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Effect of Foliar Application of 2, 4-D, Urea, Zinc Sulphate, Bavistin and Combinations on Nutrient Content of Kinnow Mandarin

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Abstract: The present experiment entitled was conducted at CCS Haryana Agricultural University, Hisar during 2019-20 and 2020-21 to find out the best concentration of foliar application of growth regulators, nutrients and fungicides in improvement of nutrient status of leaves. There were eighteen treatments, *i.e.*, 2,4-D at 10 and 15 ppm, GA_3 at15 and20 ppm, Urea at 1 and 1.5%, Zinc Sulphate at 0.5and 0.75%, Bavistin 1000 ppm and their combinations on 9-year-old Kinnow. The foliar spray was done two times *i.e*., first in the last week of May and second in the last week of July. After foliar spray, maximum leaf N (2.51%), Zn (14.97 ppm) and S content (0.22%) was with foliar spray of 2,4-D 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm, however leaf P, K and Fe were not significantly affected by foliar application of plant growth regulators, nutrients and fungicides.

Keywords: Growth regulators, Nutrients, Fungicides, Kinnow mandarin, Foliar spray

Citrus is one of the most important fruit crops of sub-tropical area belongs to family Rutaceae, sub-family Aurantioideae, tribe Citrae and subtribe Citrinae (Swingle 1943). Among citrus group, Kinnow is a hybrid between King mandarin (*Citrus nobilis* Lour) X Willow Leaf mandarin (*Citrus deliciosa* Tenora), is considered as one of the major citrus fruit crops. It was developed by H.B. Frost in 1915 and released in 1935 in California (USA) and introduced in India in 1958 at the Regional Fruit Research Station, Abohar (Punjab). Kinnow has attained a prime position in North India due to its consumer appeal, good tree vigour, high cropping potential, wider adaptability, more economic return and better performance than other citrus fruits (Kumar et al., 2017). Flower and fruit drop is a major issue faced by citrus growers (Modise et al., 2009) and it has become a limiting factor in citrus production.

Plant growth regulators serve as mobilizers of nutrients from other plant sections to the metabolic sinks that are actively growing (Agusti et al., 2002), which enhance the rapid changes in physiological and biochemical characters and improves crop productivity. Auxin prevents the abscission and facilitated the ovary to remain attached with the shoot and resulted in lower fruit drop (Jat and Kacha 2014). Foliar treatment of GA_3 has been reported to increase production by reducing the per cent fruit drop (Ullah et al., 2014), influence vegetative growth, flowering, fruiting, promotes cell elongation and cell growth and improve fruit retention and fruit quality.

Nitrogen is the most important component for citrus growers and has greater impact on tree growth, appearance and fruit quality than any other element (Obreza 2001). Due to deficiency of nutrients, some healthy orchards are converting into low production with poor quality. The use of growth regulators and chemical fertilizer spray has become an important component of agro-technical procedures for most of the cultivated plants and especially for fruit plants (Prasad et al., 2017). Micronutrients can significantly increase crop yield and quality and improve post-harvest life of produce. They play a significant role in disease resistance and lignin biosynthesis, since they function as enzyme activators (Parmar et al., 2017). In Haryana State citrus quality production is declining due to deficiency of these trace elements caused by soil alkalinity, lower organic matter content and competition from other nutrients (Bhanukar et al., 2018).

Zinc is required for the activity of several enzymes, including dehydrogenases, aldolases, isomerases, transphosphorylases, RNA and DNA polymerases which involved in the synthesis of tryptophan, cell division, maintenance of membrane structure and acts as a regulatory cofactor in protein synthesis (Sharathkumar et al., 2022). The foliar feeding of fruit trees has gained much importance in recent years as fertilizers application through soil are needed in greater amount because some portion leaches down and some does not become available to the plant due to complex chemical reactions (Bisen et al., 2020). Hence, selection of appropriate combination of the plant growth regulators and nutrients is essential to produce high-quality citrus fruits and reduce citrus fruit drop (Kaur et al., 2016). So, keeping in view the above facts and considering the importance of fruit retention to increase the productivity, the present investigation has been framed.

MATERIAL AND METHODS

The present investigation entitled was carried out on nine years old Kinnow mandarin trees at CCS Haryana Agricultural University, Hisar and the chemical analysis was undertaken in Department of Horticulture and Soil Science, CCS HAU, Hisar during the year 2019-20 and 2020-21.

