HortFlora Research Spectrum, 1(2): 153-157 (2012) Online Copy ISSN : 2250-2823

EFFECT OF PRE-HARVEST TREATMENTS OF CALCIUM SALTS ON HARVEST MATURITY IN KINNOW MANDARIN

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

F.R.S. Gangian (PAU), Hoshiyarpur

[1]Department of Agriculture, Khalsa College, Amritsar, Punjab

E-mail: tanjeetchahal@yahoo.com

ABSTRACT : The present study was undertaken at Punjab Government Progeny Orchard and Nursery, Attari, Amritsar, to judge the efficacy of different levels of Calcium Chloride ($CaCl_2$) and Calcium Nitrate {$Ca(NO_3)_2$} for retaining the fruit quality during delayed harvesting. There were six chemical treatments and the experiment was replicated three times. The fruits from the trees were harvested at different stages of maturity (1st January, 15th January, 1st February and 15th February) and were subjected to physico-chemical evaluation. On the basis of two years observation, Calcium Chloride ($CaCl_2$) at 6 per cent and Calcium Nitrate {$Ca(NO_3)_2$}at 0.3 per cent proved their effectiveness in delaying the harvest maturity of the fruits. However, the TSS, total sugars and reducing sugars level of these treated fruits was find to be lower in comparison to control. The acidity level was recorded to be higher than control.

Keywords : *Calcium chloride, calcium nitrate, apparent maturity.*

In India *Citrus* is grown in an extremely varied conditions, right from arid and semi-arid areas of Rajasthen, Punjab and Haryana to humid tropical areas of north-east India, considered to be the possible place from where citrus has travelled to countries which are today claimed to have revolutionarised the art of citrus production. This has given citrus a status of most promising fruit crop which has a great scope of world trade (Singh and Srivastava, 14). Mandarins are the most prominent among citrus fruits in India. The mandarin cultivar Kinnow occupies a predominant position in Punjab and has become a highly successful commercial fruit crop.

A large plantation has been brought under Kinnow fruit crop during the last two decades in Punjab, consequently, increased production is posing serious handling problems and invites research on expanding the harvesting maturity. As the harvesting of Kinnow is confined to a limited period, market glut is the serious problem faced by the growers, which engage the attention of horticulturists to delay its harvesting period. This process can help to overcome the hurdles in further expansion and regulation of marketing. In our country, cool chain system has not developed yet which necessitates to find out alternative measures for regulated market.

The efficiency of calcium salts in checking the time of harvesting in citrus has been advocated by very few investigators. Calcium salts are known to be involved in number of physiological processes concerning membrane structure, functioning and enzyme activity. The investigations were conducted with the aim to find out the possibility of expanding the harvesting period with the help of $CaCl_2$ and $Ca(NO_3)_2$ along with their threshold levels.

MATERIALS AND METHODS

The uniform and disease free trees of Kinnow of 15 years age were selected for the investigations from 'Punjab Government Progeny Orchard' Attari, Amritsar. All the plants were applied with standard doses of fertilizers and plant protection measures as recommended by Punjab Agricultural University, Ludhiana. The pre-harvest treatments of Calcium Chloride ($CaCl_2$) 4, 6 per cent, Calcium Nitrate {$Ca(NO_3)_2$} 0.1, 0.2 0.3 per cent and control (Spray of water) were applied on 25th October during both the experimental years.

During the experiment 6 treatments were carried out. Two trees were kept as unit treatment

Received : 15.1.2012 *Accepted : 8.2.2012*

and replicated three times. The harvesting maturity of the treated trees was judged by harvesting the fruits on four different stages, viz. January 1st, January 15th, February 1st, and February 15th. The observations were recorded for TSS, Acidity, TSS: Acid ratio, total sugars and reducing sugars in relation to apparent maturity.

