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# Effect of 2,4-D, NAA and $GA_3$ on growth, yield and fruit quality of kinnow (*Citrus nobilis* Lour x *Citrus deliciosa* Tenora.)

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**Abstract**
The investigation was carried out to study the effect of 2,4-D, NAA and $GA_3$ on growth, yield and fruit quality of kinnow (*Citrus nobilis* Lour x *Citrus deliciosa* Tenora.)" at Fruit Orchard, Sri Ganganagar (Rajasthan) during 2022-23. The experiment was laid down in Randomized Block Design which consisted 10 treatment combinations *viz;* Control ($T_0$), 2, 4 – D @ 15 ppm ($T_1$), 2, 4 – D @ 20 ppm ($T_2$), 2, 4 – D @ 25 ppm ($T_3$), NAA @ 150 ppm ($T_4$), NAA @ 200 ppm ($T_5$), NAA @ 250 ppm ($T_6$), $GA_3$ @ 25 ppm ($T_7$), $GA_3$ @ 50 ppm ($T_8$) and $GA_3$ @ 75 ppm ($T_9$) and treatments were replicated three times. The various concentrations of 2, 4-D, NAA and $GA_3$ had significant effect on various vegetative growth, yield and quality parameters and the maximum height increment (31.71 cm), annual shoot growth (24.41 cm), tree canopy (35.73 $cm^3$), fruit length (7.41 cm), fruit breadth (8.58 cm), highest fruit weight (192.45 g), maximum fruit volume (313.87 $cm^3$), juice content (53.82%), lowest acidity (0.85%) and highest (48.22 mg/100 g) vitamin–C content in fruit juice was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment. However, the minimum fruit drop (71.91%) and maximum fruit set (84.80%), fruit retention (28.09%), fruits per plant (587.16), highest fruit yield (91.99 kg/tree and (25.55 t/ha) were recorded in 2, 4-D @ 20 ppm ($T_2$) treatment. Whereas, inferior results were observed under control ($T_0$) treatment. The non-significant effects were observed in application of different levels of plant growth regulators on total soluble solids (TSS) percentage.
Results further indicated that the highest benefit: cost ratio (3.44) was recorded in 2,4-D @ 20 ppm ($T_2$) treatment followed by (3.19) and (3.15) in 2,4-D @ 15 ppm ($T_1$) and 2,4-D @ 25 ppm ($T_3$), respectively. Whereas, the lowest B: C ratio (1.99) was recorded under control ($T_0$).

**Keywords:** Kinnow, gibberellic acid, NAA, 2, 4-D, yield, quality

## Introduction

Citrus group comes under Rutaceae family and having chromosome number 2n=18. The majority of citrus species are native to tropical and subtropical regions of Southeast Asia (Bhatt *et al.*, 2017) [8]. Kinnow is a very popular among citrus fruits that is prized not only for its attractive appearance and flavor, but also for its high nutritional value, high yield, fresh consumption and superior agro-environmental adaption. It also has excellent processing quality for making value added products (Ahmed *et al.*, 2006) [1].

India is the 3rd largest citrus producing country in the world next to China and Brazil (Anonymous, 2018) [4]. Citrus ranked on 3rd position after mango and banana in India in both acreage and production. It is very popular among the growers and consumers in north India because of its superb fruit quality. Kinnow is widely grown in North India because of its wider adaptability, high yield potential and high economic returns. It is the most popular fruit in Punjab and farmers prefer to grow this fruit because of its high market demands, versatility, and financial impact. The Punjab, Rajasthan, Haryana, Himachal Pradesh, Jammu & Kashmir, and Uttar Pradesh are the major kinnow growing states in India. India is the leading country of Kinnow mandarin export (Chundawat *et al*., 1975) [10]. Kinnow is growing under 473,000 ha area with 6.265 m MT production in India (NHB, 2021) [25]. In Punjab, kinnow ranks first in area among fruits with 46,000 ha and 9, 88,000 MT production (Anonymous 2014) [3]. Punjab occupies 64.20% of the total area under kinnow fruit (Anonymous, 2014) [3]. In Rajasthan, kinnow is growing under 9,490 ha area with 1, 60,743 MT production. The districts of Sri Gangangar and Hanumangarh produces kinnow 1, 55,922 MT and 48,321.70 MT of production, respectively and both are leading districts in kinnow production in Rajasthan (DOH, 2021) [11].