The experiment was laid out in randomized block design with three replications, comprising 18 treatment combinations *i.e.* T_1: 2,4-D 10 ppm; T_2: 2,4-D 15 ppm; T_3: GA_3 15 ppm; T_4: GA_3 20 ppm; T_5: Urea 1%; T_6: Urea 1.5%; T_7: Zinc Sulphate 0.5%; T_8: Zinc Sulphate 0.75%; T_9: Bavistin 1000 ppm; T_{10}: 2,4-D 10 ppm + Urea 1% + Zinc Sulphate 0.5% + Bavistin 1000 ppm; T_{11}: 2,4-D 15 ppm + Urea 1% + Zinc Sulphate 0.5% + Bavistin 1000 ppm; T_{12}: GA_3 15 ppm + Urea 1% + Zinc Sulphate 0.5% + Bavistin 1000 ppm; T_{13}: GA_3 20 ppm + Urea 1% + Zinc Sulphate 0.5% + Bavistin 1000 ppm; T_{14}: 2,4-D 10 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm; T_{15}: 2,4-D 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm; T_{16}: GA_3 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm; T_{17}: GA_3 20 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm; T_{18}: Control. Foliar application was done twice, first in the last week of May and second in the last week of July.

Observation recorded: The content of nitrogen, phosphorus, potash, zinc, iron and sulphur were estimated in the leaf of Kinnow mandarin before and after spray. For determining the leaf nutrients status, five to six months old healthy leaf samples from non-fruiting shoots were collected and washed under running tap water followed by 0.1% HCl and two washings through distilled water. The washed leaf samples were surface dried and then oven dried at 70°C for 48 hours. The dried samples were ground and sieved through muslin cloth for further analysis as per procedure suggested by Chapman (1964). For digestion the 0.5 g quantity of ground leaf sample was taken in 500 ml separate conical flasks and 10 ml diacid mixture (H_2SO_4: $HClO_4$ in 9:1 ratio) was added to each flask. Digestion on a hot plate was carried out as described by Jackson (1967) for the determination of nitrogen, phosphorus and potash. The total volume of aliquot was made to 50 ml.

For the determination of micronutrients *viz*., Fe, Zn and S the 0.5 g of ground leaf sample was taken in 500 ml separate conical flasks and these were digested on a hot plate by adding 15 ml diacid mixture (HNO_3: $HClO_4$ in 4:1 ratio) as per the procedure described by Piper (1966). The total volume of aliquot for microelements was made to 50 ml.

The content of nutrients in the leaf samples was determined by using the following methods:

The nitrogen content and phosphorus content were determined by Nessler's reagent method (Jackson 1973) and by Vanado-molybdo phosphoric acid yellow colour method (Jackson 1973) respectively. The potassium content was determined from the digested extract on flame photometer (Piper 1966). The DTPA extractable Zn and Fe was estimated by using the method of Lindsay and Norvell (1978). The digested leaf samples were analyzed for determining zinc and iron concentration on atomic absorption spectrophotometer and their contents were expressed in ppm. The sulphur content of leaves was determined by turbidity method using spectrophotometer (Chesnin and Yien 1950).

RESULTS AND DISCUSSION

The leaf nitrogen content were significantly affected with different foliar application of growth regulators, nutrients and fungicides and their combinations after foliar spray but leaf potassium and phosphorus content was no significantly affected (Table 1). The leaf N content was maximum (2.51% after foliar spray) with T_{15} (2,4-D 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm). Leaf N content was significantly affected with various foliar treatments in August during both years of investigation over control. Minimum leaf N content of 1.19% before and 1.23% after foliar spray was in control. Phosphorus and potassium content of leaves was non-significant with foliar application of different concentrations of 2,4-D, GA_3, urea, zinc sulphate and Bavistin. The slight increasing trend in leaf N, P and K content was observed in second year as compared with first year. The increase in nitrogen content with urea might be due to the additional supply of nitrogen to the leaves. Razzaq et al. (2013) also observed that all the trees sprayed with 0.4% zinc sulphate exhibited 1.5-fold higher nitrogen content in leaves in comparison to control. Prasad et al. (2017) concluded that the trees treated with urea, zinc sulphate and 2,4-D had the maximum nitrogen content in leaves of Kinnow mandarin. Bisen et al., (2020) also observed leaf nitrogen was maximum with zinc sulphate (0.6%). Reetika et al. (2020) recorded maximum nitrogen content and level of potassium and phosphorus is not affected with foliar application of urea, K_2SO_4, $ZnSO_4$ in Kinnow mandarin. However, the results of present study are contrary to the findings of Bisen et al. (2020) who reported leaf potassium content was found maximum with zinc sulphate (0.4%).

