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# Effect of plant growth regulators and nutrients on fruit drop and yield of Kinnow mandarin

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**Abstract**
The experiment entitled "effect of plant growth regulators and nutrients on fruit drop and yield of Kinnow mandarin" was carried out at Chaudhary Farm House, Village Malapur, Hisar during 2015-2016 to assess the effect of plant growth regulators and nutrients on fruit drop and yield of Kinnow mandarin. The treatments comprising of 2, 4-D 10, 15 and 20 ppm, $GA_3$ 10, 15 and 20 ppm, $K_2SO_4$ 1%, 1.5% and 2% and $ZnSO_4$ 0.25%, 0.50% and 0.75% along with control were laid out in randomized block design with three replications. The result of investigation indicates that the foliar application of 2, 4-D 20 ppm was found quite effective in increasing final fruit retention and minimizing fruit drop. Fruit weight was recorded maximum in $K_2SO_4$ 2% and number of fruits and yield were found maximum in treatment 2, 4-D 20 ppm.

**Keywords:** Growth regulators, nutrients, Kinnow, fruit drop

## Introduction
Kinnow (*Citrus reticulata* Blanco.), a mandarin, is commercially cultivated due to its good yield, high processing quality, fresh consumption, aromatic flavour and better adaptation to agro-environmental conditions, however, fruit drop is one of the major reasons of low productivity of Kinnow in India (Sharma *et al.*, 2012) [11]. Tree is precocious in bearing and it comes to bearing as early as in third-year of age. Fruits are medium sized with globose shape and golden yellow in colour. Rind is normally tight but it becomes loose if harvested up to February under North Indian conditions. Segments separate with little difficulty.
Deficiency of micronutrients (Zn, Cu, Fe and Mn) in the soil of citrus orchards affects the fruit yield, quality and fruit dropping (Ibrahim *et al.*, 2007; Ashraf *et al.*, 2012) [6, 2]. Application of suitable combinations of plant growth regulators, and macro- and micronutrients can control the excessive fruit drop and improves the yield and quality of citrus fruits (Doberman and Fairhurst, 2000; Rodriguez *et al.*, 2005; Saleem *et al.*, 2005) [4, 9, 10]. Foliar spray of zinc sulphate 0.5% improved the general conditions of Kinnow plant and decreased the dieback of twigs and leaf chlorosis.
Low fruit set and reduced quality of fruit is due to malnutrition, water stress, insect pest attack and most importantly, the hormonal imbalance (Nawaz *et al.*, 2008). The flowers and fruits on trees senescence when the concentration of auxin decreases and the concentration of ABA increases (Marinho *et al.*, 2005).
Foliar application of potassium is a common practice to get higher yield with better quality fruits.
K deficiency leads to the production of small fruits with thin skin, while an excess of K results in the production of large fruits with thick skin and a coarse texture. Regarding the quality of juice, excess K induce high acidity. K fertilization thus an important tool to optimize the quality of citrus fruit and juice. Foliar fertilization with K is a practice that now offers a means of reaching these goals of high yield and improved fruit quality.

## Materials and Methods
The present study was carried out at Chaudhary Farm House, Village Malapur, Hisar.

It is characterized by semi-arid climate with hot and dry summer and cold winter. Thirty-nine trees of uniform size and plant vigour with spacing 6 X 6 m were selected. All the thirteen treatments were replicated three times taking one plant as a single unit. The plants were kept with uniform cultural practices and plant protection measures during the study period as per package of practice (Anonymous, 2013).

**Initial fruit set (%)**

The initial fruit set was calculated by subtracting the number of fruits set at initial stage from the total number of flowers on tagged twigs. The percent initial fruit set was calculated by using the formula given below:

$$\text{Initial fruit set (\%)} = \frac{\text{Initial fruit set}}{\text{Total number of flowers}} \times 100$$

**Fruit drop**

**i. June drop (%)**

The June drop was calculated by subtracting the number of fruits retained in the month of July from the number of fruits set at initial stage of four tagged branches. The percent June drop was calculated by using the formula given below:

$$\text{June drop (\%)} = \frac{\text{Initial fruit set - Retained fruits in month of July}}{\text{Initial fruit set}} \times 100$$

**ii. Pre-harvest drop (%)**

The Pre-harvest drop was calculated by subtracting the number of fruits retained in the month of October from number of fruits retained in the month of July. The percent fruit drop was calculated by formula given below:

$$\text{Pre-harvest drop (\%)} = \frac{\text{Retained fruits in month of July - Retained mature fruits in month of October}}{\text{Retained fruits in month of July}} \times 100$$

**Final fruit retention (%)**

The percent fruit retention was calculated by formula given below:

$$\text{Fruit retention (\%)} = \frac{\text{Retained mature fruits}}{\text{Initial fruit set}} \times 100$$

**Number of fruits per plant**

The number of fruits on whole tree was counted at the time of harvesting.

