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Effect of 2, 4-D, Urea, Zinc Sulphate and Combinations on Growth and Nutrient Status of the Kinnow Mandarin

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Abstract
The present investigations entitled "Effect of foliar application of 2, 4-D, urea and zinc sulphate on fruit drop, yield and fruit quality of Kinnow mandarin" was carried out in the Horticultural Regional Research Station, Dhaulakuan, Sirmour, of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2011-2012. The experiment was laid down in Randomized Block Design with 8 treatments and 3 replications. The study comprises of one experiment in which Kinnow trees under investigation were subjected to treatments of 1 per cent urea, 0.4 per cent zinc sulphate, 20ppm 2, 4-D and their combination. The results revealed that the foliar application of 1 per cent urea, 0.4 per cent zinc sulphate and 2, 4-D- 20ppm combination resulted in highest tree growth in comparison to control. It was found that leaf nutrient contents (N, P, K, Ca, Mg and Cu) were also recorded maximum in trees treated with 1 per cent urea 0.4 per cent zinc sulphate and 2, 4-D- 20ppm combination treatment. Maximum leaf iron content was recorded in trees treated with 1 per cent urea and 0.4 per cent zinc sulphate combination. Whereas, trees sprayed with 0.4 per cent zinc sulphate and 2, 4-D- 20ppm gave highest leaf Zn content and maximum leaf Mn found with treatment1 per cent urea and 2, 4-D- 20ppm combination.

Keywords: Kinnow, Mandarin, 2, 4-D, Urea, Zinc Sulphate, Plant Growth, Nutrient Status

Introduction
Citrus is grown through-out the world in tropical and subtropical climate, where there is suitable soil and sufficient moisture available to sustain the trees. But finest quality table citrus fruits are grown in non-humid irrigated sub-tropical areas. It is considered to be one of the most remunerative fruit crops that have a lasting niche in the international trade and world finance.

Due to higher fruit yield and excellent economic returns, citrus is becoming popular and area under cultivation is increasing in Himachal Pradesh. Progressive farmers prefer to grow kinnow because of its high yielding characteristics and its attractive quality that possesses the potential to give the lucrative return in form of profit. Foliar nutrition is practiced by the fruit grower's worldwide. Two decisive factors in its favour are the reliability and rapidity of tree responses to foliar spray. Due to these deficiencies of nutrients, some healthy orchards are turning 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 Keeping in view of the importance of Kinnow mandarin in the north India, the study has been carried out to see the effect of growth regulators and Chemical fertilizer spray on it plant growth and leaf composition.

Material and methods
The present studies were carried out on fifteen year old plants budded on Jatti Khatti (*Citrus jambhiri*) rootstock. The trial was laid out on bearing Kinnow trees in a Randomized Block Design. There were eight treatments and each treatment was replicated three times. The details of the experiment as T_1 -Urea - 1%, T_2 - $ZnSO_4$ -O.4%, T_3 - 2,4-D - 20ppm, T_4 -Urea - 1% + $ZnSO_4$ - 0.4%, T_5 -Urea-1% + 2,4-D - 20ppm, T_6 -$ZnSO_4$-0.4% + 2,4-D-20ppm, T_7 -Urea-1% +$ZnSO_4$-0.4% + 2,4-D-20ppm and T_8 –Control.

Table 1: Spray Schedule

S. No.	Time of application	1st spray	2nd spray
1	Urea	(1st week) April	(1st week) September
2	Zinc Sulphate	(2nd week) April	(2nd week) September
3	2, 4-D	(2nd week) May	(2nd week) September

Observation recorded

Increment in tree height (cm), Increment in trunk girth (cm), Shoot extension growth (cm), Tree canopy volume (m^3) Volume of the canopy was calculated by using the formula given by Westwood and expressed in m^3.

Leaf Nutrient Estimation

Leaf samples from the experimental trees were collected from current season's growth around of the trees and drying. The digestion of the samples for the estimation of nitrogen was carried out in concentrated sulphuric acid (AR grade) by adding digestion mixture. For the estimation of leaf P, K, Ca, Mg, Zn, Fe, Cu, and Mn, digestion was done in di-acid mixture prepared by mixing nitric acid and perchloric acid (AR grade) in the ratio of 4:1.

Determination of nutrient elements

Total nitrogen content was determined by Micro Kjeldahl's method, Total phosphorus content was determined by vanadomolybdophosphoric yellow colour method, Total potassium content was determined on flame photometer (Toshniwal, TMF 45), Total calcium and magnesium contents were determined with the help of atomic absorption spectrophotometer, The micro nutrients zinc, iron, copper and manganese were also determined with the help of atomic absorption spectrophotometer (1414 model) and the results were expressed in parts per million (ppm) on dry weight basis.

