*Int.J.Curr.Microbiol.App.Sci* (2020) *9*(6): 147-155

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706* Volume 9 Number 6 (2020)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2020.906.019

# Effect NAA of crop Regulation on Kinnow Decline

**Gurdeep Singh* and B. S. Chahil**

*University College of Agriculture, Guru Kashi University, Talwandi Sabo (Bathinda), Punjab (151302), India*

**Corresponding author*

**Keywords**

Crop regulation of kinnow, fruit drop, fruit size, fruit weight

**Article Info**

***Accepted:***
14 May 2020
***Available Online:***
10 June 2020

**A B S T R A C T**

Crop regulation studies were undertaken on Kinnow trees of 8th and 9th year which have started declining due to heavy crop load in the previous year to maintain the tree health and vigour for continuous production. Plano-fix (NAA) was used to thin the fruitlets in 0, 250, 300 and 350 ppm at fruitlets stage after fruit set. The experiment was laid on Randomized Block Design, replicated four times, two trees served as a unit of treatment. Applications of 350 ppm Plano-fix (NAA) decreased crop load via fruitlet thinning. It improved vegetative growth, tree vigour, fruit size & quality.

## Introduction

Citrus species are among the most popular and important fruits in India. It occupies an area of 976(‘000) ha with estimated fruit production of 11655(‘000) MT (anonymous 2016). Citrus industry in the Punjab State is unique as it has now primarily concentrated on a single interspecific mandarin hybrid cultivar ‘Kinnow’ evolved by H.B Frost in 1935.

It is being grown on an area of 49356 hectares (anonymous, 2017) and distributed in the sub-mountainous as well as in the arid-irrigated zones of the State. Punjab Agricultural University recommended Kinnow for commercial cultivation in the State and this fruit became very popular among the fruit growers of the State.

Its plantation have gained great impetus especially in the North Indian plains, because of its wide range of adaptability, high yield potential, superior fruit quality, precocious bearing, and high income and comparatively having fewer tendencies to granulation, insect pests and diseases. Unfortunately, many problems are jeopardizing cultivation of this popular crop in the region.
Among these Kinnow tree decline is the most important one, which is causing heavy losses

to the fruit growers of the State. The various factors responsible for this early tree decline may be malnutrition, insect-pest and disease but the major one is the heavy and excessive bearing habit of the tree during ($4^{th}$-$5^{th}$ year). The excessive bearing at this stage not only adversely affects the fruit size, shape, quality but also tree health, growth and vigour during the subsequent years. Finally, it leads to collapse of tree and/or induction of the rhythm of alternate bearing during$8^{th}$ and $9^{th}$ year of age (Sidhu 1988) consequently results in poor productivity (Smith, 1976). There is gradual decline of trees with of exhaustive cropping if in $4^{th}$ and $5^{th}$ year it is allowed to bear heavily. The declining of trees show retardation of growth, chlorotic foliage, premature defoliation, fruit drop and twig dieback (Gupta, 1970).During $4^{th}$ and $5^{th}$ year of age tree bears heavily, shows rhythm of alteration and decline in successive years. Ultimately tree collapses in the $8^{th}$ or $9^{th}$ year of age (Sidhu 1988).Though this is serious problem but very scanty information is available on this subject.

In the wake of the above mentioned problems, the present investigations were undertaken with the following objectives include effect of Plano-fix (NAA) applications in thinning of fruitlets. And also to study about effect of Plano-fix (NAA) on subsequent tree growth, vigour & cropping behaviors, fruit quality and size.

## Materials and Methods

The present investigations on the 'Effect of crop regulation on Kinnow decline' were carried out in village Khatrawan (Sirsa) and University College of Agriculture Guru Kashi University, Talwandi Sabo.

The kinnow orchard planted at village Khatrawan, (Sirsa) is situated on the Khatrawan -Tirlokewala Kanchian link road. The texture of the orchard soil was sandy loam having pH 8.7, Electrical conductivity 0.70 mmhos/cm and CaCO3 .75 percent. The orchard soil was low in organic matter (0.37 per cent) and phosphorus (10 kg/ha) but high in available potassium content (264 kg/ha). The experimental trees were given similar cultural practices (Package of Practices PAU, 2015), in addition to experimental treatments.