Kinnow is a rich source of ascorbic acid, vitamins A & B, sugar, amino acids and other nutrients. Kinnow tends to bear heavy fruiting in early years of production. The flowering load and fruit set depends on the cultivar, tree age and environmental conditions (Monselise and Goren, 1978) [23]. Sweet oranges produce over 50,000 flowers per tree in peak season of blooming but 95 to 99% flowers dropped out. Only a small amount of these flowers reached as mature fruits for harvesting (Chaudhary, 2006) [9].

The majority (80-91%) of fruitlets in kinnow were dropped during the first month of fruit set (Saleem *et al.*, 2005) [32]. The demand of Kinnow mandarin is increasing day by day in domestic as well as international markets. To bridge the gap between demand and supply, it is required to increase the productivity by maintaining the fruit quality. It could be achieved the fruit yield and quality by reducing fruit drop. The foliar applications of plant growth regulators (PGRs) are the only most powerful tools used to increase the flowering, fruit set, yield and fruit quality traits (Ashraf *et al.*, 2013) [39]. In addition to these, prolonging or delaying fruit maturation. The growers can avoid unfavorable environmental conditions and extend the market demands (Hegazi, 1980) [16]. The foliar spray of plant growth regulators can maintain the hormone balance in the peel, can reduce the fruit drops (Almeida *et al.*, 2004) [2]. The 2,4-dichlorophenoxyacetic acid (2,4-D) and Gibberellic acid ($GA_3$) has widely practiced to improve fruit quality and controlling fruit drop at various stages of fruit growth and development in the citrus producing countries throughout the world. The exogenous applications of growth regulators have been parcticed on different citrus species alone or in combinations (Nawaz *et al.*, 2008; Saleem *et al.*, 2008) [27, 31] at different stages. The 2, 4-D is playing a vital role in checking pre-harvest fruit drop and ultimately increasing yield without adversely affecting the fruit quality among different plant growth regulator. Keeping this in view, the present study was undertaken with objective to find out the best concentration of plant growth regulators for kinnow production in Sri Ganganagar area of Rajasthan.

## Materials and Methods

The present investigation was carried out in the Fruit Orchard at Agricultural Research Station, Sri Ganganagar (Rajasthan) to study the effect of 2, 4-D, NAA and $GA_3$ on growth, yield and fruit quality of kinnow (*Citrus nobilis* × *Citrus deliciosa* L.) during 2022-23. The seven year old plants were selected for study and experiment field was laid down in Randomized Block Design which consisted 10 treatment combinations *viz;* Control ($T_0$), 2, 4 – D @ 15 ppm ($T_1$), 2, 4 – D @ 20 ppm ($T_2$), 2, 4 – D @ 25 ppm ($T_3$), NAA @ 150 ppm ($T_4$), NAA @ 200 ppm ($T_5$), NAA @ 250 ppm ($T_6$), $GA_3$ @ 25 ppm ($T_7$), $GA_3$ @ 50 ppm ($T_8$) and $GA_3$ @ 75 ppm ($T_9$) and treatments were replicated three times. Appraisal of the result indicated that the influence of plant growth regulators on important parameters like vegetative growth, yield and yield attributing characters and quality of kinnow were significantly influenced by plant growth regulators under local agro-climatic conditions of Sri Ganganagar (Rajasthan). The observations were measured on the five randomly selected and tagged plants in each plot and their mean value was calculated. The significance of variation were tested in data obtained from various parameters. The technique of analysis of variance was adopted as suggested by Shivran (1998) [40]. Significance of difference in the treatment effect was tested at 5 per cent level of significance and CD was calculated.

## Results and Discussion

The exogenous application of various concentrations of growth regulators significantly increased the tree height. Amongst the treatment, the maximum (31.71 cm) was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (29.77 cm) with $GA_3$ @ 75 ppm ($T_9$) (Table 1). The tree height increment is due to the applied plant hormones promoted vegetative growth by active cell division, cell enlargement and cell elongation and thus helped in improving growth characteristics (Pareek *et al*., 2000) [28]. The maximum (24. 41 cm) annual shoot growth was also observed with $GA_3$ @ 50 ppm ($T_8$) treatment. The increase in tree height and annual shoot growth it might be due to exogenous application of gibberellic acid that enhances cell elongation and cell wall plasticity (Yugandhar *et al*., 2014) [38]. The maximum (35.73 $cm^3$) tree canopy was observed in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (33.51 $cm^3$) in $GA_3$ @ 75 ppm ($T_8$) the data presented in Table 1 and graphically illustrated in Fig. 4.3. These results are in accordance with the findings of Elankavi *et al*. (2009) [13] who also observed that the exogenous application of gibberellic acid significantly increases various growth characters *viz.*, tree height, number of leaves and yield attributes. The increase in tree canopy might be due to application of $GA_3$ which enhances the lateral buds, branches, and leaves. It is useful to break apical dominance and promote vegetative growth. The results are in conformation with the findings of Haokip *et al*., (2016) [41] and Singh *et al.*, (2017) [34].

