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Effect of foliar sprays of micronutrients on nutrients status, yield and fruit quality of kinnow mandarin

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ABSTRACT : The study was conducted under arid conditions of north-western Rajasthan during the year 2007-08 at CIAH, Bikaner. The experiment was laid out with 15 treatments replicated three times in randomized block design. The trees were maintained with common cultural practices under drip irrigation system. Foliar applications of micronutrients *viz.* Fe (0.50%, 1.0%), Cu (0.25%, 0.50%) and Zn (0.50%, 1.0%) alone and in combinations were done twice (at an interval of one month) in the month of June and July on six years old kinnow trees. The maximum nitrogen, phosphorus, iron, copper and zinc content was obtained in leaves by foliar sprays of micronutrients treatment Fe 0.50%+Zn 0.50%+Cu 0.25% under hot arid conditions. The higher fruit yield and quality attributes were also observed under this treatment.

Key words : Kinnow mandarin, arid environment, Micronutrients, Foliar sprays,

Kinnow cultivation is becoming popular in north India (8). It is widely adopted that hybrid is almost free from granulation, comparatively resistant to frost and insect-pests and diseases. It is an important fruit crop being grown particularly in canal irrigated areas of Rajasthan. The kinnow fruit is cultivated in about 9,000 ha area with production of 25,000 MT in the districts of Sri Ganganagar, Hanumangarh and Bikaner of Western Rajasthan. It was introduced in 1956 in Punjab which helped in replacing the traditional citrus fruits viz., sweet orange and local mandarin to some extent and strengthening the status of citrus industry in India and thereby making India as the sixth largest producer (3.79 million tones/annum) in the world with a share of 4.8% (7). It is used for fresh eaten, juice making and other drinks. It has vast potential for large scale cultivation in arid region. The major limiting factor in increasing the area under citrus in Rajasthan is poor quality of the soils, which have high pH, low nutritional status and poor in organic matter. Deficiency of any element considered essential among the 16 leads to altered metabolism and subsequently results in physiological changes and poor productivity (2). Chapman (3) reported substantial removal of macro as well as micronutrients by citrus fruits. There is a specific need of zinc, iron, copper sprays to mandarin orchards in poor soils of western Rajasthan as the soil is deficient in major and micronutrients due to the high pH of the sandy soil. Kinnow mandarin orchards sprayed with micronutrients resulted in the production of better size of fruits (5).

Therefore, realizing the importance of essential elements in plant nutrition, the present study was undertaken to find out the effect of zinc, iron and copper in enhancing productivity and quality of kinnow mandarin under arid condition of western Rajasthan.

MATERIALS AND METHODS

A field experiment was carried out at Central Institute for Arid Horticulture, Bikaner during the year 2007- 08. For conducting the study, six years old uniform trees of kinnow were selected. The soils of arid zone are characterized under aridisols which are poor in availability of nutrients, organic matter and water holding capacity. Bikaner district extends from 27°15' to 29°5' north latitudes and 71°54' to 74°12' east longitudes. Bikaner has arid climate with an annual average rainfall of about 260 mm. More than 80% rainfall is received in the southwest monsoon season. During summers, the maximum temperature may go as high as 48°C while in the winter it may fall as low as 0°C. This region is prone to high wind velocity and soil erosion. Soil drifting due to high speed winds leads to soil erosion which is a major problem in the summers.

There were 15 treatments replicated thrice tested in randomized block design. The effect of iron (0.5%, 1.0%), copper (0.25%, 0.50%) and zinc (0.50%, 1.0%) alone and in combinations was studied. The required quantities of micronutrients were dissolved in water separately and then pH of these nutrients solution was adjusted by lime and sprayed in June 2007 and July 2007. The simple water spray was done on the trees under control treatment. In each spray treatment, Teepol was added as sticking agent in prepared solution. The four –five months old 30-50 leaf samples were collected for analysis. The fruit and leaf samples were analyzed for N, P, K, Zn, Fe and Cu by the following standard procedure laid out by Chapman (3). Observations on fruit yield and quality parameters were recorded and data were subjected to statistical analysis.

