JS004 in [Table-1]. Thus, the soils were neutral to alkaline in reaction. The slightly alkaline pH of soils recorded in the study may ascribe to calcareous nature of these soils.The results were in agreement with [14] in acid lime. They served 70 acid lime orchards in Western Vidarbha region of Maharashtra and reported similar range of soil pH ranging from 7.9 to 8.3.

Electrical Conductivity (dS m^{-1})

Data from [Table-2] clearly indicates that at 60-90 cm soil depth Electrical conductivity varied from 0.15 to 0.28 with an average value of 0.22 dsm^{-1}. The lowest (0.15 dsm^{-1}) EC was observed in sample JS008. Whereas, the highest EC (0.28dsm^{-1}) was recorded in sample JS 009 in [Table-2]. Thus all sample were in safe limit. Above findings are in close conformity with the findings of [20] in Nagpur Mandarin. They reported that range of EC 0.11- 0.38 dsm^{-1} in Nagpur Mandarin orchards of Saoner Tahsil, Nagpur district of Maharashtra.

Table-2 *Physico-chemical characteristic and soil nutrient status of sweet orange orchards of Jalna Dist at 60-90 cm depth.*

Sample No.	PH	EC (dsm-1)	Organic Carbon(%)	Nitrogen Kg ha^{-1}	Phosphorus Kg ha^{-1}	Potassium Kg ha^{-1}	Calcium me $100g^{1}$	Magnesium me $100g^{-1}$	Sulphur mg Kg^{-1}	Manganese mgKg^{-1}	Zinc mg Kg^{-1}	Coper mgKg^{-1}
JS001	7.62	0.17	0.38	227.3	10.28	401.2	3.73	3.11	5.3	1.20	0.41	2.13
JS002	7.59	0.24	0.19	134.9	9.30	400.4	4.26	3.17	4.10	1.10	0.40	1.28
JS003	7.41	0.26	0.37	205.0	9.43	357.6	2.98	2.89	5.03	1.11	0.48	1.10
JS004	8.0	0.23	0.23	142.5	8.24	320.1	4.16	3.34	5.0	1.93	0.46	1.51
JS005	7.96	0.22	0.24	147.0	8.20	331.4	4.63	2.70	5.35	1.0	0.43	1.17
JS006	7.14	0.21	0.44	245.1	9.70	367.6	4.87	2.46	5.39	2.23	0.32	2.16
JS007	7.58	0.27	0.42	227.3	9.62	391.3	4.32	2.51	5.59	1.26	0.38	1.39
JS008	7.69	0.15	0.31	103.9	6.27	405.2	4.48	2.69	4.0	1.12	0.42	1.73
JS009	7.19	0.28	0.46	243.6	11.16	402.7	4.55	3.64	4.25	1.52	0.40	2.21
JS0010	7.34	0.19	0.21	178.6	6.20	356.4	3.87	2.68	4.11	2.24	0.37	1.37
Range	7.14-8.0	0.15-0.28	0.19-0.46	103.9-245.1	6.20-11.16	320.1-405.2	2.98-4.87	2.46-3.64	4.0 – 5.59	1.0 – 2.24	0.32 - 0.48	1.10 - 2.21
Mean	7.55	0.22	0.32	185.52	8.84	373.39	4.18	2.91	4.81	1.47	0.40	1.59
S.E.$\pm$	0.092	0.014	0.032	13.433	0.513	9.927	0.172	0.122	0.198	0.153	0.014	0.144

Organic Carbon content

Data from [Table-2] clearly indicates that at 60-90 cm depth, soil organic carbon content was varied from 0.19 to 0.46 per cent with an average value of 0.32 per cent. The lowest organic carbon content (0.19 percent) was observed in sample JS002. Whereas highest organic carbon content (0.46 percent) was recorded in sample JS009 in [Table-2]. Thus, soils were low to medium in organic carbon content. The result of the present findings were in agreement with [11] in Kinnow Mandarin. They observed that organic carbon contents in soils were found in range from 0.26 to 0.46 per cent in Kinnow mandarin.