Nine year old Kinnow trees of uniform size and vigour budded on Jatti Khatti (Citrus jambhiri Lush.) rootstock were utilized for the experiment. These trees were planted in square system at 6m × 6m distance. The orchard was irrigated by canal water. These trees were grown under uniform conditions of soil and orchard management practice and two trees were used per unit for the treatments. Total no. of experimental trees was used 64. The experiment was laid out in Randomized Block Design with the four replications under the following treatments:

### Main treatment: timing of plano-fix (NAA) applications

At full bloom stage (75 per cent flowers opened)

After fruit set stage (Fruitlet dia. 0.5 cm)

| Sr. No. | Chemical Treatment | Concentration |
|---|---|---|
| **1.** | Control (Water spray) | Water spray |
| **2.** | Plano-fix (α-Naphthalene acetic acid) | 250 ppm |
| **3.** | Plano-fix (α-Naphthalene acetic acid) | 300 ppm |
| **4.** | Plano-fix (α-Naphthalene acetic acid) | 350 ppm |

The aqueous solutions of this chemical thinner (Plano fix) was applied on March $27^{th}$ (full bloom stage) and again on April $27^{th}$

(Fruitlet size 0.5 cm diameter). Two trees served as a unit of treatment and each treatment was replicated four times. This experiment was laid out in a randomized-block design.

And observations on tree growth (tree height, tree spread, trunk girth), time and duration of flowering, number of flowers per shoot, fruit thinning, fruit retention percentage, fruit yield per tree and physical & chemical fruit variables were recorded and Statistical analysis of the recorded data was done as per randomized-block design using *eda* software developed by the department of Mathematics and statistics PAU, Ludhiana.

## Results and Discussion

### Fruit thinning and fruit yield (Shown in table 1)

The data presented in Table.1 showed that the treatment of Plano fix (NAA) 350 ppm resulted in significantly higher (81.06) fruitlet thinning as compared with all other treatments. The minimum fruitlet thinning was in control (71.07). Chemical thinner like NAA appear to have the capability to create a carbohydrates stress by reducing photosynthesis, increasing respiration or impeding carbohydrates movement to the fruit. Many have observed that the greatest fruit abscission caused by thinner is associated with periods to reduced carbohydrates availability immediately following thinner application. Similar result have been reported by , Hirose *et al.*, (1978) and Iwahori *et al.*, (1978) also reported that NAA (200 and 300 ppm) applied 25 days following full bloom, caused approximately 30 percent increase in fruit drop and effectively thinned Satsumas mandarins. Sidhu (1988) also investigated that NAA application (200, 300 and 400 ppm) caused thinning of fruits in kinnow.

The data given in Table.1 showed increase in Plano fix concentration (NAA) resulted in corresponding decrease in fruit yield which the result on fruit thinning. The lowest yield (248 fruits /tree) was recorded in 350 ppm Plano fix (NAA) which was significantly lower than other treatments. The highest yield was recorded (348 fruits /trees) in control. These reductions in number of fruits per tree may be attributed to the higher percentage of fruitlet abscission induced by Plano fix (NAA), which resulted in reduced fruit yield per tree. Sidhu (1988) obtained similar results in Kinnow and investigated fruit yield per tree was reduced due to promotion of abscission of young fruitlets caused by thinning NAA.

## Growth parameters

### Rootstock and Scion Girth

The mean data presented in Table 2 showed that the annual increment in Kinnow tree rootstock girth was significantly higher (8.1 cm) with application of 350 ppm Plano fix (NAA), compared to control (4.9 cm). The mean data presented in Table 2 showed that the annual increment in Kinnow tree rootstock girth was significantly higher (5.0 cm) with application of 350 ppm Plano fix (NAA), compared to control (2.5 cm). The Rootstock and Scion girth was increased as the concentrations of applied Plano fix (NAA) were increased from 100 to 350 ppm. Generally, the annual increment in trunk girth was more where flower and fruit thinning percentage was high which led to reduced fruit load and thereby making availability of more photosynthates for tree growth and vigour of the tree. NAA application resulted in annual increment in trunk girth of kinnow tree as reported by Sidhu (1988).