RESULTS AND DISCUSSION

The foliar application of iron, copper and zinc alone and in combinations increased nitrogen, phosphorus, iron, copper and zinc content in leaves, however, the potassium content decreased after spray of micronutrients. The leaf sampling was carried out 15 days after second sprays of micronutrients, the maximum nitrogen (2.55%), phosphorus (0.15%), iron (85.13 ppm), copper (5.01 ppm) and zinc (46.40 ppm) contents were recorded in leaves of kinnow mandarin tree receiving treatments T_7 (Fe 0.50+Zn 0.50+Cu 0.25%) as compared to control and other treatments (Table-1). Dube and Saxena (6) reported such results in sweet orange and Manchanda (9) also reported similar findings in sweet orange. It might be due to the fact that foliar application of

micronutrients particularly iron, copper and zinc corrected iron, copper and zinc deficiency in leaves and thus chlorotic leaves become normal, resulting in better assimilation of nitrogen and phosphorus in the leaves.

The micronutrient sprays significantly increased the fruit yield per tree in kinnow mandarin under arid conditions. The maximum fruit yield (30. 54 kg/tree) was obtained under treatment T_7 (Fe 0.50+Zn 0.50+Cu 0.25%) followed by T_{14} (Fe 1.0%+Zn 1.0%+Cu 0.50%) treatment (29.21 kg/tree). It might be possibly due to better fruit set and retention and improvement in quality of fruits by foliar feeding of micronutrients. A considerable improvement was observed under different treatments in quality attributes of kinnow mandarin (Table 2). The maximum TSS, ascorbic acid, total sugars, iron, copper and zinc contents in fruit juice were recorded maximum with foliar application of treatment T_7 (Fe 0.50% + Zn 0.50% + Cu 0.25%) viz.13.25°Brix, 27.20 mg/100 g, 7.24%, 28.10, 0.21 and 0.43 ppm, respectively, however, the acidity content was minimum (0.70%). The increased TSS and ascorbic acid content of fruit with iron may be attributed to an increase in photosynthetic activity and more production of starch and consequently conversion into sugars. Dhillon and Bindra (4) have obtained the similar results in ber and Singh *et al.* (11) in mango cv. Dashehari. Zinc sulphate sprays also increased TSS and ascorbic acid due to more synthesis of auxins which increased metabolic activity and accumulation of more total soluble solids. It is in conformity with findings of Som Dutt and Bambota (12) in citrus, and Babu *et al.* (1) in kinnow mandarin. Reduction of starch content at the time of acid deterioration and intensive translocation in fruits may be the possible reason of increase of sugar in fruits. Similarly, Singh *et al.* (10) found that foliar spray of micronutrients increased sugar content in aonla. Zinc spray also improves the auxin content

Table 1. Effect of foliar sprays of micronutrients on N, P, K, Fe, Cu and Zn content of Kinnow leaves