Available Nitrogen

Data from [Table-2] indicates that at 60-90 cm depth, available Nitrogen in soil was varied from 103.9 to 245.1 $Kgha^{-1}$ with an average value of 185.52 $Kgha^{-1}$. The lowest N (103.9) was observed in sample JS008. Whereas highest N (245.1 $Kgha^{-1}$) was recorded in sample JS006. Similar results were observed by [20] in Nagpur Mandarin. They reported that available nitrogen in soil of Nagpur Mandarin orchards in range of 38 to 225 $Kgha^{-1}$. Thus, all the sample were low to medium in nitrogen content.

Available Phosphorus

Data from [Table-2] clearly indicates that at 60-90 cm depth, available phosphorus in soil was varied from 6.20 to 11.16 $Kgha^{-1}$ with an average value of 8.84 $Kgha^{-1}$. The lowest P(6.20 $Kgha^{-1}$) was recorded in sample JS0010 Whereas, highest P(11.16 $Kgha^{-1}$) was recorded in sample JS009. Thus, all samples were low to medium in available phosphorus.

The results were in line with the findings of [20] in Nagpur Mandarin orchard soil. They reported that available P ranging from 10-22Kg ha^{-1} in mandarin orchard soils of Saoner Tahsil of Nagpur district.

Available Potassium

It is evident from the data presented in [Table-2] that at 60-90 cm depth available potassium in soil varied from 320.1 to 405.2 $Kgha^{-1}$ withan average value of 373.39 $Kgha^{-1}$. The lowest (320.1 $Kgha^{-1}$) was observed in sample JS004. Whereas, the highest value (405.2 $Kgha^{-1}$) was recorded in sample JS008. Thus, all samples were high in available K. The results were in accordance with the findings of [20] in mandarin orchards. They reported that K ranges from 48 to 385 $Kgha^{-1}$in soils of mandarin orchards of Nagpur district.

Available Calcium

Data from [Table-2] clearly indicated that at 60-90 cm depth, available calcium content varied from 2.98 to 4.87 me $100g^{-1}$ with an average value 4.18 me $100g^{-1}$. The lowest value (2.98 me $100g^{-1}$) was observed in sample JS003. Whereas the highest value (4.87 me $100g^{-1}$) was recorded in sample JS006. Thus, the soils were high in Calcium content. Similar results reported by [20] in citrus orchard. They observed that, the range of a Ca from 5.6 to 39.2 me $100g^{-1}$ in citrus orchards of Sahiwal district.

Available Magnesium

Data from [Table-2] clearly indicated that at 60-90 cm depth, available Magnesium content varied from 2.46 to 3.64 with an average value 4.81. The lowest value (2.46) was observed in sample JS006. Whereas, the highest value (3.64) was recorded in sample JS009. Thus, the soils were high in Magnesium content. Similar results were reported by [14] in acid lime orchards in Western Vidarbha.

Available Sulphur

The data on available sulphur in [Table-2] indicated that at 60-90 cm depth it was varied from 4.00 to 5.59 mg kg^{-1} with an average value 4.81 mg kg^{-1}. The lowest value (4.00 mg kg^{-1}) was observed in sample JS008. Whereas, the highest value (5.59 mg kg^{-1}) was recorded in sample JS007. Thus, the soils were low to medium in sulphur content. Similar result was observed by [16] in pomegranate, the orchards of South East region in Beed district in Maharashtra.

Available Manganese

The data on available manganese in soil in [Table-2] indicated that at 60-90 cm depth, it was varied from 1.00 to 2.24 mg kg^{-1} with an average value 1.47 mg kg^{-1}. The lowest value (1.00 mg kg^{-1}) was observed in sample JS005. Whereas, the highest value (2.24 mg kg^{-1}) was recorded in sample JS 0010. Thus, the soils were low to medium in Manganese content. The similar trends reported in soils (1.01 to 11.03) were reported in soils from Maharashtra by [9] in sweet orange orchard.

Available Zinc

The data on available zinc in soil in [Table-2] indicated that at 60-90 cm depth, it was varied from 0.32 to 0.48 mg kg^{-1} with an average value 0.40 mg kg^{-1}. The lowest value (0.32 mg kg^{-1}) was observed in sample JS006. Whereas, the highest value (0.48 mg kg^{-1}) was recorded in sample JS003. Similar results were observed by [10] in Kin now orchards grown in aridisols of Punjab, India.