RESULTS AND DISCUSSION

All the calcium salt treatments showed significantly lower TSS value over control (Table 1). The minimum level of the parameter was recorded with $Ca(NO_3)_2$ at 0.3 per cent followed by $CaCl_2$ at 6 per cent. The lower TSS level in the calcium treated fruits may be due to low respiration rate which could have slowed down the conversion of starch and other polysaccharides in sugars (Mukherjee and Datta, 9). Decrease in TSS with calcium application has been observed by Sandhu *et al.* (11) in Kinnow fruits. There was a continuous increase in TSS with each delay in harvesting date. This might be due to deposition of sugars in the fruits as polysaccharides. Increased TSS was also observed with advancement of maturity by Singh *et al.* (13) in Kinnow.

The data presented in Table 2 reveal that the treatments of calcium produced fruits with higher acid content. The maximum level of acidity was observed in the fruits from the plants treated with $CaCl_2$ at 6 per cent and $Ca(NO_3)_2$ at 0.3 per cent. The higher acid content of the Kinnow fruits with calcium application may be attributed to its role in lowering membrane permeability and hence reduced respiration rate (Godara *et al.,* 4). Similar results have also been reported by Ramakrishna *et al.* (10) in papaya. As a general trend towards maturity, the acidity periodically decreased in all the treatments. Decline in acidity during ripening has also been reported in citrus by Joolka and Awasthi (6).

The significantly lower level of TSS/acid ratio than control was observed in the fruits from the treatment of $Ca(NO_3)_2$ at 0.3 per cent which was closely followed by $CaCl_2$ at 6 per cent (Table 3). The decrease in TSS/acid ratio with calcium application can be attributed to lower gap between the TSS and acid level of the fruits. The present results relating to calcium treatments corroborate the previous findings of Brahmachari *et al.* (2) in guava. The extension of harvest period at each interval resulted in a general increase in TSS/acid ratio. This increase can be attributed to regular increase of total sugars and decrease of acidity as the natural phenomenon of ripening. Similar increase in TSS/acid ratio with delayed harvesting was observed by Ladaniya (8), though the increase was non-significant.

The data in Table 4 and 5 regarding total sugars and reducing sugars, respectively depicts that all the calcium treatments registered significantly lower level of the total and reducing sugars. The $Ca(NO_3)_2$ treatment at 0.3 per cent resulted in lowest sugars content. The decrease in the sugar content of the calcium treated fruits may be attributed to the fact that calcium probably reduces the respiration rate and the hydrolysis of starch into sugars (Faust and Klein, 3). These results are in confirmation with the findings of Ramakrishna *et al.* (19) in papaya.

Delay in harvesting date recorded a continuous increase in reducing as well as total sugars of the fruits in all the treatments. This might be due to conversion of polysaccharides, the complex sugars into monosaccharides, the simple sugars. The findings of the present study are in conformity with those of Goswami *et al.* (5) and Singh *et al*. (13) in Kinnow mandarin.

$Ca(NO_3)_2$ at 0.3 per cent and $CaCl_2$ at 6 per cent played a key role in delaying the maturity as the fruits of these treatments were last to attain the maturity (Between 1st February and 15th February) amongst all the treatments (Table 6). In the rest treatments, except control, maturity stage was attained between 15th January and 1st February. The delayed maturity due to calcium has been explained by Bangerth *et al.* (1) who suggested that calcium could have reduced the endogenous substrate catabolism during respiration by limiting

Table 1: Effect of calcium salts on TSS level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	9.18	9.34	9.51	9.71	9.44
$CaCl_2$ 6%	9.08	9.21	9.40	9.50	9.30
$Ca(NO_3)_2$ 0.1%	9.23	9.44	9.55	9.74	9.49
$Ca(NO_3)_2$ 0.2%	9.17	9.42	9.53	9.71	9.46
$Ca(NO_3)_2$ 0.3%	9.08	9.22	9.36	9.46	9.28
Control	10.08	10.19	10.34	10.50	10.28
Mean	9.30	9.47	9.62	9.77	

