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Short communication

Influence of foliar application of nutrients and growth regulator on fruit drop, yield and fruit size and quality in Kinnow mandarin

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ABSTRACT

The present investigation was carried out on the 15-year-old Kinnow mandarin trees. Nutrients (KNO_3, $ZnSO_4$), growth regulator (2,4-D) and their combinations (KNO_3 1% + 2,4-D 10 ppm, KNO_3 2% + 2,4-D 10 ppm, KNO_3 1% + $ZnSO_4$ 0.5%, KNO_3 2% + $ZnSO_4$ 0.5% and $ZnSO_4$ 0.5% + 2,4-D 10 ppm) were applied as foliar spray in first week of May and August. Fruit drop was lowest (53.5%) with $ZnSO_4$ 0.5% + 2,4-D 10 ppm. Fruit length and breadth (6.05 and 6.98 cm), fruit weight (168.6 g), fruit yield per tree (43.7 kg), TSS (10.6%) and ascorbic acid (25.81 mg/ 100 ml juice) were recorded highest with KNO_3 2%, KNO_3 2% + 2,4-D 10 ppm and KNO_3 2% + $ZnSO_4$ 0.5%, respectively. Highest juice content (49.72%) was recorded with 0.5% $ZnSO_4$.

Key words: Kinnow, nutrients, growth regulator, foliar application, fruit yield.

Kinnow - a mandarin hybrid (*Citrus nobilis* Lour. × *Citrus deliciosa* Tan.), has become an important variety in the Punjab provinces of both India and Pakistan, occupying a major part of the area under cultivation for fruit crops. It has assumed a special economic importance and export demand due to its high juice content, special flavour, and as a rich source of vitamin C, the factors which have contributed to the success of this fruit are its beautiful golden-orange colour its abundant juice, and its excellent aroma and taste. It is a well established fact that deficiency of K deteriorates vegetative growth, quality and production of fruit and causes heavy flower and fruit drop, which resulted in production of poor quality fruit coupled with yield losses. Among the micronutrients, zinc deficiency is the most widespread which alone occupies eleven percent of the cultivated area in India. Foliar spray of zinc sulphate (0.5%) improved the general condition of the Kinnow plants and decreases the die-back of twigs and leaf chlorosis. Although, few reports on effect of potassium and 2,4-D on fruit drop, fruit size and yield are there, however the effect of foliar application of 2,4-D along with potassium nitrate and zinc sulphate on fruit size of Kinnow has not been evaluated. Therefore, this study was undertaken.

The present investigation was carried out on 15-year-old Kinnow mandarin trees spaced at 6 m × 6 m distance. They were maintained under uniform of orchard management condition during the study period where all the agronomic practices were carried out as per package of practices. The experiment was laid out in randomized block design with three replications, comprising 10 treatment combinations of KNO_3, $ZnSO_4$ and 2,4-D. The treatments were T_1 = $ZnSO_4$ 0.5% , T_2 = KNO_3 1%, T_3 = KNO_3 2%, T_4 = 2,4-D 10 ppm, T_5 = KNO_3 1% + 2,4-D 10 ppm, T_6 = KNO_3 2% + 2,4-D 10 ppm, T_7 = KNO_3 1% + $ZnSO_4$ 0.5%, T_8 = KNO_3 2% + $ZnSO_4$ 0.5%, T_9 = $ZnSO_4$ 0.5% + 2,4-D 10 ppm and T_{10} = Control. These treatments were applied twice, *i.e.* in first week of May and first week of August during the year 2010-11. The observations were recorded on fruit drop, yield and fruit physical and quality parameters.

Fruit length, breadth and rind thickness were measured with the help of digital Vernier calipers and the average value was calculated. The average fruit weight was calculated by dividing the total fruit weight with total number of fruits taken. The total fruit yield per tree was calculated by multiplying total number of fruits per tree with the average fruit weight. Total soluble solids were measured with the help of digital refractometer. The juice was weighed with physical balance and percentage of juice was worked out on the basis of total weight of fruit and the weight of juice. Ascorbic acid and acidity were analyzed as per standard procedures (AOAC, 1). The data was analyzed following randomized block design with three replication using OPSTAT software.

Minimum fruit drop (53.5%) was recorded with application of $ZnSO_4$ 0.5% + 2,4-D 10 ppm and maximum (77.1%) was recorded under control followed by KNO_3 1% treatment (70.3%). The decrease in fruit drop in this study can be attributed to making up the deficiency of endogenous auxin preventing the formation of abscission layer possibly through the inhibition of enzymatic activity such as pectinase and also polygalactouronase. Highest number of fruits per tree (279.4) was obtained with the foliar application

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Table 1. Effect of nutrients and growth regulator on fruit drop, yield and fruit physical and quality parameters in Kinnow mandarin.