**Yield (kg/plant)**

The total fruit yield per tree was calculated by multiplying total number of fruits per tree with the average fruit weight and expressed in (kg/plant).

**Fruit weight (g)**

Four fruits were selected randomly from different positions of the tree and weighed on top pan electric balance. The average weight was calculated by dividing the total fruit weight by total number of fruits taken and expressed in gram.

## Results and Discussion

**Initial fruit set (%)**

The Table 1 indicates the percent initial fruit set in Kinnow mandarin before the application of different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$. The maximum initial fruit set (%) was recorded in treatment $ZnSO_4$ 0.25% and the minimum initial fruit set was recorded in treatment 2, 4-D 15 ppm.

**Final fruit retention (%)**

The data in Table 1 indicates that the foliar application of different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ significantly affected the percent final fruit retention in Kinnow mandarin. The maximum fruit retention (%) was observed in treatment 2, 4-D 20 ppm (26.32%) and minimum fruit retention was observed in control (19.57%). The results of present study are in confirmation with the findings of Modise *et al*. (2009) [8] who found that foliar application of 2, 4-D increased the fruit retention in citrus.

**Table 1:** Effect of different plant growth regulators and nutrients on percent initial fruit set and final fruit retention in Kinnow mandarin fruit

| Treatments | Initial fruit set (%)* | Final fruit retention (%) |
|---|---|---|
| $T_1$:2,4-D 10 ppm | 53.33 | 24.01 |
| $T_2$:2,4-D 15 ppm | 52.33 | 24.50 |
| $T_3$: 2,4-D 20 ppm | 54.66 | 26.32 |
| $T_4$: $GA_3$ 10 ppm | 57.00 | 20.53 |
| $T_5$: $GA_3$ 15 ppm | 55.33 | 21.57 |
| $T_6$: $GA_3$ 20 ppm | 54.33 | 22.08 |
| $T_7$: $K_2SO_4$ 1.0% | 54.00 | 20.18 |
| $T_8$: $K_2SO_4$ 1.5% | 56.00 | 20.70 |
| $T_9$: $K_2SO_4$ 2.0% | 54.00 | 21.22 |
| $T_{10}$: $ZnSO_4$ 0.25% | 57.33 | 21.11 |
| $T_{11}$: $ZnSO_4$ 0.50% | 56.00 | 24.17 |
| $T_{12}$: $ZnSO_4$ 0.75% | 55.33 | 24.53 |
| $T_{13}$: Control | 54.66 | 19.57 |
| CD at 5% level of significance | N/S | 1.74 |

*Before foliar application

**June drop (%)**

The data pertaining to the effect of different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ on percent June drop (%) are presented in Table 2. The different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ significantly influenced the June drop (%). The minimum June drop (%) was observed in treatment 2, 4-D 20 ppm (44.96%) and maximum fruit drop was observed in control (57.24%). The results of present study are in confirmation with the findings of Nawaz *et al*. (2008) [8] who reported that 2, 4-D, NAA and $GA_3$ treatments reduced pre-harvest drop of Kinnow mandarin significantly as compared to control fruits.

**Pre-harvest drop (%)**

The data on pre-harvest drop (%) in Table 2 reveals the significant influence of different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ in Kinnow mandarin. The pre-harvest drop (%) was found minimum in treatment 2, 4-D 20 ppm (12.69%) and maximum pre-harvest drop (%) was found in

control (16.25%). These results were close conformity with Davies and Zalman (2006) [3] who found that application of 2, 4-D and $GA_3$ significantly reduced the pre-harvest fruit drop in citrus species.

