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Short communication

Improving growth, yield and quality of Kinnow mandarin through foliar application of potassium and zinc

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ABSTRACT

Present investigation was carried out at Krishi Vigyan Kendra, Chittorgarh, Rajasthan. The experiment consists of 10 foliar K and Zn application treatments. Among the treatments, combined application of 1.5 per cent potassium nitrate + 0.1 per cent EDTA Zinc (T_4) was found best for vegetative growth (plant height, canopy volume, shoot length), treatment (T_7) with 1.5 per cent potassium phosphate + 0.1 per cent EDTA zinc was found best for yield (fruit retention, number of fruit plant^{-1}, fruit weight, fruit diameter (equatorial & polar), yield plant^{-1}, estimated yield^{-1}) and treatment (T_{10}) with 1.5 per cent potassium sulphate + 0.1 per cent EDTA zinc resulted into highest quality (TSS, acidity, TSS/ acid ratio, reducing sugar, total sugars, ascorbic acid, rind thickness and juice content), fruit and leaf nutrient status (NPK and Zn).

Key words: Potassium, zinc, foliar, fruit quality, yields.

Kinnow cultivation is providing to be major attraction for fruit growers in India because of the increasing demand from consumers and the highest content of limonene. Productivity depends on many abiotic (climate, site, soil, nutrition and irrigation management) and biotic (rootstock, cultivar, insect pest and disease management) factors. Among nutrients, K_2O and Zn have much significance due to poor nutrient status of soil in Southern region of Rajasthan. Zinc (Zn) is one of the micronutrient required for normal plant growth. It is well known that Zn acts as a co-factor of many enzymes and affects many biological processes such as photosynthesis reactions, nucleic acid metabolism, protein and carbohydrate biosynthesis (Marschner, 8) because leaf is the principle site of plant metabolism and changes in the nutrient supply are clearly inflicted in the composition of leaf. In recent past, poor fruit set, uneven fruiting, poor quality and yield of fruits is being reported from the Kinnow growers of the region, further farmers are not applying nutrients in proper quantity several orchards are turning unproductive.

The present study was carried out at KVK, Chittorgarh, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan during the year 2013-14. Five-year-old 30 uniform and healthy Kinnow mandarin trees grafted on rough lemon (*Citrus jambhiri* L.) rootstock were planted in square system at 5 m distance and grown under uniform soil conditions (150.7 kg ha^{-1}available nitrogen, 24.3 kg ha^{-1} available phosphorous, 150.8 kg ha^{-1}available potash, 0.61 ppm available zinc and 0.49 ppm available boron) were used. The experiment consisted of 10 treatments, *viz.*, T_1 - Water spray (control), T_2 (0.5% K_2NO_3 + EDTA zinc 0.1%), T_3 (1.0% K_2NO_3 + EDTA zinc 0.1%),T_4 (1.5% K_2NO_3 + EDTA zinc 0.1%), T_5 (0.5% K_2PO_5 + EDTA zinc 0.1%), T_6 (1.0% K_2PO_5 + EDTA zinc 0.1%), T_7 (1.5% K_2PO_5 + EDTA zinc 0.1%), T_8 (0.5% K_2SO_4 + EDTA zinc 0.1%), T_9 (1.0% K_2SO_4 + EDTA zinc 0.1%), T_{10} (1.5% K_2SO_4 + EDTA zinc 0.1%) applied at fruit set and peach size stage of fruit through foliar spray. These treatments were evaluated under one way analysis of variance replicated thrice adopting uniform cultural schedules during the experimentation. The observations were recorded on vegetative attributes, yield characteristics, qualitative attributes and leaf nutrient status. The vegetative parameters regarding the tree height (m), tree canopy were measured at the beginning, *i.e.* in the month of March 2013 and at the end of the experiment, *i.e.* January, 2014 and average increase in the tree height (m) and tree spread (m) were recorded. Five newly emerged flushes were tagged from each side (North, South, East and West) of experimental trees to record the shoot length. The yield attributes per cent fruit retention were calculated on the basis of initial number of fruit set and total number of fruits at the time of fruit maturity. Average fruit weight was calculated on digital electronic balance. Fruit diameter and rind thickness were measured by digital Vernier calipers. The total fruit yield plant^{-1} was calculated by multiplying total number of fruits tree^{-1}with the average fruit weight and estimated yield

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ha^{-1} was calculated by multiplying total fruit yield per tree with number of plants ha^{-1}. All fruit quality parameters were analyzed as per standard methods (AOAC, 1). Juice was extracted from weighed fruits and percentage was calculated. Data were collected for leaf nutrient analysis (NPK and Zn) before and after termination of the experiment. Uniform, healthy and seven-month-old leaves were collected in the month of April and again in 3rd week of September from non-bearing terminal of current season growth. The leaf samples were processed and digested in a di-acid mixture of nitric acid and perchloric acid (5:1). The micronutrient (Zn) was determined by using atomic absorption spectrophotometer with specific lamp. Whereas, the amount of NPK, colorimeter method after development of colour with Nesseler's reagent, vandomolybdo phosphoric acid yellow colour method and flame photometer method (Jackson, 7), respectively. Data were analyzed as per standard statistical method. One way analysis of variance/and interpretation of the data was carried out in accordance to Panse and Sukhatme (9).