The zinc and sulphur content in leaf was significantly affected by different foliar applications of various growth regulators, nutrients and fungicides and their combinations after foliar spray (Table 2). Maximum leaf zinc content (14.97 ppm after foliar spray) and sulphur content (0.22% after foliar spray) were in T_{15} (2,4-D 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm). Minimum leaf zinc content (11.74 ppm before and after foliar spray, sulphur content

Table 1. Effect of foliar application of growth regulators, nutrients and fungicides on leaf nitrogen, phosphorus and potassium content of Kinnow mandarin (%) (Pooled Data of 2019-20 and 2020-21)

Treatments	N content (%)		P content (%)		K content (%)	
	Before foliar spray	After foliar spray	Before foliar spray	After foliar spray	Before foliar spray	After foliar spray
T_1	1.20	2.24	0.15	0.15	1.00	1.02
T_2	1.27	2.31	0.16	0.16	1.01	1.03
T_3	1.20	2.23	0.15	0.15	0.99	1.02
T_4	1.22	2.26	0.14	0.15	1.00	1.02
T_5	1.24	2.31	0.15	0.16	1.01	1.04
T_6	1.30	2.43	0.16	0.18	1.03	1.06
T_7	1.20	2.22	0.14	0.14	0.99	1.01
T_8	1.26	2.30	0.15	0.14	1.00	1.01
T_9	1.26	2.29	0.14	0.14	0.98	1.00
T_{10}	1.30	2.40	0.15	0.17	1.02	1.05
T_{11}	1.28	2.40	0.15	0.17	1.02	1.06
T_{12}	1.22	2.36	0.15	0.16	1.02	1.04
T_{13}	1.30	2.38	0.16	0.17	1.02	1.05
T_{14}	1.32	2.49	0.16	0.19	1.04	1.09
T_{15}	1.31	2.51	0.16	0.19	1.05	1.10
T_{16}	1.31	2.46	0.15	0.18	1.03	1.07
T_{17}	1.31	2.47	0.16	0.18	1.02	1.07
T_{18}	1.19	1.23	0.13	0.13	0.97	0.99
CD (p=0.05)	NS	0.19	NS	NS	NS	NS

Table 2. Effect of foliar application of growth regulators, nutrients and fungicides on leaf zinc (ppm), sulphur (%) and iron content (ppm) of Kinnow mandarin (Pooled Data of 2019-20 and 2020-21)

Treatments	N content (%)		P content (%)		K content (%)	
	Before foliar spray	After foliar spray	Before foliar spray	After foliar spray	Before foliar spray	After foliar spray
T_1	12.20	12.99	0.13	0.14	101.43	103.51
T_2	12.41	13.37	0.14	0.17	101.61	103.87
T_3	12.46	13.10	0.13	0.15	100.90	102.73
T_4	12.60	13.28	0.14	0.16	101.15	103.06
T_5	12.66	13.42	0.14	0.17	101.74	104.20
T_6	12.47	13.73	0.14	0.18	101.85	104.55
T_7	12.62	13.95	0.14	0.18	102.03	104.89
T_8	12.94	14.57	0.15	0.21	102.36	106.66
T_9	12.48	13.23	0.13	0.15	100.22	102.27
T_{10}	13.13	14.50	0.15	0.19	101.71	106.13
T_{11}	12.97	14.52	0.15	0.20	102.40	106.49
T_{12}	12.84	14.21	0.14	0.18	102.23	105.33
T_{13}	12.96	14.33	0.14	0.19	101.91	105.74
T_{14}	13.24	14.93	0.16	0.22	102.97	107.98
T_{15}	13.26	14.97	0.16	0.22	103.56	108.19
T_{16}	13.11	14.70	0.15	0.20	102.43	107.07
T_{17}	13.19	14.76	0.15	0.21	103.00	107.50
T_{18}	11.74	11.74	0.13	0.14	100.18	100.16
CD (p=0.05)	NS	1.17	0.014	0.016	NS	NS

(0.13% before foliar spray and 0.14% after foliar spray) were in control. Iron content was non-significantly affected by all the treatments. All the foliar applications significantly increased the leaf zinc, sulphur and iron content over control after foliar spray. The maximum content of zinc in leaves of Kinnow mandarin might be due to absorption of sprayed micronutrients. Bisen et al. (2020) recorded zinc sulphate (0.6%) increased leaf zinc content. Reetika et al. (2020) observed foliar application of urea, K_2SO_4, $ZnSO_4$, $FeSO_4$ and H_3BO_3 increased leaf zinc content in Kinnow. Rajaiea et al. (2009) observed that foliar application of zinc increased the zinc and iron level in lemon seedlings and Razzaq et al., (2013) recorded that trees sprayed with $ZnSO_4$ (0.6%) showed highest zinc and iron content in leaf of Kinnow mandarin. Khan et al. (2012) observed that combined application of boric acid (0.3%) and $ZnSO_4$ (0.75%) at fruit set stage effectively improved the iron levels in leaves of Feutrell's Early mandarin.

CONCLUSION

The foliar application of 2,4-D 15 ppm + Urea 1.5% + Zinc Sulphate 0.75% + Bavistin 1000 ppm proved most effective in improving leaf N, Zn and S content however P, K and Fein leaf were not significantly affected by foliar application of plant growth regulators, nutrients and fungicides.

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