Symbols	Treatments	After second spray of micronutrients (August, 2007)					
		N (%)	P (%)	K (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)
T_0	Control (water sprays)	2.01	0.05	0.67	42.14	3.01	19.70
T_1	Fe 0.50%	2.50	0.11	0.65	81.78	3.29	22.17
T_2	Cu 0.25%	2.43	0.10	0.64	53.08	4.90	22.03
T_3	Zn 0.50%	2.53	0.13	0.65	53.17	3.30	42.13
T_4	Fe 0.50%+Cu 0.25%	2.51	0.11	0.64	81.81	4.95	23.15
T_5	Fe 0.50%+Zn 0.50%	2.54	0.14	0.64	82.11	3.33	42.39
T_6	Zn 0.50%+Cu 0.25%	2.53	0.13	0.64	55.10	4.91	43.09
T_7	Fe0.50%+Zn 0.50%+Cu 0.25 %	2.55	0.15	0.63	85.13	5.01	46.40
T_8	Fe 1.0%	2.51	0.12	0.64	81.94	3.46	23.98
T_9	Cu 0.50%	2.45	0.11	0.63	55.10	4.96	23.11
T_{10}	Zn 1.0%	2.54	0.14	0.63	55.20	3.45	43.18
T_{11}	Fe 1.0%+Cu 0.50%	2.51	0.12	0.64	82.14	5.03	24.16
T_{12}	Fe 1.0%+Zn 1.0%	2.55	0.15	0.64	85.81	3.48	44.11
T_{13}	Zn 1.0%+Cu 0.50%	2.54	0.14	0.64	58.20	5.06	44.21
T_{14}	Fe 1.0%+Zn 1.0%+Cu 0.50%	2.57	0.16	0.62	86.18	5.13	46.71
	S. Em±	0.06	0.01	0.02	0.78	0.09	0.44
	C. D. at 5%	0.17	0.02	NS	2.26	0.26	1.29

Table 2. Effect of foliar sprays of micronutrients on yield and quality attributes of Kinnow fruits

Treatments	Fruit yield (kg/tree)	TSS (°Brix)	Ascorbic acid content (mg/100 g)	Acidity (%)	Total sugars (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)
Control (water spray)	19.21	11.06	20.26	0.88	6.50	18.44	0.11	0.32
Fe 0.50%	24.91	12.40	24.47	0.76	6.90	24.44	0.13	0.36
Cu 0.25%	23.39	12.33	23.56	0.78	6.88	19.01	0.17	0.34
Zn 0.50%	26.84	12.43	24.78	0.75	7.10	19.19	0.13	0.40
Fe 0.5.0%+Cu 0.25%	25.52	12.40	24.65	0.75	6.95	25.80	0.18	0.37
Fe 0.50.%+Zn 0.50%	28.18	13.01	25.79	0.71	7.15	26.14	0.13	0.42
Zn 0.50%+Cu 0.25%	27.87	12.69	25.65	0.74	7.14	21.11	0.19	0.41
Fe 0.50%+Zn0.50%+Cu 0.25 %	30.54	13.25	27.20	0.70	7.24	28.10	0.21	0.43
Fe 1.0%	26.17	12.48	24.80	0.75	7.10	26.70	0.13	0.37
Cu 0.50%	23.80	12.40	24.08	0.76	7.04	20.04	0.21	0.35
Zn 1.0%	28.61	12.60	25.01	0.74	7.21	20.14	0.14	0.42
Fe 1.0%+Cu 0.50%	24.74	12.38	24.60	0.76	6.90	25.72	0.17	0.36
Fe 1.0%+Zn 1.0%	27.19	12.89	25.76	0.72	7.05	26.01	0.13	0.40
Zn 1.0%+Cu 0.50%	26.43	12.60	25.61	0.72	7.15	20.89	0.19	0.39
Fe 1.0%+Zn 1.0%+Cu 0.50%	29.21	13.01	26.01	0.71	7.21	27.92	0.20	0.38
S. Em±	1. 41	0.26	0.18	0.02	0.04	1.41	0.01	0.02
C. D. at 5%	4. 09	0.76	0.52	0.05	0.13	4.09	0.02	0.05

and it also acted as catalyst in oxidation process. Its presence is of great importance in sugar metabolism. Similar findings have also been reported by Babu *et al.* (1) in kinnow mandarin. The decrease in fruit acidity owing to the application of Fe, Cu and Zn might be because of quick conversions into sugars and its derivatives by the reaction of glycolytic pathway. Increased sugars and reduced starch content, which were due to more intensive translocation of starch to sugars in fruits, might be the second reason of reduced acidity of fruits. Singh *et al.* (10) in anola and Babu *et al.* (1) in kinnow mandarin also reported decrease in fruit acidity due to application of micronutrients.

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