Fruit set is one of the most key factors in fruit crops since it impacts the amount of fruit production and increase the total yield. Fruit set is a critical stage in the conversion of flowers into a fruits in order to get a high yield and maximize the profits of grower's. The maximum (84.80%) fruit set per plant was recorded in 2,4-D @ 20 ppm ($T_2$) treatment followed by (81.20%) and (78.65%) fruit set in 2,4-D @ 15 ppm ($T_1$) and 2,4-D @ 25 ppm ($T_3$), respectively (Table 1). It might be due to 2, 4-D increases fruit abscission. Moreover, Modise *et al.* (2009) reported that 20 mg $L^{-1}$ 2, 4-D increased fruit abscission. The similar results were also reported by Prem *et al.* (2020) [30] and Hiteshbhai *et al*. (2023) [18].

A variety of factors including fluctuation in temperature, moisture stress during flowering or fruiting period, and nutrient deficiency are the key factors of fruit drop in citrus orchards. The foliar spray of plant growth regulators found to be effective in reducing premature fruit drop in kinnow. The minimum (71.91%) fruit drop per plant was observed in 2,4-D @ 20 ppm ($T_2$) treatment followed by (75.67%) and (78.51%) fruit drop in 2,4-D @ 15 ppm ($T_1$) and 2,4-D @ 25 ppm ($T_3$), respectively (Table 1). 2,4-D @ 20 ppm reduced physiological pre-harvest fruit drop in Kinnow (Chundawat *et al*., 1975) [10]. The foliar spray of 2, 4-D significantly enhanced the number of fruits per plant and reduced fruit drop in Kinnow mandarin. At blooming stage, 2, 4-D also helpful in fruit development and color progression (Ashraf *et al*., 2013) [39]. The use of 2, 4-D sprayed before mature fruit abscission significantly reduced fruit drop in sweet orange (*Citrus sinensis* L. Osbeck) cvs. ‘Washington navel’ and ‘Navelate’ at 15 mg $L^{-1}$ (Agusti *et al*., 2006) [42]. The 2, 4-D reduced by 50–75% abscised fruits compared to untreated trees, depending on the variety. Bharti *et al.* (2020) [7] reported that 2, 4-D application prevented pre-harvest fruit drop in citrus. It could be possible due to 2, 4-D had more auxin activity than NAA when it used in the same concentration. It may be attributed to formation of abscission layer at the stem point in citrus (Lal *et al.*, 2015) [43]. The similar findings also reported by Sihag *et al*. (2019) [33]; Bharti *et al*. (2020) [7] and Hiteshbhai *et al*. (2023) [1].

Fruit retention refers to the number of fruits that remain on the plant until harvesting. The maximum (28.09%) fruit retention was recorded in 2, 4-D @ 20 ppm ($T_2$) treatment, whereas, minimum (1.59%) fruit retention was recorded in water spray i.e. control (Table 1). Auxin and gibberellin are cumulatively used to increase fruit retention and improve fruit quality by timely reacting on fruit set (Suman *et al.*, 2017) [35]. In Kinnow mandarin, 2, 4-D 10 ppm and Aureofungin 50 ppm had the best fruit retention (Tiwana and Bajwa, 2007) [37]. It might be due to 2, 4-D has high activity of auxin. It can promote cell division as well as cell enlargement more than NAA. These results are in close conformity with the findings of Jain *et al.* (2014) [19]; Bharti *et al*. (2020) [7] and Hiteshbhai *et al*. (2023) [18].

The maximum (587.16) fruits per plant was recorded in 2,4-D @ 20 ppm ($T_2$) treatment followed by (544.36) and (539.77) fruits per plant in 2,4-D @ 15 ppm ($T_1$) and 2,4-D @ 25 ppm ($T_3$), respectively (Table 1). It might be due maximum fruit set, minimum fruit drop and maximum fruit retention by 2, 4-D treatment that ultimately increases the number of fruits per plant. Similar results were also reported by Jain *et al*. (2014) [19].

