www.hortflorajournal.com ICV: 4.79

HortFlora Research Spectrum, 2(4): 335-340 (Oct.-Dec. 2013) ISSN : 2250-2823

EFFECT OF PRE-HARVEST APPLICATION OF GA_3, TRIACONTANOL AND CALCIUM SALTS ON YIELD AND PHYSICAL CHARACTERS OF KINNOW FRUITS HARVESTED ON DIFFERENT DATES

Tanjeet Singh Chahal* and J.S. Bal[1]

Fruit Research Station, PAU- FRS Jallowal-Lesriwal, Punjab

[1]*Department of Horticulture, Khalsa College, Amritsar, Punjab*

**E-mail: tanjeetchahal@pay.edu,* tanjeetchahal@yahoo.com

ABSTRACT: The study on the effect of pre-harvest chemical treatments in Kinnow mandarin was conducted at Khalsa College, Amritsar for two years. Pre-harvest foliar application of GA_3 (10, 20, 30ppm), triacontanol (400, 600ppm), $CaCl_2$ (4, 6%) and $Ca(NO_3)_2$ (0.1, 0.2, 0.3%) was given to the Kinnow plants of fifteen years of age. The harvesting of the fruits was done on January 1st, January 15th, February 1st and February 15th during both the years and yield of the fruits was calculated along with their physical analysis. It was observed that the maximum fruit yield to the tune of 54.88kg/plant was recorded with the application of GA_3 at 30ppm and it was proved to be the most efficacious treatment for improving fruit quality in respect of fruit size, weight and juice content. Maximum peel thickness was observed with $CaCl_2$ at 6 per cent.

Keywords: *Kinnow mandarin, GA_3, $CaCl_2$, $Ca(NO_3)_2$, triacontanol.*

Kinnow mandarin, a hybrid of King x Willow Leaf mandarin, grows successfully in all frost free, tropical and sub-tropical regions of India. Kinnow appears to be very exacting in its climatic requirements. The tree is vigorous, large, tall and columnar with dense foliage. Fruits are medium in size, moderate to slightly oblate both base and apex flattened or slightly depressed (Singh *et al*., 19). It is the dominating fruit crop of Punjab and is expanding fastly to the neighbouring states. Since the last two decades, large plantation has been brought under Kinnow and consequently it has become the major fruit crop of the state (Chahal and Bal, 3).

Essential plant nutrients and growth regulators like calcium and GA_3 are known to be involved in number of physiological processes concerning membrane structure, functioning and enzymatic activity. Their use for improving fruit quality and increasing yield has good scope in Kinnow mandarin. Keeping this in view, the investigations were conducted with the aim to study the effect of different chemicals on yield and physical fruit characters in Kinnow with the help of GA_3, triacontanol and calcium salts along with their thresh hold levels.

MATERIALS AND METHODS

The uniform and disease free trees of Kinnow with 15 years of age were selected from 'Punjab Government Progeny Orchard' Attari, Amritsar. The plants were applied with standard doses of fertilizers and plant protection measures as recommended by Punjab Agricultural University, Ludhiana. Gibberellic acid (GA_3) at 10, 20 and 30ppm, Vipul (Triacontanol) at 400 and 600ppm, Calcium Chloride ($CaCl_2$) at 4 and 6 per cent and Calcium Nitrate {$Ca(NO_3)_2$} at 0.1, 0.2 and 0.3 per cent were applied as pre-harvest treatments on 25th October during both the experimental years. The experiment consisted of 11 treatments. Two trees were kept as unit treatment and replicated three times. The yield of the plants was calculated on 15th January and the physical analysis of the fruits was carried by harvesting the fruits on four different stages, *viz*. January 1st, January 15th, February 1st, and February 15th. The two year data was pooled and analyzed statistically.