**Table 2:** Effect of different plant growth regulators and nutrients on percent fruit drop in Kinnow mandarin

| Treatments | June drop (%) | Pre-harvest drop (%) |
|---|---|---|
| $T_1$:2,4-D 10 ppm | 47.50 | 14.22 |
| $T_2$: 2,4-D 15 ppm | 45.80 | 13.60 |
| $T_3$: 2,4-D 20 ppm | 44.96 | 12.69 |
| $T_4$: $GA_3$ 10 ppm | 56.38 | 15.48 |
| $T_5$: $GA_3$ 15 ppm | 55.23 | 14.97 |
| $T_6$: $GA_3$ 20 ppm | 52.38 | 14.67 |
| $T_7$: $K_2SO_4$ 1.0% | 54.62 | 15.01 |
| $T_8$: $K_2SO_4$ 1.5% | 54.55 | 15.04 |
| $T_9$: $K_2SO_4$ 2.0% | 53.33 | 14.40 |
| $T_{10}$: $ZnSO_4$ 0.25% | 55.77 | 14.15 |
| $T_{11}$: $ZnSO_4$ 0.50% | 50.95 | 12.07 |
| $T_{12}$: $ZnSO_4$ 0.75% | 48.94 | 13.21 |
| $T_{13}$: Control | 57.24 | 16.25 |
| CD at 5% level of significance | 1.08 | 0.79 |

**Number of fruits per plant**

The data in Table 3 show significant effect of different concentrations of 2,4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ on number of fruits per plant in Kinnow mandarin. The number of fruits per plant was recorded maximum in treatment $T_3$- 2, 4-D 20 ppm (611.63) and minimum in control (538.59). Similar beneficial effect of 2, 4-D on number of fruit per tree and fruit retention was also recorded by Ashraf *et al.* (2013) [1] in Kinnow mandarin.

**Fruit weight (g)**

The data on fruit weight (g) are presented in Table 3. The foliar application of different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$ significantly influenced the fruit weight in Kinnow mandarin. The fruit weight was registered maximum under the treatment $K_2SO_4$ 2% (172.40 g) and minimum fruit weight was registered under control (160.63 g).

**Yield (kg/plant)**

The data presented in Table 3 represent that the fruit yield (kg/plant) was significantly influenced by different concentrations of 2, 4-D, $GA_3$, $K_2SO_4$ and $ZnSO_4$. The yield was observed maximum from the plant sprayed with treatment 2, 4-D 20 ppm (100.55 kg/plant) and minimum yield was observed in control (86.51 kg/plant). The results of present experiment confirms the findings of Nawaz *et al.* (2008) [8] and El-Kobbia *et al.* (2011) [8] who found that application of 2, 4-D increased the fruit yield in Kinnow mandarin.

**Table 3:** Effect of different plant growth regulators and nutrients on number of fruits per plant, fruit weight (g) and per plant yield in Kinnow mandarin

| Treatments | No. of fruits/plant | Fruit weight (g) | Yield (kg/tree) |
|---|---|---|---|
| $T_1$: 2,4-D 10 ppm | 588.52 | 163.25 | 96.08 |
| $T_2$: 2,4-D 15 ppm | 594.74 | 165.28 | 98.30 |
| $T_3$: 2,4-D 20 ppm | 611.63 | 164.40 | 100.55 |
| $T_4$: $GA_3$ 10 ppm | 548.62 | 162.18 | 88.98 |
| $T_5$: $GA_3$ 15 ppm | 550.85 | 165.78 | 91.32 |
| $T_6$: $GA_3$ 20 ppm | 574.55 | 167.86 | 96.44 |
| $T_7$: $K_2SO_4$ 1.0% | 543.67 | 168.25 | 91.47 |
| $T_8$: $K_2SO_4$ 1.5% | 550.67 | 170.28 | 93.77 |
| $T_9$: $K_2SO_4$ 2.0% | 556.33 | 172.40 | 95.91 |
| $T_{10}$: $ZnSO_4$ 0.25% | 548.33 | 162.81 | 89.27 |
| $T_{11}$: $ZnSO_4$ 0.50% | 592.89 | 165.63 | 98.31 |
| $T_{12}$: $ZnSO_4$ 0.75% | 598.66 | 165.19 | 98.89 |
| $T_{13}$: Control | 538.59 | 160.63 | 86.51 |
| CD at 5% level of significance | 17.96 | 4.50 | 3.34 |

**Conclusion**

Based on this study, it is concluded that 2,4-D 20 ppm had positive effect on June and pre-harvest fruit drop, final fruit retention, number of fruits per plant and fruit yield. The treatment $K_2SO_4$ 2% had positive effect on fruit weight. Therefore, for better fruit yield and minimizing fruit drop 2, 4-D 20 ppm should be used.

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