Treatment	Fruit drop (%)	No. of fruits/ plant	Av. fruit wt. (g)	Yield/ plant (kg)	Fruit length (cm)	Fruit breadth (cm)	No. of days taken for colour break	Rind thickness (mm)	No. of seeds/ fruit	Juice content (%)	TSS (%)	Acidity (%)	TSS/ acid ratio	Ascorbic acid (mg/100 ml juice)
$ZnSO_4$ 0.5%	66.0	262.3	153.6	40.3	5.83	6.78	214.7	3.21	20.1	49.72	9.8	0.84	11.7	22.34
KNO_3 1%	70.3	254.7	163.3	41.6	5.96	6.92	219.3	3.54	21.1	47.49	10.2	0.92	11.0	22.82
KNO_3 2%	69.1	252.4	168.6	42.5	6.05	6.98	224.3	3.60	23.9	46.48	10.6	0.86	12.3	25.81
2,4-D 10 ppm	57.0	268.3	152.6	40.9	5.86	6.78	219.0	3.35	19.5	49.12	10.2	0.93	10.9	22.40
KNO_3 1% + 2,4-D 10 ppm	58.0	255.4	158.3	40.4	5.94	6.86	224.3	3.54	19.8	48.51	10.3	0.83	12.4	23.52
KNO_3 2% + 2,4-D 10 ppm	61.6	257.3	153.7	39.5	5.89	6.83	221.7	3.56	18.9	48.08	9.9	0.98	10.1	23.71
KNO_3 1% + $ZnSO_4$ 0.5%	53.5	279.4	151.5	42.3	5.84	6.77	223.0	3.32	18.5	49.45	9.7	0.83	11.7	22.63
KNO_3 2% + $ZnSO_4$ 0.5%	59.5	261.2	164.2	42.9	5.99	6.94	226.7	3.59	21.2	46.85	10.5	0.94	11.1	25.54
$ZnSO_4$ 0.5% + 2,4-D 10 ppm	64.0	264.5	165.3	43.7	5.97	6.92	225.7	3.55	21.9	47.04	10.4	0.96	10.8	24.96
Control	77.1	238.6	148.3	35.4	5.82	6.76	215.0	3.31	18.5	48.20	9.6	0.89	10.8	21.86
CD at 5%	4.2	11.6	4.6	2.1	0.06	0.06	4.6	0.22	NS	1.04	0.53	NS	0.64	1.52

of $ZnSO_4$ 0.5% + 2,4-D 10 ppm followed by 2,4-D 10 ppm (268.3 fruits/plant) and minimum (238.6) under control. The significant effect of zinc sulphate and 2,4-D in increasing the number of fruits might be due to synthesis of tryptophan which serve as precursor for auxin synthesis (Modise *et al*., 5). The maximum fruit weight (168.6 g) was recorded with the foliar application of KNO_3 2% which was followed by KNO_3 2% + $ZnSO_4$ 0.5%. Minimum fruit weight (148.3 g) was noted under control. The maximum yield per plant (43.7 kg) was recorded with foliar application of KNO_3 2% + $ZnSO_4$ 0.5% which was at par with the yield (42.9, 42.3 and 42.5 kg) recorded under the foliar application of KNO_3 2% + 2,4-D 10 ppm, $ZnSO_4$ 0.5% + 2,4-D 10 ppm and KNO_3 2%, respectively. Minimum yield per plant (35.4 kg) was noted under control. Similar, results were also observed by Sangwan *et al*. (6) and Gill *et al*. (4) on Kinnow mandarin. The increase in fruit weight might be due to increased photosynthesis with K application, which led to accumulation of more carbohydrates. Maximum fruit length and breadth recorded with the foliar application of KNO_3 2% which was followed by KNO_3 2% + 2,4-D 10 ppm and minimum fruit weight recorded under control. An increasing trend in fruit size was recorded with increase in concentration of different sources of foliar K. Maximum days (226.7) taken for colour break recorded with the foliar application of KNO_3 2% + 2,4-D 10 ppm and minimum with the $ZnSO_4$ 0.5%. Maximum rind thickness (3.60 mm) was recorded with the foliar application of KNO_3 2% and minimum (3.21 mm) with the foliar application of $ZnSO_4$ 0.5%. The results depicted in Table 1 reveal that number of seeds was not significantly affected by foliar application of different nutrients and growth regulator.

Maximum juice content (49.72%) was recorded with the foliar application of $ZnSO_4$ 0.5%, which was at par with the $ZnSO_4$ 0.5% + 2,4-D 10 ppm and 2,4-D 10 ppm, respectively. The increase in juice percentage due to zinc can be attributed because it might have regulated the water relations in plants. Minimum juice content (46.48%) noted with the foliar application of KNO_3 2%. The reduction in juice content under potassium treatments could be due to higher proportion of peel under these treatments. Maximum TSS (10.6%) was recorded with the foliar application of KNO_3 2%, which was at par with TSS (10.5, 10.4, 10.3 and 10.2 %) noted under the foliar application of KNO_3 2% + 2,4-D 10 ppm, KNO_3 2% + $ZnSO_4$ 0.5%, KNO_3 1% + 2,4-D 10 ppm and KNO_3 1%, respectively. Minimum TSS (9.6%) was recorded under control. Zinc and potassium regulate the enzymatic activities; and would have activated the enzymes involved in conversion of polysaccharide into simple sugars that increased the TSS of fruits (Emam *et al*., 3). Maximum ascorbic acid (25.81 mg/100 ml juice) was recorded with the foliar application of KNO_3 2% which was at par with the ascorbic acid content (25.54 mg/100 ml juice and 24.96 mg/100 ml juice) noted with the foliar application of KNO_3 2% + 2,4-D 10 ppm and KNO_3 2% + $ZnSO_4$ 0.5%, respectively. Minimum ascorbic acid content (21.86 mg/ 100 ml juice) recorded under control. The increased ascorbic acid content with potassium foliar application might be related with improved sugar metabolism (Ashraf *et al*., 2). The acidity of fruit juice was not significantly affected by foliar application of various nutrients and growth regulator (Table 1). Hence, application of nutrients (KNO_3, $ZnSO_4$), growth regulator (2,4-D) and their combinations (KNO_3 1% + 2,4-D 10 ppm, KNO_3 2% + 2,4-D 10 ppm, KNO_3 1% + $ZnSO_4$ 0.5%, KNO_3 2% + $ZnSO_4$ 0.5% and $ZnSO_4$ 0.5% + 2,4-D 10 ppm) as foliar spray in first week of May and August significantly reduced fruit drop and improved quality parameters of Kinnow mandarin.

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