Received : 21.08.2013 *Accepted : 20.09.2013*

RESULTS AND DISCUSSION

Fruit Yield

The data on fruit yield indicates significant response of GA_3 sprays in increasing the yield of Kinnow fruits per plant (Table 1). Spraying of GA_3 at 30ppm recorded the maximum fruit yield of 54.88kg/plant. GA_3 at 20ppm was the next best treatment followed by GA_3 at 10ppm with average yield of 53.70kg/plant and 52.32kg/plant, respectively. A non-significant variation was observed between all the GA_3 treatments but were significantly higher than control. The promotive effect of GA_3 on yield per plant is due to increment in all yield attributing characters. These results elucidate the findings of Kaur *et al.* (9) in Kinnow. The plants treated with calcium salts resulted into lower fruit yield. The minimum fruit yield to the tune of 41.69kg/plant was recorded with the treatment $CaCl_2$ at 6 per cent, followed by $Ca(NO_3)_2$ at 0.3 per cent (44.37kg/plant). $CaCl_2$ at 6 per cent was observed to be significantly lower than control while $Ca(NO_3)_2$ at 0.3 per cent was found to be statistically at par with control and $CaCl_2$ at 6 per cent. The lower fruit yield with calcium might be due to the decreased fruit size and weight as increased calcium accumulation acts as antagonists of GAs, thereby suppressing the activity of physiologically active GAs. Singh and Arora (20) recorded a decrease in fruit yield of Flordasun peach with the application of $Ca(NO_3)_2$ and $CaCl_2$, while Bhatt *et al.* (2) observed increased yield with the aid of chemicals. The application of triacontanol, resulted in decreasing the yield. The decrease in yield was observed to be higher with triacontanol at 400ppm (45.29 kg/plant) while it was comparatively low with triacontanol at 600ppm (45.85kg/plant). However, both these treatments failed to produce any significant effect over control.

Physical Characters of Fruits

The fruit size in term of length and breadth of the Kinnow mandarin as influenced by chemical applications revealed that the chemical treatments were not able to exert any significant effect on the fruit length (Table 2). However, the maximum value of fruit length was recorded to be 5.83cm with the application of GA_3 at 30ppm. The GA_3 treatments at 10ppm, 20ppm and 30ppm, showed higher level of fruit breadth in comparison to control (Table 2), but the maximum fruit breadth (7.15cm) was also achieved with GA_3 at 30ppm level. The reason for this increase in fruit size of Kinnow mandarin during the experimentation can be explained as the resultant of the rapid cell elongation caused by the presence of GA_3 (Krishnamoorthy, 10). The increase in fruit size with GA_3 application has also been well documented by Dhillon *et al.* (5) in Kinnow mandarin. Amongst the calcium treatments, $CaCl_2$ at 6 per cent registered the minimum level of fruit length to the tune of 5.44cm. In case of fruit breadth also, the minimum value (6.58cm) was registered in fruits treated with $CaCl_2$ 6 per cent but showed non-significant variation with control. The small fruit size in calcium treatments can be owed to the fact that increased calcium accumulation acts as antagonist to GAs, thereby suppressing the activity of physiologically active GAs. The increase in calcium level in fruits may also cause endogenous restriction of root growth, resulting in reduced interference of GAs (Saure, 15). This activity could not effect in the next year. The results are in conformity with the findings of Roychoudhury *et al.* (14) in case of litchi. Triacontanol could not exert any significant effect on fruit size conforming to the findings of Jindal and Chandel (6) in plum.

The fruit weight of Kinnow mandarin (Table 3) showed an increasing trend with increase in GA_3 concentration during the research investigation. The maximum fruit weight to the

Table 1: Effect of GA_3, triacontanol and calcium salts on fruit yield (kg/plant) per plant

Treatments	Yield/Plant (Kg)
GA_3 10 ppm	52.32
GA_3 20 ppm	53.70
GA_3 30 ppm	54.88
Tria 400 ppm	45.29
Tria 600 ppm	45.85
$CaCl_2$ 4%	45.75
$CaCl_2$ 6%	41.69
$Ca(NO_3)_2$ 0.1%	45.80
$Ca(NO_3)_2$ 0.2%	45.07
$Ca(NO_3)_2$ 0.3%	44.37
Control	47.18

CD (P=0.05) 4.27

value of 186.4g was significantly higher than the control and was recorded with GA_3 30ppm. The reason for this increase in fruit weight with GA_3 treatment may be that the increase in sugar molecules in the plant cells mobilizes the nutrients towards the fruits leading to increase in fruit growth and weight (Singh and Rajput, 18). Similar observations were also made by Pal and Mishra (13) in litchi. Higher fruit quality attributes in litchi by pre harvest spray of GA_3 were also observed by Mishra *et al.* (12). The minimum fruit weight (156.3g) was observed in the fruits treated with $CaCl_2$ 6 per cent and $Ca(NO_3)_2$ at 0.3 per cent, however the decrease recorded was non-significant with control. The decrease in fruit weight in the calcium treatments have been well documented by Saure (15) who had reported that the decrease of calcium concentration results in increased fruit mass and the vice versa. The results are in accordance with the findings of Sharma *et al*. (17) who had recorded a decrease in fruit weight in Kagzi lime with the application of $CaCl_2$.