The different concentrations of $GA_3$, NAA, and 2, 4-D resulted in a considerable increase in fruit length, breadth, weight and volume (Kaur *et al.*, 2016) [20]. The role of gibberellic acid in improving fruit quantity namely, fruit weight and fruit size may be due to its role in increasing cell elongation and cell division (Eman *et al*., 2007) [14]. The maximum (7.41 cm) fruit length was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (7.12 cm) and (7.00 cm) fruit length in $GA_3$ @ 75 ppm ($T_9$) and $GA_3$ @ 25 ppm ($T_7$), respectively (Table 2). These results are in close conformity with the findings of Bharti *et al*. (2020) [7] and Prem *et al*. (2020) [30].

The application $GA_3$ had significant influenced on the fruit growth rate like fruit length and fruit diameter. The foliar spray with 50 ppm $GA_3$ resulted in the greatest (8.58 cm) fruit breadth followed by (8.25 cm) and (8.12 cm) in $GA_3$ @ 75 ppm ($T_9$) and $GA_3$ @ 25 ppm ($T_7$), respectively (Table 2). It might be due to exogenous application of gibberellic acid that enhances cell elongation and cell wall plasticity (Yugandhar *et al*., 2014) [38]. These results are in accordance with the findings of Hifny *et al.* (2017) [17] and Talat *et al.* (2020) [36].

The role of gibberellic acid in improving the fruit weight and fruit size may be due to its role in increasing cell division and cell elongation (Eman *et al*., 2007) [14]. Data presented in Table 2 revealed that there was significant increase in fruit weight among treatments. The foliar spray of 50 ppm $GA_3$ resulted in the greatest (192.45 g) fruit weight followed by (185.11 g) in $GA_3$ @ 75 ppm. Same trend also reported on fruit volume and the maximum (313.87 $cm^3$) fruit volume was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (286.51 $cm^3$) in $GA_3$ @ 75 ppm (Table 2). Nawaz *et al.* (2011) [44] reported that the application of $GA_3$ increased the fruit size and fruit weight by increasing cell elongation, enlargement of vacuoles and loosening of cell wall. (Prem *et al*., 2020) [30] Reported that the $GA_3$ encourage cell expansion in the fruit mesocarp, which ultimately increases fruit volume. These results are in close conformity with the findings of Hifny *et al*. (2017) [17] and Talat *et al*. (2020) [36].

Among the different concentrations of 2,4-D, NAA and $GA_3$ and the maximum (91.99 kg) fruits per tree was achieved with foliar spray of 2, 4-D @ 20 ppm ($T_2$) treatment followed by (85.08 kg/tree) in 2, 4-D @ 15 ppm ($T_1$) and (84.52 kg/tree) in 2, 4-D @ 25 ppm ($T_3$) presented in Table 2. Similar trend was also reported on yield per hectare and the treatment 2, 4-D @ 20 ppm ($T_2$) produced the highest (25.55 t/ha) fruit yield followed by (23.64 t/ha) and (23.48 t/ha) kinnow fruit yield in 2, 4-D @ 15 ppm ($T_1$) and 2, 4-D @ 25 ppm ($T_3$). Hence, the foliar application of 2, 4-D @ 20 ppm performed significantly superior (Table 2). It might be due to increasing fruit set and maximum fruit retention and minimize of fruit drop that ultimately increase the number of fruits per tree by exogenous application of 2,4-D. It could be due to application of 2, 4-D, which has high activity of auxin. It can promote cell division and cell enlargement than those in the other treatment. These results are in close conformity with the findings of Jain *et al.* (2014) [14]; Prem *et al*. (2020) [30] and Hiteshbhai *et al*. (2023) [18].

The highest B: C ratio (3.44) of kinnow fruit production was recorded in 2,4-D @ 20 ppm ($T_2$) treatment followed by (3.19) and (3.15) in 2,4-D @ 15 ppm ($T_1$) and 2,4-D @ 25 ppm ($T_3$), respectively (Table 2). It might be due to increasing fruit set, fruit retention, and number of fruits per tree and minimized the fruit drop percentage in 2, 4-D @ 20 ppm that ultimately increased the yield per tree as well as per hectare. These results are in close conformity with the findings of Patil and Ingle (2011) [29] and Bakshi *et al*. (2018) [6] in kinnow. Similar results were reported by Nasreen *et al*., (2013) [24] in mandarin (*Citrus reticulata*) in mandarin.