### Tree spread and height

The mean data on annual increment in tree

spread and height is given in Table 2. The perusal of the data revealed that the annual increase in tree spread was significantly higher (21.56 cm) with 350 ppm Plano fix (NAA) treatment, compared with control. Similar trend was recorded in tree height. The annual increment in tree height was significantly higher (25.62 cm) with application of 350 ppm Plano fix (NAA) as compared with control (17.07 cm) and all other treatments. The annual tree spread and height was increased as the concentrations of applied NAA were increased. Generally, the annual increment in tree spread and height was higher where fruit thinning percentage was high which lead to reduced fruit load and thereby making availability of more photosynthates for tree growth and vigour of the tree. Sidhu (1988) reported the annual increment in Kinnow tree spread with NAA application.

## Fruit quality

### Physical parameter

The perusal of the data given in Table 3 revealed that fruit diameter was the minimum (6.2 cm) in control. The fruit diameter was significantly higher (7.6 cm) with the application of 350 ppm as compared with all other treatments and the fruit diameter increased as the concentrations of applied NAA were increased from 100 to 350 ppm. Likewise, Hilgeman *et al.,* (1964) and Sidhu (1988) reported that fruit thinning of Kinnow mandarins had markedly increased the fruit size.

The mean data presented in Table 3 revealed that all the treatments of Plano fix (NAA) have increased fruit weight as compared with control. Fruit weight was the maximum (171 g) with the application of 350 ppm. In general, Plano fix (NAA) resulted in corresponding increase in fruit weight. However, the lower concentrations of NAA (Plano fix 300 ppm and 250 ppm) did not significantly increased fruit weight as compared with control. The higher concentration of Plano fix (350 ppm) have significantly increased the number of seeds per fruit (Table 4).

The minimum number of seeds (18.5) per fruit was recorded in 250 ppm treatment. Although mean seed weight was the highest (0.91g /seed) with application of 250 ppm NAA. The NAA treatments have significantly increased the juice percentage of fruit compared with the control. Similarly, Tsertsvadze, (1978) reported that about 50 percent of the flowers should be thinned for regular cropping of Satsumas. But fruit weight, percent juice and sugars percentage were the highest where 75 percent of the flowers had been thinned. Lewin and Monselise (1976) also found that the number of developed seeds in 'Temple' and 'Ortanique' mandarin cultivars was reduced with 150 ppm NAA applications at early fruitlet development stage. Sidhu (1988) also observed in kinnow.

### Total soluble solids and acids

The perusal of mean data presented in Table 4 revealed that the higher concentrations of Plano fix (NAA) significantly increased the total soluble solids (TSS) as compared with control. The minimum total soluble solids (8.9 per cent) were recorded in control treatment. The various flower and fruit thinning treatments did not significantly affect the average acid content of fruit juice as compared with control. Juice acidity was found to be the maximum (0.94 per cent) in 300 ppm and the minimum (0.89 per cent) in Plano fix (NAA) 350 ppm treatment.

**Table.1** Effect of spray application of Plano fix (NAA) on fruit thinning & fruit yield

| Treatment | Fruit thinning (%) | Fruit yield (Mean number of fruits per tree) |
|---|---|---|
| **Control** | 71.07 | 348 |
| **Plano fix (NAA) 250 ppm** | 76.76 | 318 |
| **Plano fix (NAA) 300 ppm** | 79.76 | 273 |
| **Plano fix (NAA) 350 ppm** | 81.06 | 248 |
| **LSD (0.05)** | 2.08 | 8.85 |