Table 2: Effect of GA_3, triacontanol and calcium salts on fruit length and breadth (cm) of Kinnow fruits harvested at different dates.

Treatments	Harvesting Dates									
	Fruit length (cm)					Fruit breadth (cm)				
	1st Jan	15th Jan	1st Feb	15th Feb	*Mean*	1st Jan	15th Jan	1st Feb	15th Feb	Mean
GA_3 10ppm	5.43	5.67	5.80	5.81	5.68	6.73	6.86	6.94	6.96	6.87
GA_3 20ppm	5.45	5.74	5.85	5.85	5.72	6.85	7.00	7.09	7.11	7.01
GA_3 30ppm	5.50	5.85	5.97	5.98	5.83	7.01	7.13	7.22	7.24	7.15
Tria 400ppm	5.20	5.50	5.60	5.61	5.48	6.52	6.66	6.76	6.76	6.68
Tria 600ppm	5.27	5.55	5.64	5.64	5.53	6.56	6.70	6.81	6.83	6.72
$CaCl_2$ 4%	5.29	5.47	5.55	5.56	5.48	6.55	6.66	6.75	6.76	6.68
$CaCl_2$ 6%	5.27	5.44	5.52	5.53	5.44	6.46	6.57	6.64	6.66	6.58
$Ca(NO_3)_2$ 0.1%	5.34	5.55	5.67	5.67	5.56	6.56	6.75	6.80	6.81	6.73
$Ca(NO_3)_2$ 0.2%	5.31	5.53	5.65	5.65	5.54	6.56	6.65	6.72	6.73	6.67
$Ca(NO_3)_2$ 0.3%	5.30	5.49	5.60	5.60	5.50	6.47	6.60	6.68	6.70	6.61
Control	5.36	5.60	5.71	5.71	5.60	6.62	6.74	6.84	6.84	6.76
Mean	5.34	5.58	5.69	5.69		6.63	6.75	6.84	6.86	

CD(P=0.05)

Fruit length: Treatments (A) – NS Harvesting dates (B) – 0.24 AxB – NS

Fruit breadth: Treatments (A) – 0.26 Harvesting dates (B) – 0.16 AxB – NS

Table 3: Effect of GA_3, triacontanol and calcium salts on fruit weight (g) and peel thickness (cm) of Kinnow fruits harvested at different dates.

Treatments	Harvesting Dates									
	Fruit weight (g)					Peel thickness (cm)				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean	1st Jan	15th Jan	1st Feb	15th Feb	Mean
GA_3 10ppm	161.5	171.4	175.7	176.6	171.3	0.23	0.26	0.27	0.27	0.26
GA_3 20ppm	172.0	181.1	184.5	185.0	180.7	0.25	0.26	0.28	0.28	0.27
GA_3 30ppm	177.9	185.4	190.9	191.2	186.4	0.26	0.28	0.30	0.30	0.29
Tria 400ppm	139.9	154.4	166.2	166.7	156.8	0.25	0.26	0.29	0.29	0.27
Tria 600ppm	139.8	156.6	164.7	164.9	156.5	0.24	0.26	0.29	0.29	0.27
$CaCl_2$ 4%	145.1	158.9	165.6	166.0	158.9	0.26	0.27	0.28	0.28	0.27
$CaCl_2$ 6%	140.3	157.3	163.6	164.1	156.3	0.31	0.32	0.35	0.35	0.33
$Ca(NO_3)_2$ 0.1%	151.7	161.6	165.2	166.7	161.3	0.26	0.27	0.28	0.28	0.27
$Ca(NO_3)_2$ 0.2%	150.2	156.0	161.8	162.0	157.5	0.25	0.27	0.29	0.29	0.28
$Ca(NO_3)_2$ 0.3%	148.9	156.1	159.7	160.5	156.3	0.29	0.31	0.32	0.32	0.31
Control	142.3	160.1	170.7	171.1	161.0	0.24	0.27	0.29	0.29	0.27
Mean	151.8	163.5	169.8	170.4		0.26	0.28	0.30	0.30	

CD(P=0.05)