Juice content is an important parameter in the processing industry and cultural practices. The uses of plant growth regulators have significant impact on juice content in citrus fruits. The amount of juice might be raised by as much as 10% by using plant growth regulators. The application of plant growth regulators alters several physiological and biochemical processes within plants and that helps in improvement in juice Content (Nawaz *et al*., 2011) [44]. The maximum (53.82%) juice content was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (51.87%), (51.63%), (49.68%) and (49.61%) in $GA_3$ @ 75 ppm ($T_9$), NAA @ 200 ppm ($T_5$), $GA_3$ @ 25 ppm ($T_7$) and 2, 4-D @ 20 ppm ($T_2$), respectively (Table 2). The increase in juice percentage of Mandarin may be due to the fact that PGRs play a important role in the mobilization of metabolites within a plant. It is well established fact that developing fruits are extremely active metabolic ‘sinks’ which mobilize metabolites and direct their flow from vegetative structure. These results are in accordance with the findings of Jain *et al.* (2014) [19].

The use of plant growth regulators reduced the titrable acidity, which is really a desirable characteristic of high-quality fruits. The lowest (0.85%) acidity in juice was recorded in $GA_3$ @ 50 ppm ($T_8$) treatment followed by (0.89%) in $GA_3$ @ 75 ppm ($T_9$) and (0.93%) in $GA_3$ @ 25 ppm ($T_7$). As a result it seems that $GA_3$ application had a reducing effect on the acidity acid values drastically. Therefore, from the data presented in Table 3 indicated that $GA_3$ applications greatly decrease effect on the acidity value compared to the control treatment, in term the lowest acidity was recorded in $GA_3$ @ 50 ppm spray. The foliar application of plant growth regulators significantly reduced the titratable acidity because it could be attributed due to the conversion of the organic acids to sugar during fruit ripening. These results are in agreement with the findings of Hifny *et al*. (2017) [17] and Talat *et al*. (2020) [36].

Ascorbic acid is a powerful antioxidant in human food for the health. It helps to protect human body against a variety of diseases by acting as a scrubber for damaging reactive oxygen species (ROS) that created in the body. Hence, it is preventing oxidative stress (Rekha *et al*., 2012) [45]. The highest (48.22 mg/100 g) vitamin–C content in fruit juice was recorded in $GA_3$ @ 50 ppm (Table 2). Gurung *et al*. (2016) [15] reported that the treatment with $GA_3$ 15 ppm + zinc (0.5%) + boron (0.1%) resulted in maximum ascorbic acid in Darjeeling mandarin. Hifny *et al*. (2017) [17] also reported the direct application of $GA_3$ @ 20 ppm + NAA @ 25 ppm resulted in the maximum ascorbic acid content in Washington navel orange. These results are in close conformity with the findings of Jain *et al*. (2014) [19] and Talat *et al*. (2020) [36].

**Table 1:** Effect of 2, 4-D, NAA and $GA_3$ on vegetative growth, fruit set and fruit retention in Kinnow.

| Treatments | Tree height increment (cm) | Annual Shoot growth (cm) | Tree canopy ($cm^3$) | Fruit set (%) | Fruit drop (%) | Fruit retention (%) | No. of fruits per plant |
|---|---|---|---|---|---|---|---|
| Control (Water spray) ($T_0$) | 17.15 | 13.3 | 23.55 | 43.87 | 98.41 | 1.59 | 338.3 |
| 2, 4 – D @ 15 ppm ($T_1$) | 21.55 | 16.31 | 24.45 | 81.2 | 75.67 | 24.34 | 544.36 |
| 2, 4 – D @ 20 ppm ($T_2$) | 23.73 | 18.52 | 26.75 | 84.8 | 71.91 | 28.09 | 587.16 |
| 2, 4 – D @ 25 ppm ($T_3$) | 24.46 | 17.42 | 25.63 | 78.65 | 78.51 | 21.49 | 539.77 |
| NAA @ 150 ppm ($T_4$) | 24.65 | 18.5 | 27.65 | 69.43 | 83.51 | 16.49 | 412.42 |
| NAA @ 200 ppm ($T_5$) | 28.43 | 20.54 | 31.27 | 72.03 | 80.65 | 19.33 | 484.87 |
| NAA @ 250 ppm ($T_6$) | 26.53 | 19.97 | 29.33 | 71.73 | 81.41 | 18.58 | 465.49 |
| $GA_3$ @ 25 ppm ($T_7$) | 27.66 | 21.6 | 32.49 | 65.35 | 91.03 | 8.98 | 386.77 |
| $GA_3$ @ 50 ppm ($T_8$) | 31.71 | 24.41 | 35.73 | 70.07 | 86.48 | 13.54 | 459.5 |
| $GA_3$ @ 75 ppm ($T_9$) | 29.77 | 22.62 | 33.51 | 67.43 | 87.33 | 12.67 | 410.99 |
| SE m± | 1.11 | 0.72 | 0.88 | 2.08 | 3.54 | 0.68 | 20.25 |
| C.D. (p=0.05) | 3.31 | 2.15 | 2.64 | 6.22 | 10.61 | 2.03 | 60.62 |
| CV (%) | 7.49 | 6.42 | 5.25 | 5.11 | 7.35 | 7.12 | 7.58 |

