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Influence of soil calcium carbonate on yield and quality of Nagpur mandarin

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This article examines the macronutrient status and quality of 11-14 years old of five Nagpur mandarin orchards of Saoner tahsils, Nagpur district as influenced by soil calcium carbonate. Calcareous soils (pH 7.41 to 8.38) with high free $CaCO_3$ content (3.13 to 15.48%) indicating that these soils are moderate to high calcareous in nature and it adversely affects the availability of macronutrients and yield of Nagpur mandarin. In context of nutrient status for these mandarin soils contain, available nitrogen is low (38 to 251 kg ha^{-1}), available phosphorus is low to medium (10 to 22 kg ha^{-1}) and available potassium is low to high (48 to 385 kg ha^{-1}). Leaves that are 4 to 6 months old from non-fruiting terminals contain optimum leaf macronutrient concentration (%) as 1.80–2.50 nitrogen (N), 0.11–0.15 phosphorus (P) and 0.62–0.97 potassium (K) in relation to fruit yield of 13.6–19.6 tonnes ha^{-1}. The findings show a low amount of macronutrients in leaves and reduced yield. In addition the poor quality oranges observed was influenced by increased content of $CaCO_3$.

Key words: $CaCO_3$, nutrient status, mandarin yield, quality

INTRODUCTION

Late Shri Ragujiraje Bhonsale in Central India introduced Nagpur mandarin in 1894. The rapid cultivation of Nagpur mandarin since then in this region has taken place. Mandarin orange (*Citrus reticulate* Blanco), a world famous cultivar popularly known as Nagpur Santra is the main cash and fruit crop of Central India grown on a large scale in Amravati and Nagpur division of Saoner region of Maharashtra and is famous for its taste and quality in India as well as abroad. It is grown since long times by the farmers of the region as the agro climatic condition are favourable for cultivation of citrus (Shrivastava et al., 1999).

In India, citrus is grown in an area of 9.87 lakh ha and total production of 96.38 lakh tonnes with productivity of 9.76 tonnes. In Maharashtra, citrus is grown in an area of 2.87 lakh ha and total production of 17.25 lakh tonnes with productivity of 6 tonnes (IHD 2009-10). Maharashtra state stands 1st followed by Andhra Pradesh and Punjab in area and second in production (Singh, 1999). Oranges prefer more humid and tropical summer climate with warm winter and high rainfall conditions. Nagpur mandarin cultivated in sub-humid to semi arid conditions of central India. Saoner region, part of Marathwada region and areas near Satpura hills proved to be excellent areas for oranges. Average temperature required for growth is 16 to 20°C and it can grow well in 13 to 37°C under tropical climate with humidity nearly of 55%. Oranges require deep, uniform and well drained soil because number of feeder roots is less in citrus with pH 5.5 to 7.5. It should be free from hard pans and salty

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Abbreviations: $CaCO_3$, Calcium Carbonate; **N,** Nitrogen; **P,** Phosphorous; **K,** Potassium.

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The highest global citrus production comes from the soils represented by the order Alfisol, Ultisol, Entisol and Inceptisol (Kohli and Srivastava, 1997; Srivastava and Singh, 2002). Balanced nutritional programme play a dominant role in producing healthy trees with maximum yield and good fruit quality. An exact evaluation of citrus orchard necessitates a compressive survey with respect to climatic conditions, soil characteristics and leaf analysis of orange plants in selected orchards and on their influence on the quality of the fruits. An unscrupulous expansion of acreage under the citrus has taken place over the last 4 decades without a concurrent increase in productivity on account of suitable soils site selection as one of the major reasons. The cultivation of free lime, excessive salt, defective drainage, and presence of hard pan in the subsurface, soil texture, citrus is dependent on several factors like presence of mineralogy composition of soil, cation exchange capacity, soil fertility, etc. (Srivastava et al., 1999). The free $CaCO_3$, powdery lime, and massive structure in soils limit the water and nutrient absorption (Jagdish et al., 2001). Among the various factors which affect the crop production of citrus, $CaCO_3$ plays a very important role. Many researchers reported that, the favourable and the unfavourable effect on growth and yield of citrus. Therefore, it is pertinent to find out what is the actual role of $CaCO_3$ in relation to the macronutrient availability in soil, yield and quality of Nagpur mandarin is of prime importance.