Fruit weight: Treatments (A) –5.9 Harvesting dates (B) –3.6 AxB – NS

Peel thicknes: Treatments (A) 0.02 Harvesting dates (B) – 0.01 AxB – NS

Table 4: Effect of GA_3, triacontanol and calcium salts on juice content (%) of Kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	*Mean*
GA_3 10 ppm	47.61	49.14	51.26	51.44	49.86
GA_3 20 ppm	48.65	50.17	52.18	52.62	50.91
GA_3 30 ppm	48.50	50.44	52.55	52.75	51.06
Tria 400 ppm	41.33	43.03	45.11	45.60	43.77
Tria 600ppm	40.55	41.98	44.20	44.32	42.76
$CaCl_2$ 4%	38.62	39.75	41.94	42.46	40.69
$CaCl_2$ 6%	39.51	40.32	42.52	43.26	41.40
$Ca(NO_3)_2$ 0.1%	38.90	39.70	42.87	42.61	41.02
$Ca(NO_3)_2$ 0.2%	39.80	40.76	42.06	43.60	41.56
$Ca(NO_3)_2$ 0.3%	38.95	39.76	42.86	42.65	41.06
Control	42.68	44.35	46.56	47.08	45.17
Mean	42.28	43.58	45.83	46.22	

CD (P=0.05) : Treatments (A)–1.43, Harvesting dates (B)–1.10, AxB–NS

The data (Table 2 and 3) showed that length, diameter and weight of Kinnow fruits continuously increased with advancement of fruit development upto 1st February. After that the fruit growth registered negligible increase. The initial period of fruit development represents the period of cell division and cell elongation. The slow growth later on can be attributed to the fact that fruits had already acquired the metabolites to its full capacity.

A significantly higher peel thickness in comparison to control during the two years of the investigation period was recorded in the fruits treated with $CaCl_2$ at 6 per cent (Table 3). This treatment recorded average peel thickness of 0.33 cm. Higher peel thickness in the calcium treated fruits may be due to the tendency of calcium to serve as a binding agent in the cell wall, in the form of calcium pectate (Sharma *et al*., 17), which might have checked the moisture loss from the peel. Kaur *et al*. (7) concluded similar results with calcium salts while working on sweet orange cv. Jaffa. The minimum level of peel thickness to the value of 0.26 cm, though non-significant with control, was found in fruits treated with GA_3 at 10ppm during the two year evaluation. The decrease in peel thickness may be due to the fact that GA_3 reduces the uptake of calcium from the nutrient solution and prevent the accumulation of calcium in the fruits (Saure, 15), thereby, reducing calcium pectate content. These results are in accordance with Lima and Davies (11) for Navel orange. A continuous increase in peel thickness of the fruits was recorded from 1st January harvesting to 1st February, after which it remained almost static till 15th February. Similar increase in peel thickness of Kinnow fruits from December end to January end has been advocated by Dharampal and Saini (4).

The data with regard to juice content (Table 4) showed that on an average the fruits treated with GA_3 retained maximum juice content as compared to control with the highest value of 51.06 per cent in those applied with GA_3 30ppm. This increase in the juice percentage may be explained by the fact that growth regulators play a regulating role in mobilization of metabolites within a plant towards fruits (Singh, 21). These observations are in agreement with the work of Babu *et al*. (1) on Kagzi Lime. The juice content experienced a declining trend with the application of triacontanol and calcium salts in the present investigation. The minimum juice level (40.69 per cent) during the study was reported with $CaCl_2$ at 4 per cent. The lower juice content in calcium treated fruits might be due to its tendency to delay ripening (Sharma *et al*. 16) which retards juice development. Decrease in juice percentage with calcium has also been advocated by Kaur *et al.* (8) in sweet orange cv. Mosambi. As an average of all the treatments, the juice percentage showed regular increment with each delayed harvesting. Exactly similar trend in juice percentage of Kinnow fruits was recorded by Dharampal and Saini (4).

From the above discussion, it can be concluded that GA_3 at 30ppm proved to be the most efficacious treatment among all the chemicals used, in term of improving the yield and physical characters of the fruits. However, application of triacontanol and Ca salts failed to produce any significantly positive effect on yield and quality of Kinnow fruits. Thus GA_3 at 30ppm can help in increasing the fruit yield and thus fetching the farmers more profit from their produce.