Available Copper

The data on available copper in soil in [Table-2] indicated that at 60-90 cm depth, it was varied from 1.10 to 2.21 mg kg^{-1} with an average value 1.59 mg kg^{-1}. The lowest value (1.10 mg kg^{-1}) was observed in sample JS003. Whereas, the highest value (2.13 mg kg^{-1}) was recorded in sample JS001. Thus, the soils were sufficient in available copper content. Such type of trend was also observed in soil samples reported by [18] in micro-propagated banana orchards of Marathwada..

Yield attributes

Number of fruits tree^{-1}

It is revealed from the data presented in [Table-3] that there were significant differences in number of fruits $tree^{-1}$. The sample JS009 produced maximum number of fruits (550 $tree^{-1}$) which was followed by sample JS006 (540 $tree^{-1}$). The minimum number of fruits (432 $tree^{-1}$) was produced in sample JS004. Maximum number of fruits recorded might be due to high nutrient status of nutrients in general and more available K, Ca, Mg and Cu in orchard soil. These results are in conformity with the findings of [8] in sweet orange cultivars under arid and semi arid region of Punjab.

Yield Kg tree^{-1}

The data recorded in [Table-3] indicated that the maximum yield (137.94 Kg $tree^{-1}$) was recorded in sample JS009. However, it was followed by sample JS006 (132.58 Kg $tree^{-1}$). The lowest yield (101.52 kg $tree^{-1}$) was recorded in sample JS004. Similar results were reported by [3] in citrus in South China.

Yield Mt ha^{-}

The data recorded in [Table-3] indicated that the highest yield was recorded in sample JS009 (38.20 $MTha^{-}$) which was followed by sample JS006 (36.72 MT ha^{-}). The lowest yield was recorded in sample JS004 (28.12 Mt ha^{-1}). The variation in yield may be due to variation of nutrient status, variation in age and management practices of orchard. The high yielding orchards had highest rhizosphere as well as high leaf nutrient status. These results are in conformity with [22] surveyed 18 Orchards of Nagpur Mandarin in Jhalawar district of Rajasthan and reported estimated yield of 43.50 $Mtha^{-1}$.

Table-3 *Yield attributes of different sweet orange orchards*

Sample No	No. of fruits tree^{-1}	Yield Kg tree^{-1}	Yield tons^{-1}
JS001	529.00	128.81	35.68
JS002	510.00	120.26	33.31
JS003	519.00	125.47	34.75
JS004	432.00	101.52	28.12
JS005	448.00	107.57	29.79
JS006	540.00	132.58	36.72
JS007	514.00	122.39	33.90
JS008	490.00	115.20	31.91
JS009	550.00	137.94	38.20
JS0010	490.00	118.65	32.86
SE +	12.054	3.50	0.97
CD at 5%	38.55	11.20	3.10

Correlation coefficient between soil nutrient status at different depths with fruit yield.

Data from [Table-4] showed that, the correlation between fruit yield and soil nutrient status from the data it is clear that fruit yield had significant positive correlation with OC, N, P, K and Cu at all three depths of soils. Fruit yield also was found positive correlation with EC, Ca, Mn except Mg. It had positive correlation at 0-30 depth. Whereas at two depths 0-30, 30-60 cm had positive correlation and at 60-90 cm depth had negative correlation with the yield, pH and Zn had negative correlation with yield at all depths

Table-4 *Correlation coefficient between soil nutrients status at different depths with fruit yield*

Soil nutrients	'r' values		
Soil Depths (cm)	0-30	30-60	60-90
pH	-0.83	-0.90	-0.88
EC	0.19	0.39	0.23
OC	0.91**	0.83**	0.77**
N	0.91**	0.75**	0.84**
P	0.77**	0.66**	0.65**
K	0.58**	0.63**	0.65**
Ca	0.15	0.02	0.02
Mg	0.18	-0.02	0.10
S	0.27	0.30	-0.01
Mn	0.16	0.03	0.07
Zn	-0.58	-0.49	-0.47
Cu	0.60**	0.61**	0.48**

Conflict of Interest: None declared

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