**Table.2** Effect of spray application of Plano fix (NAA) on tree height, rootstock girth, scion girth and tree spread

| Treatment | Tree height | Rootstock girth | Scion Girth | Tree spread |
|---|---|---|---|---|
| | Annual increment in cm | Annual increment in cm | Annual increment in cm | Annual increment in cm |
| **Control** | 17.07 | 4.9 | 2.5 | 15.13 |
| **Plano fix (NAA) 250 ppm** | 20.0 | 6.8 | 3.9 | 19.35 |
| **Plano fix (NAA) 300 ppm** | 24.65 | 7.5 | 4.3 | 20.95 |
| **Plano fix (NAA) 350 ppm** | 25.62 | 8.1 | 5.0 | 21.56 |
| **LSD (0.05)** | 0.54 | 0.33 | 0.37 | 0.58 |

**Table.3** Effect of spray application of Plano fix (NAA) on fruit quality (Physical parameters)

| Treatment | Fruit diameter (cm) | Fruit weight (g) | Mean Seed number per fruit | Seed weight (g) | Juice percentage |
|---|---|---|---|---|---|
| **Control** | 6.2 | 146.0 | 22.5 | 0.84 | 40.38 |
| **Plano fix (NAA) 250 ppm** | 7.0 | 159.6 | 18.5 | 0.91 | 36.40 |
| **Plano fix (NAA) 300 ppm** | 7.3 | 163.0 | 20.7 | 0.86 | 40.01 |
| **Plano fix (NAA) 350 ppm** | 7.6 | 171.0 | 19.0 | 0.73 | 40.90 |
| **LSD (0.05)** | 0.18 | 1.7 | 1.0 | NS | NS |

**Table.4** Effect of spray application of Plano fix (NAA) on fruit quality (TSS and Acidity) in Kinnow

| Treatment | TSS (%) | Acidity (%) |
|---|---|---|
| **Control** | 8.9 | 0.90 |
| **Plano fix (NAA)250 ppm** | 9.6 | 0.91 |
| **Plano fix (NAA)300 ppm** | 9.9 | 0.94 |
| **Plano fix (NAA)350 ppm** | 10.1 | 0.89 |
| **LSD (0.05)** | 0.19 | 0.03 |

Similar observations that Brix° contents were increased after fruit thinning of Satsumas with 100-200 ppm of NAA applications 45-50 days after full bloom were reported by Mango (1983). Likewise, fruit thinning has improved the fruit quality in 'Kinnow' mandarin (Ali *et al.,* 1975), 'Satsuma' mandarin (Hirose *et al.,* 1975), 'Wilking' mandarin (Lavon *et al.,* 1976) and 'Kinnow' mandarin (Sidhu 1988).

## Acknowledgement

The author is thankful to the Department of Horticulture, University College of Agriculture for providing the orchard and laboratory facilities.

## References

Agusti M, Almela V and Guardiola J L (1981) the regulation of fruit cropping in mandarin through the use of growth regulators. *In Proc Int Soc Citriculture* 1: 216-220.

Ali N, Asi A A and Zahid N A (1975) Induction of regulator cropping in citrus with plant growth regulators. *Pak. J. Agri. Sciences* 8(3/4): 1-17.

Asi A A and Ali N (1973) Effect of growth regulators on physic-chemical characters and fruit quality of Kinnow mandarins. *Pakistan J. Sciences* 22(5-6): 233-238.

Auchter E C and Roberts J W (1934) Experiments in spraying apples for the prevention of fruit set. *Proc. Amer. Soc. Hort. Sci* 30: 22-25.

Babu G H V R and Lavania M L (1985) Vegetative growth and nutritional studies as influenced by auxins and gibberellic acid and their effect on fruit yield in lemon. *Scientia Horti* 26(1): 25-33.

Babu G H V R, Lavania M L and Misra K K (1984) Effect of plant growth regulator sprays on yield and physico-chemical composition of Pant lemon-1 (*Citrus limon*) fruits in the off-season flush. *Progr Horti* 16(3/4): 191-198.