MATERIALS AND METHODS

The Nagpur mandarin orchards selected for the present investigation in Saoner Tahsil of Nagpur District were surveyed and 5 orchards were selected on the basis of their yield performance for last three years and visual observations to know the Influence of soil $CaCO_3$ on yield and quality of Nagpur mandarin. Among the 5 orchards, 2 sites were from non calcareous soils for comparison.

The sampling site is located at 21° 23' 09" N latitude and 78° 55' 12" E longitudes with an altitude of 675 m above mean sea level. The annual average rainfall during the study period was 1016.5 mm and mean monthly temperature ranged from 31.5°C minimum in January to 38.8°C maximum in June. Most of the rainfall is received during the month of July to September. The soil type in the experimental is clayey in texture. The 10 to 12 years old mandarin orchards were selected preferably on medium to deep soils and having common management practices. The profiles were dug in the month of December. The horizon wise samples were collected for their analysis. Soil samples were air-dried and pulverized to pass through a 2 mm sieve. Soil samples were also analysed for pH, EC, organic carbon, free $CaCO_3$, available N, P, and K by standard methods (Jackson, 1973). Leaf samples were collected from 2^{nd}, 3^{rd} and 4^{th} leaf on fruiting shoot and non-fruiting, preferably at height of 1.5 to 2.0 m from ground, from all the sites (Kohli et al., 2000). The leaf samples were analyzed for total N, P, and K by standard methods (Piper, 1966). Three well developed and mature fruits were randomly selected from each mandarin orchard and were used for physical and chemical analysis (Ranganna, 1986).

RESULTS AND DISCUSSION

Soil status of the site

Results of nutrients status and the soil pH were ranged from (7.41 to 8.38) indicating slightly alkaline reaction (Table 1). Comparatively, high soil pH was found in Pedon-1, 3 and 4 due to calcareous in nature. There was slightly increase in pH with increase in depth in all pedons. The electrical conductivity of soil (Table 1) ranged from 0.11 to 0.38 dSm^{-1}. The electrically conductivity of soil increased with depth. The highest values were found in Pedon-5 and lowest were found in pedon-3. The organic carbon was found low to moderately high range (2.3 to 11.8 g kg^{-1}). The organic carbon was decreased with increase in depth. The free $CaCO_3$ ranged from 3.13 to 15.48% (Table 1). The $CaCO_3$ were found highest in Pedon-3 followed by Pedon-4 and 1 and was comparatively lowest in Pedon-2 and 5. The available N were found in low range and available P were found in medium range except available K found in all sites in a very high range.

Leaf nutrient content

The total N in leaf were found to be ranged from 1.8 to 2.5%, total P were found to be ranged from to 0.11 to 0.15% and total K were found to be 0.62 to 0.97%. The total N, P, and K were found to be higher in Pedon-5 and lower in Pedon-4 (Table 2).

Yield and quality

The yield of Nagpur mandarin orchards varied from

Table 1. Chemical and nutrient characteristics of soils in pedons of Nagpur Mandarin.

