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Soil fertility and plant nutrional factors contributing towards citrus decline in central India

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ABSTRACT

The present investigation was carried out to determine role of soil fertility and leaf nutrition composition in healthy versus declining Nagpur mandarin orchards of central India. Total of forty two representative surface and depthwise soil samples and leaf samples from healthy and declined orange orchards were collected and analyzed for various nutrients. The available nitrogen, phosphorus and potassium content of healthy orchards surface soils varied from 206.0 to 273.7 kg ha^{-1}, 25.0 to 38.3 kg ha^{-1}, 324.0 to 672.0 kg ha^{-1} and in declining orchards, it varied from 135.4 to 206.8 kg ha^{-1}, 19.8 to 23.3 kg ha^{-1}, 364.0 to 750.4 kg ha^{-1}, respectively. Micronutrients status of Nagpur mandarin orchards showed that available copper, zinc, iron and manganese in healthy orchards surface soils varied from 2.30 to 5.90 mg kg^{-1}, 0.56 to 0.84 mg kg^{-1}, 4.60 to 6.39 mg kg^{-1}, 12.71 to 17.11 mg kg^{-1} and in declined orchards it varied from 2.00 to 2.88 mg kg^{-1}, 0.39 to 0.51 mg kg^{-1}, 3.50 to 5.13 mg kg^{-1}, 8.13 to 12.34 mg kg^{-1} respectively. While, leaf nutrients content showed that nitrogen, phosphorus and potassium content in leaf of healthy orchards varied from 2.30 to 2.55%, 0.12 to 0.16%, 0.80 to 1.00% and in declined orchards it varied from 1.70 to 2.08%, 0.08 to 0.11%, and 0.83 to 1.73% respectively. Calcium, magnesium and sulphur content in healthy orchards varied from 3.02 to 3.86%, 0.57 to 0.71%, 0.19 to 0.17% and in declined orchards it ranged from 2.46 to 3.21%, 0.31 to 0.70%, and 0.16 to 0.20% respectively. Results pertaining to micronutrient showed that iron, manganese, copper and zinc in healthy orchards varied from 101.6 to 138.6 mg kg^{-1}, 19.72 to 31.62 mg kg^{-1}, 27.40 to 33.96 mg kg^{-1}, 28.45 to 37.18 mg kg^{-1}, and in declined orchards it varied from 73.66 to 102.00 mg kg^{-1}, 22.38 to 30.67 mg kg^{-1}, 20.72 to 25.05 mg kg^{-1}, and 17.22 to 24.00 mg kg^{-1} respectively.

Keywords: Nagpur mandarin, healthy orchards, declining orchards, soil fertility, leaf nutrient, central India

INTRODUCTION

Citrus is often regarded as one of the rumunative commercial fruit crop of India after mango and banana (Srivastava and Singh, 2002). Fertilizers inputs account for 30-40 per cent of total cost of citrus production (Srivastava and Singh, 2001c) suggesting the significance of citrus nutrition (Srivastava and Singh, 2001a; 2001b). Among the important citrus fruits orange is cultivated on a very large scale especially in central and south India. Central is known for growing Nagpur mandarin (Srivastava and Singh, 2003a; 2009). Of late, Nagpur mandarin orchards have proven to be failure because of defective selection soil site and less availability of nutrients causes deterioration in citrus (Srivastava and Kohli, 1997; Srivasatva and Singh 2001a). Soil nutritional status and leaf analyses in recent years have been widely used to identify nutritional problems, to detect deficiency of nutrient and to measure the response to the applied plant nutrients. (Srivastava and Singh, 2003b; 2004a, Srivastava *et al.* 2017) It is considered fairly good index to measure the fertilizer need of citrus plants (Srivastava and Singh, 2005) Nutritional deficiencies especially of the micronutrient have been observed based on visual observation or leaf analysis in different orchards. (Srivastava and singh, 2003; 2004b) Therefore, the present study has been taken to determine nutritional status of Nagpur mandarin orchards based on the soil and leaf analysis.