Bhathal H S (2015), Crop regulation in kinnow (*Citrus reticulata Blanco).* M.sc Thesis GKU, Talwandi sabo.

Cutuli G (1973) Three-year studies on chemical thinning of Avana mandarin fruit using naphthalene acetic acid. Annali dell' Instituto Sperimentale per L'Agrumicoltura 1/2: 147-169. (*Cf Hort* 43:6358 Abst).

Dhatt A S (1973) Studies on the bearing behavior of mango (*Mangifera indica* L.) Ph.D. Thesis P.A.U. Ludhiana: 40-48.

Duhanaj G G, Susaj L, Roshanji N and Susaj E (2015) Effects of fruit thinning method on crop load and yield on "Golden Delicious" apple cultivar, under Gjakova's climate conditions. *Online International Interdisciplinary Research Journal {Bi-Monthly} ISSN* 2249-9598 Volume-V.

Fainzack M, Egozi Y and Giladi B (2002) effects of auxins sprays on yield, fruit size, fruit splitting and the incidence of creasing of 'Nova' mandarin. *Ministry of Agriculture Israel.*

Gallasch P T (1978) Control of alternate cropping of Valencia orange with ethephon and naphthalene acetic acid. *Aust J Expt Agr Anim Husb* 18: 152-157.

Gonkiewicz A, Blaszczy K J and Basak A (2011) Chemical pear fruit thinning. *Journal of fruit and Ornamental Plant Research* 19(1): 73-78.

Gradner FE, Reece P C and Horanic G E (1961) Thinning of Dancy tangerines at bloosom time with maleic hydrazine. *Proc Amer Soc Hort Sci* 77:188-193.

Hield H Z and Hilgeman R H (1969) alternate bearing and chemical fruit thinning of certain citrus varieties. *In Proc 1st Int Citrus Symp* 3: 1145-1153.

Hield H Z, Burns R M and Coggins Jr C W (1962) some fruit thinning effects of naphthalene acetic acid on Wilking mandarin. *Proc Amer Soc Hort Sci* 81: 281-222.

Hield H Z, Coggins C W, Knapp J C F and Burns R M (1966) Chemical fruit thinning on mandarins and Valencia orange. *Calf Citrog*. 51:312, 337-343.

Hilgeman R H, True L and Dunlap J A (1964) Effect of naphthalene acetic acid spray and hand thinning on size of kinnow mandarin fruit in Arizona. *Proc Fla State Hort Sci* 77: 84-87.

Hirose K (1970) chemical thinning of Satsuma mandarin by NAA (α-naphthalene acetic acid). *Japan Agricultural Research Quart.* 5(4): 31-33. (*Cf Hort* 42: 4859 Abst).

Hirose K, Isao, Iwagaki and Suzuki K (1978) IZAA (5-chloroindazol-8-acetic acid ethyl ester) as a new thinning agent of Satsuma mandarin (*C. unshiu* Marc.). *Proc Int Soc Citrucel* : 270-273.

Hirose K, Koremura M, Daito H and Suzuki K (1975) Studies in thinning citrus fruits by applying chemicals. VI. The effects of NAA on the concentration of free amino acids, sugar and citric acid in Satsuma juice. *Bulletin of the Fruit Tree Research Station B (Okitsu) 1*: 7-23. (*Cf. Hort* 45: 2784 Abst).

Hirose K, Yamamoto M and Ohata T (1974) Studies on thinning citrus fruits by applying chemicals. 3. The effect of 1-naphthalene acetic acid on fruit thinning of satsumas. *Bull of the Hort Res StaB (Okistu)* 12: 55-62.

Hitchcock A E, Zimmerman P Wand Thompson Boyce (1943) Summer sprays with potassium α- naphthalene acetate retard opening of buds on fruit trees. *Proc Amer Soc Hort Sci* 42: 141-145.

Iwahori S (1978) Use of growth regulators in the control of cropping of mandarin varieties. *Proc Int Soc Citriculture* 263-270.