Among the treatments, significantly higher shoot length (102.65 cm), maximum canopy volume (EW 4.11 m & NS 4.21 m) and plant height (3.55 m) were recorded in treatment T_4 (1.5% K_2NO_3 + EDTA zinc 0.1%), which was closely followed by treatment T_3 (1.0% K_2NO_3 + EDTA zinc 0.1%) and T_7 (1.5% K_2NO_5 + EDTA zinc 0.1%) with minimum in control (Table 1). However, treatment T_4, T_3 and T_7 were at par with each other. Potassium and zinc are an essential component of enzymes responsible for carbohydrates and nitrogen metabolism, thereby resulting in increased uptake of nitrogen by the plant. Further, involvement of Zn in the synthesis of tryptophan, which is a precursor of indole acetic acid, consequently increased tissue growth and development. These results are in accordance with the earlier finding of Ashraf *et al*. (4) for various vegetative growths attributes of Kinnow mandarin. The effect of foliar application of potassium and zinc at different concentrations on yield attributes of Kinnow suchas fruit retention, number of fruits per plant, fruit weight (g), fruit diameter (equatorial & polar), yield per plant (kg) and yield/ ha (tonnes) were studied. Results revealed that higher fruit retention (71.86%), higher number of fruits plant^{-1} (516.67), fruit weight (154.77 g), yield (79.96 plant^{-1}) and (31.98 ha^{-1}) were registered in treatment T_7 (1.5% K_2NO_5 + EDTA zinc 0.1%). These results are in accordance with the earlier findings of Gill *et al*. (5) in pear. Increase in fruit number might be due to reduction in the fruit drop because Zn is required for preventing the abscission layer formation and consequently might have controlled pre-harvest fruit drop. The higher fruit diameter due to combined application of K and Zn may be attributed to their stimulatory effect of plant metabolism.

Table 1. Effect of potassium and zinc on growth and yield attributes of Kinnow mandarin.

Treatment	Tree height (m)	Tree canopy (m)		Shoot length (cm)	Fruit retention (%)	No. of fruits per plant	Fruit weight (g)	Fruit dia. (cm)		Yield plant^{-1} (kg)	Yield ha^{-1} (t)
		N-S	E-W					Equatorial	Polar		
A. Control v/s rest treatments											
Control	3.43	3.86	3.90	95.34	64.84	466.00	141.13	5.70	5.20	65.76	26.30
Treatment	3.52	4.00	4.15	99.84	69.62	500.56	148.39	6.72	6.03	74.30	29.71
CD (p = 0.05)	0.03	0.24	0.09	0.83	2.58	2.79	3.74	0.36	0.36	1.78	0.71
B. Rest treatments											
T_2	3.52	4.00	4.12	96.74	69.04	496.33	145.22	6.50	6.13	72.07	28.82
T_3	3.53	4.05	4.16	102.60	69.87	502.33	147.25	6.90	6.37	73.96	29.58
T_4	3.55	4.11	4.21	102.65	71.44	513.67	152.89	7.26	6.60	78.53	31.41
T_5	3.49	3.92	4.11	98.26	67.04	482.00	147.31	6.20	5.36	71.00	28.40
T_6	3.49	3.96	4.14	100.40	70.71	508.33	148.11	7.10	6.20	75.28	30.11
T_7	3.53	3.99	4.20	102.11	71.86	516.67	154.77	7.27	6.65	79.96	31.98
T_8	3.51	3.95	4.10	98.19	68.99	496.00	144.75	6.30	5.40	71.79	28.71
T_9	3.51	3.98	4.13	98.50	68.71	494.00	147.12	6.35	5.50	72.67	29.06
T_{10}	3.53	4.01	4.15	99.10	68.94	495.67	148.11	6.56	6.10	73.41	29.36
CD (p = 0.05)	0.03	0.24	0.09	0.75	2.40	2.94	3.93	0.36	0.39	1.86	0.75

The effect of foliar application of potassium and zinc at different concentrations on quality parameters of Kinnow fruit like total soluble solids, acidity, TSS/ acid ratio, sugar content (reducing sugar), ascorbic acid, rind thickness, juice content and number of seeds per fruit were also studied. Higher TSS (12.57°Brix), TSS/acid ratio (17.95), reducing sugar (3.93%), total sugars (7.95%), ascorbic acid content (24.12 mg/ 100 g), rind thickness (3.99 mm), juice content (41.87%), number of seeds per fruit (23.90) and minimum acidity (0.70%) was found in T_{10} (1.5% K_2SO_4 + EDTA zinc 0.1%) treatment. The improvement in quality of fruit is might be due to the fact that nutrients directly play an important role in plant metabolism (Gurjar and Rana, 6). Application of treatments significantly influenced zinc content of leaf at harvesting stage by the supplementation of the foliar application of potassium and zinc (Table 2). Among the treatments maximum (24.94 ppm) zinc content was recorded in treatment T_8 (0.5% K_2SO_4 + EDTA zinc 0.1%), which was closely followed by treatments T_{10} (24.45 ppm) and T_7 (23.69 ppm), while it was minimum in control (16.22 ppm). Various levels of foliar spray of K and Zn significantly increased the leaf zinc content as compared to the control. An increasing trend was observed in zinc content with the increase concentration of the treatment. Among the treatments maximum (1.75%) nitrogen concentration was recorded in treatment T_{10} (1.5% K_2SO_4 + EDTA zinc 0.1%), which was closely followed by treatment T_9 (1.72%), while it was minimum (1.45%) in control. However, treatments T_{10} and T_9 were at par with each other.