MATERIALS AND METHODS

The present investigation of orange orchards comes under eight villages in Warud tahsil of Amravati district (M.S.). Twelve orchards from healthy and declined condition were selected on the basis of their yield performance for last five years and visual observations. Forty two representative depth wise sample, twenty one from healthy and twenty one from declined orange orchards were collected. Soil samples were analyzed for total nitrogen and available nitrogen, phosphorus,

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potassium, sulphur by modified Kjeldhal's method (Pipper, 1966), alkaline potassium permanganate method (Subbaih and Asija, 1956), Olsens method (Jackson, 1967), flame photometer method (Jackson, 1967) and turbidimetric method (Chopra and Kanwar, 1976), respectively. Exchangeable cations (calcium and magnesium) were determined by neutral normal ammonium acetate method (Pipper, 1966). Available micronutrients (copper, zinc, iron and manganese) were determined by Atomic absorption spectrophotometer in DTPA-extract (Lindsay and Norvell, 1978). The leaf samples were collected following the procedure as suggested by Srivastava *et al.* (1994) and analyzed for nitrogen, phosphorus, potassium, calcium magnesium and sulphur by standard methods as described by Jackson (1967). Total iron, manganese, copper and zinc were determined by Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Soil fertility of healthy versus declining orchards

Depthwise distribution showed decreasing trend of available nitrogen vertically in all healthy and declined orchards soil. The results showed that total nitrogen content in healthy orchards was much higher as compared to declining orchards. The past works of Srivastava and singh (2001c) showed that sub-optimum level of available N was the major production constraint in central India. Available nitrogen content in healthy and declined orchards soils varied from 206.0 to 273.7 kg/ha and 135.4 to 206.8 kg/ha respectively. All soils of orange orchards were categorized as low to very low in available nitrogen. Available nitrogen content was found higher in soils supporting healthy orchards than declining orchards. The results showed that available nitrogen decreases with soil depth in all healthy and decline orchards. Similar results were observed by Srivastava and Patel (2014).The available phosphorus content of healthy and declining mandarin orchards surface soils ranged from 25.0 to 38.3 kg ha^{-1} and 19.8 to 23.3 kg ha^{-1} respectively. According to the standard rating it appears that healthy orchard soils were found to be low to medium and declined orange orchards in low in available P_2O_5 content. From observation it was observed that available P_2O_5 decreased continuously with soil depth. Similar results were reported by Srivastava and Patel (2014). Available potassium content in healthy and declined orange orchards ranged from 291.2 to 672.0 kg ha^{-1} and 327.5 to 750.4 kg ha^{-1} in surface layer respectively. All soils of healthy and declined orchards were under high to very high available potassium content according to standard ratings. The high potassium content may be attributed to the presence of potassium supplying minerals in the parent rock of the area. High amount of available potassium was also been reported by Kashikar (1983) for the black soil. Data clearly indicated that there was no uniform increase or decrease trend of available potassium content with depth of the soil.

The DTPA-Cu varied from 2.30 to 5.90 mg kg^{-1} and 2.02 to 2.88 mg kg^{-1} in healthy and declining mandarin orchards respectively. (Table 1) Similar observations were also reported by Srivastava and Patel (2014). The availability of copper in healthy and declining mandarin orchards soils was quite high as compared with its critical limit (0.2 ppm) as suggested by Lindsay and Norvell (1971). Similar results were also reported by Sharma and Mahajan *et al.* (1990). DTPA-Zn in healthy and declined orchards varied from 0.56 to 0.84 mg kg^{-1} and 0.39 to 0.51 mg kg^{-1} in surface soil samples respectively. It was further observed that by and large, the soil samples from declined orange orchards soils content comparatively less available zinc than healthy orchards. Similar observation was also reported by Srivastava and Patel (2014). The critical limit for available zinc is 1.0 mg kg^{-1}, so zinc content in all declined orange orchards showed low content of available zinc (Srivastava and Singh, 2001). While DTPA-Fe content in healthy and declined orchards varied from 4.69 to 6.39 mg kg^{-1} and 3.50 to 7.12 mg kg^{-1} in surface soil samples respectively. It was observed that most of the orchards soils were well supported with available iron. Available manganese content in healthy and declined orange orchards ranged from 12.71 to 17.11 mg kg^{-1} and 8.13 to 12.34 mg kg^{-1} in surface soil samples respectively. The available manganese content was invariably higher in the soils of healthy orchards than decline orange soils.