Iwasaki T, Shichijo T and Iba Y (1962) Studies on the control of alternate bearing in citrus. 6. An investigation on thinning materials for Satsuma orange. *Jour Jap Soc Hort Sci* 31: 1-12.

Jain M C, Choudhary H D, Sharma M and Singh B (2014) Yield and quality attributes of Nagpur mandarin as affected by use of different plant growth regulators. *Environment and Ecology* 32(3A): 1141-1145.

Koupil S (1981) Effect of some fruit thinning chemicals on apple shoot growth. *Sbornik UVTIZ Zahradnic tvi* 5/6(1-2): 7-14.

Lavon R and Bar-Akiva A (1976) Mineral nutrients as thinning agents in 'Wilking' mandarin trees. *Hort Science* 11(4): 419-420.

Lewin I J and Monselise S P (1976) Further studies on the reduction of seeds in mandarins by NAA sprays. *Scientia Hort* 4(3): 229-234.

Llyod R H (1962) Results of fruits thinning and sizing trails with 2, 4, 5-T on Early Imperials and Emperors. *Citrus News (Aust.)* 38: 125-131.

Manabe K, Humuro M and Ashizawa M (1983) Relationship between flower thinning and leaf number and mineral content and the incidence of fruit dropping in satsumas. *Technical Bull Faculty of Agri Kagawa Univ* 33(2): 165-173. (*Cf Hort* 53: 3703 Abst).

Manago M (1983) Studies of chemical fruit thinning of citrus. Effect of J-455 (5-chloroindazol acetic acid ethylester) on fruit thinning and fruit quality of Satsumas. *Bull of the kanagawa Hort Expt Stat* 28: 14-23. (*Cf Hort* 53: 1340 Abst).

Marth P C, William V Audia and Mitchell John W (1956) Effect of gibberellic acid on growth and development of plants of

various genera and species. *Bot Gaz* 118(2): 106-111.

Meitei S B, Patel R K, Deka B C, Deshmukh N A and Singh A (2013) Effect of chemical thinning on on yield and quality of Peach cv. Flordasun. *The Ecoscan: an international journal of environmental sciences, Special Issue* 6: 467-471.

Monselise S P (1979) the use of growth regulators in citriculture: a review. *Scientia Hort* 11: 151-162.

Monselise S P, Goren R and Wallerstein Israela (1972) Girdling effects on orange fruit set and young fruit abscission. *Hort Sci* 7(5): 514-515.

Moss G I, Bevington K B and Gallasch P T (1978) Methods to control alternate cropping of Valencia orange trees in Australia. *In Proc Int Soc of Citriculture* 2 *Lake Alfred [Florida]. USA:* 704-708.

Nakajima T, Manago M and Ogaki C (1969) Practical studies on the use of naphthalene acetic acid for thinning the fruits of 'Unshiu' orange trees. *Bull Kanagawa hort Expt Stat* 17: 9-17. (*Cf Hort* 41: 2362 Abst).

Nawaz M A, Afzal M, Ahmed W, Ashraf M, Silva J A T , Akhtar N, Shahzad S M, Ullah H and Hussain Z (2011) Exogenous application of 2, 4-D, $GA_3$ and NAA at flowering improves yield and quality of Kinnow mandarin (*Citrus reticulata* Blanco.). *The Asian and Australasian Journal of Plant Science and Biotechnology* 5(1): 17-21.

Nawaz M A, Ahmad W, Ahmad S and Khan M M (2008) Role of growth regulators on pre harvest fruit drop, yield and quality in Kinnow mandarin. *Pak J Bot* 40(5): 1971-1981.

Nejad G S, Shahsavar A R and Mirsoleimani A (2015) Effect of naphthalene acetic acid and carbaryl on fruit thinning in 'Kinnow' mandarin trees. *Journal of Chemical Health Risks* 5(2): 137-144.

Noma Y (1977) the mechanism of chemical thinning in Satsuma. 4. Relation of NAA treatments to abscission layer formation in the young fruits and to fruit drop. *Technical Bulletin of the Faculty of Hort Chiba Univ* 24: 45-50. (*Cf Hort* 47: 11914 Abst).