REFERENCES

1. Babu, R., Sri Hari, Rajput, C. B. S. and Rath, S. (1982). Effect of zinc, 2,4-D and gibberellic acid in Kagzi Lime (*Citrus aurantifolia* Swingle) on fruit quality. *Haryana J. Hort. Sci*., **11**(1-2) : 59-65.
2. Bhatt, A., Mishra, N.K., Mishra, D.S. and

Singh, C.P. (2012). Foliar application of potassium, calcium, zinc and boron enhanced yield, quality and shelf life of mango. *HortFlora Res. Spectrum,* **1** (4):300-305.

3. Chahal, T.S. and Bal, J.S. (2012). Effect of pre harvest treatments of calcium salts on harvest maturity in Kinnow mandarin. *HortFlora Res. Spectrum*, **1**(2):153-157.
4. Dharampal and Saini, S.P.S. (1994). Seasonal variations in fruit quality of Kinnow. *The Punjab Hort. J.,* **34**(3-4) : 6-13.
5. Dhillon, G. S., Dhatt, A.S. and Singh, S. N. (1997). Effect of bio-regulators on reduction of seed number and quality parameters in Kinnow. *J. Res. Punjab Agric. Univ.,* **34**(2) : 168-173.
6. Jindal, K. K. and Chandel, J.S. (1996). Effect of triacontanol and paclobutrazol on fruit set, growth and quality of *Prunus salicina* Lindl. *Indian J. Hort.*, **53**(4) : 262-268.
7. Kaur, H., Aulakh, P.S., Kapur, S.P. and Singh, S.N. (1990). Effect of growth regulators and micronutrients on granulation and fruit quality of sweet orange cv. Jaffa. *The Punjab Hort. J.* , **30**(1-4) : 13-19.
8. Kaur, H., Chanana, Y.R. and Kapur, S.P. (1991). Effect of growth regulators on granulation and fruit quality of sweet orange cv. Mosambi. *Indian J. Hort*., **48**(3) : 224-227.
9. Kaur, N., Monga,P.K., Thind, S.K., Vij, V.K. and Thatai, S.K. (1997). Physiological fruit drop and its control in Kinnow mandarin. *Indian J. Hort.,* **54**(2) : 132-134.
10. Krishnamoorthy, H.N. (1981). *Plant Growth Substances*. Tata McGraw Hill Publishing Company Limited, New Delhi, pp: 50-87.
11. Lima, J. E. O. and Davies, F.S. (1985). Growth regulators-fruit drop, yield and quality of Navel Orange in Florida. *J. Amer. Soc. Hort. Sci.,* **109**(1) : 81-84.
12. Mishra, D.S., Kumar, P. and Kumar, R. (2012). Effect of GA_3 and BA on fruit weight, quality and ripening of 'Rose Scented' litchi. *HortFlora Res. Spectrum*, **1** (1):80-82.
13. Pal, M. and Mishra, D.S. (2012). Extending harvesting period of litchi (*Litchi chinensis*) through chemical application. *HortFlora Res. Spectrum,* **1** (3): 235-238.
14. Roychoudhury, R., Kabir, J., Dutta, S.K. and Dhua, R.S. (1992). Effect of calcium on fruit quality of litchi. *Indian J. Hort*., **49**(1) : 27-30.
15. Saure, M. C. (2005). Calcium translocation to fleshy fruits: its mechanism and endogenous control. *Scientia Hort.,* **105** : 65-89
16. Sharma, R. M., Yamdagni, R., Gaur, H. and Sukla, R.K. (1996). Role of calcium in Horticulture – A review. *Haryana J. Hort. Sci*., **25**(4) : 205-212.
17. Sharma, R. R., Saxena, S.K., Goswami, A.M. and Shukla, A.K. (2002). Effect of foliar application of calcium chloride on fruit cracking, yield and quality of Kagzi lime. *Indian J. Hort*., **59**(2): 145-149.
18. Singh, A. K. and Rajput, C.B.S. (1988). Effect of gibberellic acid, BA and calcium on the chemical properties of fruit in mango (*Mangifera indica* L.). *The Punjab Hort. J*., **28**(3-4) : 159-163.
19. Singh, Awtar, Naqvi, S.A.M.H. and Singh, S. (2002). *Citrus Germplasm*. Kalyani Publishers, New Delhi, pp: 61
20. Singh, D. and Arora, R.L. (1997). Effect of pre-harvest sprays of zinc, boron and different sources of calcium on yield, quality and shelf life of peach cv. Flordasun. *Prog. Hort.,* **29**(1-2) : 22-27.
21. Singh, Shyam (2000). Citrus in India. *Hi-Tech Citrus Management : Proceedings of International Symposium on Citriculture.* 278-303.