Table 1: Available pool of nutrients in healthy versus declining Nagpur mandarin orchards in central India

Depth (cm)	Available macronutrients (kg ha^{-1})			Available micronutrients (mg kg^{-1})			
	N	P_2O_5	K_2O	Fe	Mn	Cu	Zn
Healthy mandarin orchards							
Location : Loni (Age of trees – 14 years)							
0 – 20	222.9	37.6	392.0	6.39	14.32	2.33	0.56
20 – 50	189.1	26.8	296.8	5.42	8.33	2.01	0.63
50 – 80	177.8	23.2	347.2	8.81	9.75	1.80	0.50
80 - 100	172.1	21.5	358.4	7.20	3.92	1.22	0.41
Location : Dhanodi1(Age of trees – 12 years)							
0 – 20	234.2	38.4	672.0	5.82	17.11	3.15	0.84
20 – 50	214.5	30.6	638.4	6.40	13.71	2.27	0.42
50 – 80	208.8	28.6	560.0	6.56	6.10	2.18	0.38
80 - 100	169.3	19.7	532.0	8.28	4.92	1.97	0.32
Location : Bahda (Age of trees – 12 years)							
0 – 20	206.0	25.0	324.0	4.69	12.72	2.85	0.69
20 – 50	189.1	23.2	284.8	5.84	11.0	2.76	0.52
50 – 80	186.2	19.7	296.5	5.01	8.61	2.31	0.30
80 - 100	177.8	14.1	294.4	7.21	6.33	2.40	0.32
Location : Temburkheda (Age of trees – 08 years)							
0 – 20	241.6	31.4	492.8	5.70	14.35	2.30	0.80
20 – 50	210.3	21.5	324.8	5.83	12.65	2.55	0.62
50 – 80	194.7	17.3	291.2	6.22	7.37	2.40	0.41
80 - 100	176.2	13.4	257.6	6.15	6.39	2.30	0.41
Declining mandarin orchards							
Location : Loni (Age of trees – 07 years)							
0 – 20	208.8	19.8	368.4	4.13	12.07	2.02	0.51
20 – 50	180.6	16.0	390.8	4.51	7.71	1.44	0.31
50 – 80	163.6	12.1	280.0	5.17	6.91	2.00	0.30
80 - 100	149.5	9.9	357.6	5.21	4.44	1.05	0.20
Location : Jamalpur (Age of trees – 15 years)							
0 – 20	208.8	19.8	368.4	4.13	12.07	2.02	0.51
20 – 50	180.6	16.0	390.8	4.51	7.71	1.44	0.31
50 – 80	163.6	12.1	280.0	5.17	6.91	2.00	0.30
80 - 100	149.5	9.9	357.6	5.21	4.44	1.05	0.20
Location : Jamalpur (Age of trees – 09 years)							
0 – 20	177.8	20.2	750.4	4.83	10.15	2.25	0.42
20 – 50	152.4	19.1	587.2	4.72	11.27	2.07	0.39
50 – 80	141.1	17.3	465.8	4.81	7.30	1.51	0.22
80 - 100	135.4	12.5	517.9	4.49	5.40	1.17	0.20
Location : Wathoda (Age of trees – 16 years)							
0 – 20	149.5	23.3	554.4	3.50	11.24	2.88	0.46
20 – 50	141.1	19.8	412.8	3.90	8.27	1.33	0.36
50 – 80	124.1	14.3	291.2	3.98	6.62	1.21	0.31
80 - 100	112.8	12.3	327.5	4.10	4.25	1.07	0.30

Leaf nutrient composition of healthy versus declining orchards

The data regarding nitrogen content in leaves of healthy mandarin orchards varied from 2.30 to 2.55 % with mean value of 2.41 % and in declined orchards it varied from 1.70 to 2.08 % with mean value of 1.92 % (Table 2). Similar observations were also reported in central India (Srivastava and Singh, 2001; Srivastava *et al.*, 2008. It was observed that nitrogen content in leaves of healthy orchards was higher as compared with declined ones. This may be due to higher soil nitrogen status of healthy orange orchards than declined orange orchards. while, phosphorus content in the leaves of Nagpur mandarin varied from 0.12 to 0.16% in healthy trees and 0.08 to 0.1% in declined trees with a

mean value of 0.14% and 0.09% in the leaves of healthy and declined orchards respectively. Similar observations were also reported by Srivastava and Singh (2001a). It was observed that phosphorus content in the leaves of healthy trees was higher as compared to declining trees. Low concentration phosphorus might be due to low available phosphorus status in soils of declined orange orchards and inadequate use of phosphatic fertilizers. Potassium content in the leaves of healthy trees varied from 0.80 to 1.00% with an average of 0.89%. In declining trees it varied from 0.83 to 1.73% with mean value of 1.06%. It was observed that the declined trees accumulated more potassium in the leaves than the healthy ones.