Rawash M A, EL-Hammady S, Halifa A S and EL-Masry (1985) Regulation of flowering and fruiting in mango trees by using some growth regulators. *Annals of Agri Sci Ain Shams Univ* 28(1): 227-240.

Reddy P A and Prasad D M (2012) Effect of plant growth regulators on fruit characters and yield of Pomegranate (*Punica granatum* L.) cv. Ganesh . *Int. J. P. A. E. Sci., 2(2): 2331-4490.*

Rensburg P Van (1985) Fruit size of Clementine. *Information Bulletin, Citrus and Subtropical Fruit Research Institute* (1985)159: 1-2 (*Cf Hort* 56: 8341 Abst).

Saleem B A, Malik A U and Farroq M (2007) Effect of exogenous growth regulators application on June fruit drop and fruit quality in *Citrus sinensis* cv. Blood Red. *Pak J Agri Sci* 44(2).

Sharma R K and Awasthi R P (1990) Effects of growth regulators on crop regulation in kinnow. *Indian J Hort* 471: 162-166.

Shweta, U. and Misra, K.K., 2015. Effect of plant growth regulators on fruit drop and quality of *Bael* under *Tarai* conditions of Uttarakhand. *Indian Journal of Horticulture*, 71(1): 126-129.

Sidhu M S (1988) Physiological manipulations of crop regulation in Kinnow mandarin. Ph. D. Thesis PAU, Ludhiana.

Singh V (1980) Effect of plant regulators on growth, yield and quality of guava (*Psidium guajava* L.) *Cv.Safeda*. *Plant Sci* 12: 13-17.

Stover Ed, Ciliento S and Rite our M (2002)

NAA thinning of "Murcott": Comparison of small plot and commercial harvest data. *Proc Fla State Hort Soc* 115: 287-291.

Sweety (2016), Effect of growth regulators on fruit drop, yield and quality of sweet orange *(Citrus sinensis Osbeck.)* cv. Jaffa. M.sc Thesis HAU, Hisar.

Tsertsvadze V V (1978) Regulating cropping in Satsuma trees by moderating flowering. *Subtropicheskie Kul'tury* 3: 87-89. (*Cf Hort* 48: 8616 Abst).

Tsertsvadze V V (1981) Regulation of bearing in citrus trees by means of shoot and flower thinning. *Subtropicheskie Kul'tury* 2.19-23. (*Cf Hort* 51: 9002 Abst).

Watanabe J, Akiyoshi H, Amano S, Inove S and Murakami K (1986) Studies on the coloring of citrus fruit.1. Coloring at maturation of Wase Satsuma fruit as affected by fruit load and NAA spraying. *Memoirs of the College of Agri Ehime Univ* 29(2): 215-225 (*Cf Hort* 56: 2058 Abst).

Wheaton T A (1982) Fruit thinning of Florida mandarins using plant growth regulators. *In Proc Int Soc Citriculture* 1: 263-268.

Wheaton T A and Stewart I (1973) Fruit thinning of tangerines with Naphthalene acetic acid. *Proc Soc* 86: 48-52.

Yamamoto M, Hirose K and Daito H (1974) Studies on thinning citrus fruits by applying chemicals. The effect of NAA on thinning Satsuma fruits in relation to temperature, distance from the coast and elevation. *Bull Hort Res Sta (B) (Okitsu)* 12: 63-75.

Yasui A, Iimuro S, Ura K and Fukunaga S (1976) Effects of α-naphthalene acetic acid on fruit thinning of Satsumas. *Bull Hort the Nasa Agricultural Experiment Station* 6: 1-8.

**How to cite this article:**

Gurdeep Singh and Chahil. B. S. 2020. Effect NAA of crop Regulation on Kinnow Decline. *Int.J.Curr.Microbiol.App.Sci.* 9(06): 147-155. doi: https://doi.org/10.20546/ijcmas.2020.906.019