Results and Discussion

Effect of 2, 4-D, Urea, Zinc Sulphate and Their Combinations on Growth

In the present studies, foliar application of 2,4-D, urea, zinc sulphate and their combinations were observed to exert a significant influence on growth parameters such as tree height, trunk girth, tree volume and shoot extension growth of Kinnow (Table 2). The application of urea + $ZnSO_4$ + 2,4-D caused maximum increment in tree height, trunk girth, tree volume and shoot extension growth. This increase in growth characters might be due to the fact that nitrogen is an integral part of chlorophyll which primarily absorbs light energy needed for photosynthesis, so it may be attributed to higher photosynthetic efficiency (Tisdale *et al*., 1997) [29]. These observations are also in conformity with the finding of several other workers, who have also reported that urea increase tree growth of oranges and Kinnow mandarin (Ram and Bose, 1994; Malik *et al*. 2000) [20, 12]. The increase in the tree height perhaps was brought about by an increase in the dimensions of individual cell both in pith and cortex region. These observations are also in conformity with the findings of other workers, who have also reported that nitrogen fertilization increase tree growth in citrus (Rathore and Chandra 2003) [22]. In case of cashew, also greatest plant height, stem girth and mean canopy area was obtain with nitrogen application (Kumar *et al*., 2005) [8].

In the present studies the application of 2,4-D and zinc sulphate, were observed to have less effect on various growth parameters. In fact the foliar application of zinc Sulphate alone or in combination with 2,4-D were similar to control in respect of various growth parameters, but their effects were more pronounced only when combined with nitrogen. Therefore, nitrogen seems to be most important factor in enhancing the vegetative growth and the beneficial effect on growth promotion may be because of it's involvement in cell division and cell expansion and as a constituent of amino acids, proteins, nucleic acids and enzymes (Hewitt and Smith, 1975) [6].

Increase in tree growth in treated trees might be due to active involvement of Zn in the synthesis of tryptophan which is a precursor of indole acetic acid synthesis; consequently it increased tissue growth and development (Swietlik, 1999) [28]. It has also been reported that sufficient level of Zn is plants promote the photosynthesis, nucleic acid metabolism and protein biosynthesis. Our results are in agreement with the finding of Dawood *et al.* (2001) [3] who also reported increase in growth of Washington Navel orange with Zn application.

Effect of 2, 4-D, Urea, Zinc Sulphate and Combinations on Leaf Macro-Nutrient Status

Nitrogen

Maximum leaf nitrogen content was observed with Urea + $ZnSO_4$ + 2, 4-D treatment (Table 4.3). These results are further supported by the finding of Lodhi and Rashid (1980) [11] who also reported that Urea increased leaf N, especially at the higher rate. Nirmaljit *et al*. (2005) [17] recorded that N content of Kinnow leaves was higher in treated trees with foliar urea application. Nijjar (1985) [16] reported positive influence of N fertilizer on leaf N status. Leaf N increased significantly with increased N rates through soil or with foliar urea sprays (Rawat, 1974) [23]. The combination of zinc sulfate with growth regulators increased N in the leaves of Navel orange trees (El-Rahman, 2003) [4].

Phosphorus

In these investigation, Urea + $ZnSO_4$ + 2,4-D treatment resulted in increased leaf phosphorus content. These results are in accordance with the finding of Shashi Suman (2003) [24], Raina *et al*. (2005) [19] and Tisdale *et al*. (1997) [29] who also reported increased leaf phosphorus with nitrogen application. The auxin stimulated increase gains support from the observation of Hatch and Powell (1971) [5] who contended that auxin is involved in directing the movement of P to the point of application.

Potassium

Leaf potassium content in present studies was found to be maximum with Urea + $ZnSO_4$ + 2, 4-D treatment (Table 4.3). These finding are in accordance with Ahmad Khan *et al.* (2012) [1] who also found foliar application of Zn significantly increased the level of K in Feutell's Early (*Citrus reticulata* Blanco.). Ponder *et al*. (1998) [18] also found increased leaf potassium concentration with application of nitrogen in Walnut. The difference in the foliar K content of growth regulator treated and untreated plants were found to be significant. Such a difference could be possibly explained in the light of source –sink relationship where exogenous application of growth regulators could enhance the sink strength of leaves for greater attraction and mobilization of K from other plant organs. Existence of such a source sink relationship in the plant and enhancement of greater

mobilization paved by plant regulator treated organs has been well documented by several workers (Shindy and Weaver, 1967; Shindy *et al*, 1973 and Letham, 1967) [25, 26, 10]. The effect of different treatments on leaf Calcium content of Kinnow was found to be non-significant.