Table 2: Leaf Nutrient composition of healthy versus declining Nagpur mandarin orchards in central India

Location	Macronutrient (%)						Micronutrient (mg kg^{-1})			
	N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn
Healthy mandarin orchards										
Loni	2.40	0.15	0.87	3.78	0.61	0.20	138.6	28.45	27.69	28.37
Dhanodi	2.37	0.13	0.87	3.20	0.57	0.19	122.3	28.52	27.40	29.13
Bahda	2.51	0.16	0.99	3.86	0.71	0.20	102.6	32.54	29.94	28.31
Temburkheda	2.43	0.12	0.81	3.02	0.64	0.18	130.6	37.18	32.46	25.79
Dhanodi	2.30	0.16	0.80	3.37	0.60	0.20	101.0	36.16	33.96	22.31
Warud	2.55	0.16	1.00	3.34	0.71	0.21	130.0	36.16	28.37	28.08
Mean	2.41	0.14	0.89	3.42	0.64	0.19	120.81	33.16	29.97	26.99
Declining mandarin orchards										
Loni	1.82	0.10	1.73	3.08	0.70	0.19	96.66	30.00	22.00	20.30
Jamalpur	2.08	0.08	1.00	2.72	0.49	0.16	82.66	22.38	20.72	21.54
Jamalpur	1.70	0.11	0.95	3.10	0.48	0.20	94.00	24.20	24.92	20.72
Pusla	1.99	0.08	0.89	3.21	0.44	0.18	73.66	30.67	23.08	20.93
Wathoda	2.04	0.09	0.83	2.46	0.33	0.16	102.00	25.61	21.60	22.60
Dhanodi	1.90	0.09	0.97	2.83	0.31	0.17	100.33	23.18	25.05	19.58
Mean	1.92	0.09	1.06	2.90	0.45	0.17	91.55	25.53	22.89	20.94

.It was evident from the results that the concentration of iron in the leaves of healthy orchards varied from 101.0 to 138.6 ppm with mean concentration of 120.81ppm. In declined orchards, it varied from 73.66 to 102.00 mg kg^{-1} with mean concentration of 91.55 mg kg^{-1}. Results indicated that the iron content in the leaves of healthy orchards was higher as compared to declining orchards (Table 2). The iron content in the leaves of healthy and declined trees was in the optimum range. Manganese content ranged from 28.45 to 37.18 mg kg^{-1} with mean value of 33.16 mg kg^{-1} in leaves of healthy orchards and 22.38 to 30.67 mg kg^{-1} with mean value 25.53 mg kg^{-1} in declining orchards. From the results it was observed that manganese content in the healthy orchards was found higher as compared to declined orchards. Concentration of copper varied from 27.40 to 33.96 mg kg^{-1} with an average 29.97 mg kg^{-1} in healthy orchards and in declining orchards it varied from 20.72 to 25.05 mg kg^{-1} with an average value of 22.89 mg kg^{-1}. Copper content in healthy trees was higher than that of declined orchards. Zinc is required in very minute quantity by citrus trees. It ranks next to nitrogen in citrus nutrition. Zinc concentration ranged from 22.31 to 29.13 mg kg^{-1} with mean value of 26.99 mg kg^{-1} in leaves of healthy orchards and in declined orchards it varied from 19.58 to 22.60 ppm with mean value of 20.94 mg kg^{-1}. It was evident from the results that the concentration of zinc in leaves of healthy orchards was higher than that of declined orchards. A comparison of leaf zinc and copper status with the standards values (Srivastava and Singh, 2003b) showed that all declining orchards were in low range whereas most of the healthy orchards registered much better available supply of micronutrients in soil and their consequent effect on leaf nutrient composition.

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