Depth (cm)	pH (1:2.5 H_2O)	Electrical conductivity (dSm^{-1})	Organic carbon (%)	$CaCO_3$ equivalent %)	Available nutrients (kg ha^{-1})		
					N	P_2O_5	K_2O
Pedon-1							
0-20	7.41	0.16	0.69	4.62	250.8	22.4	345
20-40	7.74	0.19	0.50	5.64	150.3	19.3	305
40-70	7.78	0.17	0.41	8.40	118.8	17.2	297
70-110	8.10	0.23	0.37	8.58	95.7	16.2	288
110+	8.21	0.31	0.32	9.45	86.8	15.7	265
Pedon-2							
0-30	7.46	0.18	0.97	3.58	112.8	20.1	330
30-60	7.55	0.19	1.18	3.13	100.3	17.2	327
60-95	7.66	0.20	0.77	4.68	97.8	15.2	312
95-120	7.69	0.24	0.82	6.28	87.8	14.8	300
120+	7.82	0.33	0.66	6.98	62.7	13.4	293
Pedon-3							
0-30	7.58	0.15	0.38	6.84	75.2	22.4	385
30-65	7.96	0.14	0.48	9.62	62.7	21.9	240
65-100	7.93	0.11	0.32	10.20	54.7	15.4	216
100+	8.21	0.16	0.23	12.42	37.6	11.4	210
Pedon-4							
0-35	7.63	0.12	0.64	7.24	137.9	16.2	168
35-70	7.94	0.14	0.72	7.98	125.4	15.4	158
70-110	8.22	0.15	0.30	10.24	112.8	10.6	108
110-140	8.33	0.16	0.59	13.44	75.2	10.2	84
140+	8.38	0.17	0.45	15.48	73.2	9.8	48
Pedon-5							
0-25	7.72	0.25	1.13	3.78	112.8	21.9	252
25-45	7.76	0.28	0.73	4.26	100.3	17.1	180
45-80	7.78	0.38	0.54	4.18	87.8	15.9	145
80-120	7.70	0.35	0.68	4.10	87.8	13.2	108
120+	7.85	0.38	0.66	5.84	75.2	12.8	120

Table 2. Yield performance and leaf nutrient content in Nagpur mandarin.

Orchard	Age years	Yield t ha^{-1}	Macronutrient		
			Total N	Total P	Total K
Orchard-1	14	18.2	2.40	0.14	0.90
Orchard-2	11	15.7	2.10	0.13	0.64
Orchard-3	11	16.8	2.00	0.13	0.87
Orchard-4	13	13.6	1.80	0.11	0.62
Orchard-5	12	19.6	2.50	0.15	0.97

13.6 to 19.6 tonnes ha^{-1} (Table 2). The maximum yield recorded in Orchard-5 and minimum yield in Orchard-4. The similar results were observed by Awasthi et al. (1984). The average fruit weight of Nagpur mandarin orchards of study area ranged between 159.70 to 190.20 g (Table 3) with an average weight of 163.9 g. The

Table 3. Physical and chemical characteristics in fruits of Nagpur mandarin.

Name of orchard	Weight of fruit (gm)	Thickness (cm)	Juice (%)	Acidity (%)	TSS (%)	Reducing sugar (%)	Non-reducing sugar (%)	Vitamin C mg/100 ml
Orchard-1	172.50	0.26	47.40	0.51	10.80	1.03	1.12	57.90
Orchard-2	168.50	0.26	47.40	0.52	9.40	1.01	1.18	55.40
Orchard-3	161.90	0.22	41.50	0.57	8.90	0.96	1.21	56.70
Orchard-4	159.70	0.16	40.30	0.60	9.50	0.99	1.20	53.10
Orchard-5	190.20	0.34	59.30	0.50	10.80	1.05	1.12	58.70

average peel thickness of fruit of Nagpur mandarin varied from 0.16 to 0.34 cm (Table 3) with an average of 0.24 cm. The average juice content varied from 40.3 to 59.3% with an average of 45.72%. The acidity of Nagpur mandarin fruit juice varied from 0.50 to 0.60% with an average of 0.54%. The high acidity was found in Orchard-4 and low acidity found in Orchard-5 similar research findings found by Munshi et al. (1979). Total soluble solids content in fruit juice of Nagpur mandarin ranged between 8.9 to 10.80% with an average of 9.88%. Reducing sugar varies from 0.96 to 1.05% of Nagpur mandarin with an average of 0.98% (Table 3) and non-reducing sugar varies from 1.12 to 1.21 with an average of 1.20% of Nagpur mandarin. The Vitamin C content in fruit juice ranged between 53.10 to 58.70 mg 100 ml^{-1}. The maximum vitamin C was found in Orchard-5 and minimum was observed in Orchard-4.

Conclusions

It is concluded that, the $CaCO_3$ played very important role in the quality of Nagpur mandarin. $CaCO_3$ severely affects the availability of macronutrients in soil. To sum up, all the soils of mandarin orchards are potentially good for its growth and yield but the high amount of $CaCO_3$ found to be responsible for reduction in yield and poor quality of mandarin. The high $CaCO_3$ content in the soils are responsible for the lower production of Nagpur mandarin in the study area.

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