Among the treatments phosphorus exhibited non-significant increase in concentrations but maximum (0.25%) was recorded in treatment T_7 (1.5% K_2PO_5 + EDTA zinc 0.1%) and T_{10} (0.24%), which was closely followed by treatment T_4 (0.23%), while it was minimum in control (0.12%). Various levels of foliar spray of K and Zn increased the phosphorus concentrations content as compared to the control. Among the treatments maximum potassium content (1.2%) was recorded in treatment T_{10} (1.5% K_2SO_4 + EDTA zinc 0.1%) followed by T_9 (1.13%), while it was minimum in control (0.84%). Various levels of foliar spray of K and Zn significantly increased the leaf potassium content as compared to control. The increase in zinc and NPK content by foliar application has been reported by Perez and Romero (10).

Foliar application of macro- and micro-nutrients registered significantly higher gross and net return over control (Table 3). Maximum gross returns of Rs. 3,83,760 ha^{-1} and maximum net returns (Rs. 3,19,820 ha^{-1}) was obtained under treatment T_7 (1.5% K_2PO_5 + EDTA zinc 0.1%) through foliar application and minimum gross returns (Rs. 3,15,600 ha^{-1}) and net returns was obtained (Rs. 2,52,374 ha^{-1}) in control. Treatment economics further revealed that maximum B:C ratio (1:5) was recorded in T_7 followed by treatment T_4 (1:4.89) as compared to minimum in control (1:3.99).

From the present study, it is revealed that the foliar application of treatment combination T_7 (1.5% K_2PO_5 + EDTA zinc 0.1%), T_4 (1.5% K_2NO_3 + EDTA zinc 0.1%) and T_{10} (1.5% K_2SO_4 + EDTA zinc 0.1%)

Table 2. Effects of foliar application of potassium and zinc on leaf nutrient status in Kinnow.

Treatment	Zinc (ppm)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
A. Control v/s rest treatments				
Control	16.22	1.45	0.12	0.84
Treatment	22.70	1.57	0.20	0.98
CD (p = 0.05)	1.81	0.06	NS	0.03
B. Rest treatments				
T_2	20.71	1.49	0.15	0.92
T_3	21.21	1.47	0.20	0.97
T_4	22.29	1.42	0.23	0.95
T_5	22.59	1.50	0.15	0.88
T_6	22.68	1.44	0.17	0.91
T_7	23.69	1.62	0.25	0.93
T_8	24.94	1.70	0.18	0.93
T_9	21.78	1.72	0.20	1.13
T_{10}	24.45	1.75	0.24	1.20
CD (p = 0.05)	1.95	0.03	NS	0.03

Table 3. Total cost of cultivation and net returns (Rs. ha^{-1}) of Kinnow cultivation.

Treatment		Cost due to treatment (B)	Total cost of cultivation (A + B)	Estimated yield/ ha (t)	Gross returns (Rs. ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1	Control	-	63226	26.3	315600	252374	3.99
T_2	0.5% K_2NO_3 + EDTA zinc 0.1%	614.32	63840	28.82	345840	282000	4.42
T_3	1.0% K_2NO_3 + EDTA zinc 0.1%	664.32	63890	29.58	354960	291070	4.56
T_4	1.5% K_2NO_3 + EDTA zinc 0.1%	714.32	63940	31.41	376920	312980	4.89
T_5	0.5% K_2PO_5 + EDTA zinc 0.1%	614.32	63840	28.4	340800	276960	4.34
T_6	1.0% K_2PO_5+ EDTA zinc 0.1%	664.32	63890	30.11	361320	297430	4.66
T_7	1.5% K_2PO_5 + EDTA zinc 0.1%	714.32	63940	31.98	383760	319820	5.00
T_8	0.5% K_2SO_4 + EDTA zinc 0.1%	614.32	63840	28.71	344520	280680	4.40
T_9	1.0% K_2SO_4 + EDTA zinc 0.1%	664.32	63890	29.06	348720	284830	4.46
T_{10}	1.5% K_2SO_4 + EDTA zinc 0.1%	714.32	63940	29.36	352320	288380	4.51

were found effective for achieving higher yield, growth and quality, respectively in Kinnow mandarin.

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