Magnesium

Highest leaf magnesium content was observed with Urea + $ZnSO_4$ + 2, 4-D treatment (Table 3). These results are in line with the finding of Singh (2000) [27], who also observed increased leaf magnesium content with foliar application of urea in pecan nut. Similar results were also reported by Worley (1991) [31] and Randhawa (2004) [21]. This might be due to efficient translocation or utilization of available magnesium in the plant.

Effect of Foliar Application of 2, 4-D, Urea, Zinc Sulphate and Their Combinations on Leaf Micro- Nutrients of Kinnow Mandarin

Zinc

$ZnSO_4$ + 2,4-D treatment resulted in significantly higher leaf zinc content of Kinnow leaf (Table 4). These results are in accordance with the finding of Ahmad Khan *et al*. (2012) [1], who also reported that foliar application of Zn significantly increased the Zn content of Feutell's Early (*Citrus reticulata* Blanco.) tree from deficient to optimum and higher range. Results are also in agreement with the finding of Worley *et al*. (1972) [30]; Mann *et al.* (1986) [15]; Keley *et al*. (1979) [7]; Manchanda *et al*. (1971) [13] and Mann and Sindhu (1983) [14]. This might be due to the fact that application of zinc improves the concentration of zinc in plant tissue. Similar results were also reported by El-Rahman, (2003) [4] that the combination of zinc sulphate with growth regulators increased Zn in the leaves of Kinnow.

Manganese

In the present studies, maximum leaf manganese content was observed with foliar application of Urea + 2,4-D treatment (Table 4). The results are in line with those of Leece (1978) [9] who observed increased leaf manganese content with the nitrogen application. Under the nitrogen application, higher availability of manganese might have led to greater uptake of manganese. The combination of zinc sulphate with growth regulators increased Mn in the leaves of Kinnow (El-Rahman, 2003) [4].

Iron

Urea + $ZnSO_4$ treatment increased the leaf iron content significantly (Table 4). These results are in line with Singh (2000) [27] who also observed that the foliar application of nitrogen results in higher leaf iron content. Ahmad Khan *et al*. (2012) [1] also reported that foliar application of Zn significantly increased the leaf Fe content of Feutell's Early (*Citrus reticulata* Blanco) trees.

Copper

Foliar application of Urea + $ZnSO_4$ + 2,4-D enhanced the leaf copper content significantly (Table 4). These results are in accordance with the finding of Badyal (1980) [2]. Cu has a direct relationship with nitrogen applied through soil or foliar sprays. The combination of zinc sulphate with growth regulators increased N, Ca, Fe, Zn Cu and Mn in the leaves of Kinnow (El-Rahman, 2003) [4].

Table 2: Effect of foliar application of 2,4-D, urea, zinc sulphate and their combinations on fruit tree growth characteristics of Kinnow mandarin

Treatment	Tree height (cm) increment	Trunk girth (cm) increment	Tree volume (m^3)	Shoot extension growth (cm)
T_1	29.67	2.61	29.22	19.64
T_2	24.00	2.49	28.54	17.85
T_3	23.33	2.32	28.30	16.64
T_4	27.67	2.67	29.66	19.96
T_5	28.00	2.42	29.96	18.30
T_6	25.67	2.39	28.57	17.33
T_7	35.33	2.81	31.42	20.43
T_8	20.33	2.23	27.96	15.79

Table 3: Effect of foliar application of 2, 4-D, urea, zinc sulphate and their combinations on leaf macro- nutrients in percentage of Kinnow mandarin

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
T_1	2.45	0.18	1.03	2.52	0.55
T_2	2.18	0.16	1.04	2.30	0.48
T_3	2.23	0.17	1.07	2.33	0.47
T_4	2.38	0.19	1.06	2.41	0.53
T_5	2.40	0.15	1.01	2.49	0.52
T_6	2.32	0.16	1.05	2.24	0.51
T_7	2.55	0.21	1.11	2.57	0.61
T_8	2.11	0.14	0.97	2.17	0.44

Table 4: Effect of foliar application of 2, 4-D, urea, zinc sulphate and their combinations on leaf micro- nutrients of Kinnow mandarin

Treatment	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)
T_1	12.58	117.07	15.76	51.12
T_2	16.95	113.89	14.77	45.53
T_3	14.09	115.99	15.53	46.39
T_4	15.50	120.88	15.66	48.09
T_5	14.13	119.24	16.49	54.26
T_6	17.96	114.28	15.09	44.62
T_7	16.77	117.64	16.82	52.31
T_8	12.16	110.22	13.21	42.92

Conclusion

Based on the present investigations, it is concluded that maximum growth and nutrient status was observed in treatment Urea + $ZnSO_4$ + 2, 4-D. Hence, it can be suggested that the foliar application of Urea+ $ZnSO_4$ + 2, 4-D may be given at fruit set stage and again in September to reduce fruit drop and for enhance growth, yield, fruit quality and nutrient status of Kinnow mandarin.

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