**Table 2:** Effect of 2, 4-D, NAA and $GA_3$ on yield and yield attributing characters of kinnow.

| Treatments | Fruit length (cm) | Fruit breadth (cm) | Fruit weight (g) | Fruit volume ($cm^3$) | Fruit yield (kg/tree) | Fruit yield (t/ha) | Juice content (%) | TSS (%) | Titrable acidity (%) | Vitamin C (mg/100 g) | B:C Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control (Water spray) ($T_0$) | 5.48 | 6.35 | 142.88 | 174.59 | 52.81 | 14.67 | 41.37 | 11.79 | 1.13 | 35.72 | 1.99 |
| 2, 4 – D @ 15 ppm ($T_1$) | 6.32 | 7.31 | 164.21 | 197.16 | 85.08 | 23.64 | 46.67 | 13.31 | 1.05 | 41.1 | 3.19 |
| 2, 4 – D @ 20 ppm ($T_2$) | 6.62 | 7.67 | 172.21 | 224.77 | 91.99 | 25.55 | 49.61 | 14.15 | 1.02 | 43.11 | 3.44 |
| 2, 4 – D @ 25 ppm ($T_3$) | 6.52 | 7.54 | 169.37 | 216.24 | 84.52 | 23.48 | 47.82 | 13.64 | 1.03 | 42.4 | 3.15 |
| NAA @ 150 ppm ($T_4$) | 6.61 | 7.67 | 172.22 | 231.65 | 64.62 | 17.95 | 47.77 | 13.62 | 0.99 | 43.45 | 2.37 |
| NAA @ 200 ppm ($T_5$) | 6.72 | 7.8 | 174.99 | 256.03 | 76.03 | 21.12 | 51.63 | 14.73 | 0.97 | 43.82 | 2.76 |
| NAA @ 250 ppm ($T_6$) | 6.54 | 7.58 | 170.12 | 241.56 | 72.89 | 20.25 | 48.91 | 13.95 | 0.99 | 42.59 | 2.62 |
| $GA_3$ @ 25 ppm ($T_7$) | 7.00 | 8.12 | 182.24 | 275.43 | 60.58 | 16.83 | 49.68 | 14.17 | 0.93 | 45.98 | 2.25 |
| $GA_3$ @ 50 ppm ($T_8$) | 7.41 | 8.58 | 192.45 | 313.87 | 72.13 | 20.04 | 53.82 | 15.35 | 0.85 | 48.22 | 2.63 |
| $GA_3$ @ 75 ppm ($T_9$) | 7.12 | 8.25 | 185.11 | 286.51 | 64.37 | 17.88 | 51.87 | 14.79 | 0.89 | 46.7 | 2.31 |
| S.Em± | 0.2 | 0.23 | 3.31 | 9.37 | 3.22 | 0.89 | 1.49 | 0.7 | 0.03 | 1.26 | |
| C.D. (p=0.05) | 0.6 | 0.69 | 9.87 | 28.06 | 9.64 | 2.68 | 4.46 | N.S. | 0.09 | 3.76 | |
| CV (%) | 5.25 | 5.21 | 6.71 | 6.71 | 7.69 | 7.69 | 5.28 | 8.73 | 5.07 | 5.02 | |

## Conclusion

The application of plant growth regulators significantly influenced the fruit yield and quality of kinnow. The foliar application of 2, 4 – D @ 20 ppm at pea stage was found the best treatment on vegetative growth parameters, yield, yield attributing character and benefit: cost ratio whereas, quality and biochemical parameters foliar application of GA 3 @ 50 ppm was the best treatment.

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