CD(P=0.05) : Treatments (A) – 0.51; Harvesting dates (B) – 0.31; A×B – NS

Table 2: Effect of calcium salts on acidity level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	0.85	0.83	0.79	0.76	0.81
$CaCl_2$ 6%	0.88	0.85	0.82	0.79	0.84
$Ca(NO_3)_2$ 0.1%	0.85	0.82	0.79	0.77	0.81
$Ca(NO_3)_2$ 0.2%	0.87	0.83	0.80	0.78	0.82
$Ca(NO_3)_2$ 0.3%	0.89	0.85	0.82	0.80	0.84
Control	0.80	0.76	0.74	0.71	0.75
Mean	0.86	0.82	0.79	0.77	

CD (P=0.05) :Treatments (A) – 0.03; Harvesting dates (B) – 0.02; A×B – NS

Table 3: Effect of calcium salts on TSS/acid ratio of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	10.80	11.32	12.74	12.77	11.91
$CaCl_2$ 6%	10.38	10.84	11.54	12.03	11.20
$Ca(NO_3)_2$ 0.1%	10.86	11.52	12.09	12.73	11.80
$Ca(NO_3)_2$ 0.2%	10.61	11.35	11.91	12.45	11.58
$Ca(NO_3)_2$ 0.3%	10.26	10.85	11.42	11.90	11.11
Control	12.59	13.50	14.07	14.79	13.74
Mean	10.92	11.56	12.30	12.78	

CD (P=0.05) : Treatments (A) – 0.42; Harvesting dates (B) – 0.25; A×B – NS

Table 4: Effect of calcium salts on total sugars level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	5.93	6.12	6.22	6.34	6.15
$CaCl_2$ 6%	5.63	5.82	5.99	6.09	5.88
$Ca(NO_3)_2$ 0.1%	5.94	6.15	6.27	6.40	6.19
$Ca(NO_3)_2$ 0.2%	5.82	6.01	6.15	6.25	6.06
$Ca(NO_3)_2$ 0.3%	5.59	5.80	5.92	6.09	5.85
Control	6.56	6.73	6.84	6.96	6.77
Mean	5.91	6.11	6.23	6.36	

CD(P=0.05) : Treatments (A) – 0.18; Harvesting dates (B) – 0.11; A×B – NS

Table 5: Effect of calcium salts on reducing sugars level (%) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	3.03	3.05	3.09	3.16	3.08
$CaCl_2$ 6%	2.86	2.88	2.92	2.97	2.91
$Ca(NO_3)_2$ 0.1%	3.00	3.04	3.07	3.13	3.06
$Ca(NO_3)_2$ 0.2%	2.88	2.99	3.02	3.04	2.98
$Ca(NO_3)_2$ 0.3%	2.80	2.86	2.91	2.96	2.88
Control	3.33	3.36	3.39	3.43	3.38
Mean	2.98	3.03	3.06	3.12	

CD P=(0.05) : Treatments (A) – 0.09; Harvesting dates (B) – 0.06; AXB – NS.

Table 6: Effect of calcium salts on apparent fruit maturity (per cent).

Treatments	Harvesting Dates			
	1st Jan	15th Jan	1st Feb	15th Feb
$CaCl_2$ 4%	54	61	82	90
$CaCl_2$ 6%	47	54	66	84
$Ca(NO_3)_2$ 0.1%	61	67	84	98
$Ca(NO_3)_2$ 0.2%	55	59	82	91
$Ca(NO_3)_2$ 0.3%	47	56	61	88
Control	76	84	90	100

CD P=(0.05) : Treatments (A) – 0.92; Harvesting dates (B) – 0.73; AXB – NS.

the diffusion of substrate from vacuole to the cytoplasm and favoured the uptake of sorbital, thus disallowing its involvement in reactions related to internal breakdown. Jones *et al.* (7) contended that calcium controlled the disintegration of mitochondria, endoplasmic reticulum and cytoplasmic membranes and thus helped in retarding respiration rate and delaying maturity. Delay in fruit maturity with calcium application has been advocated by Sharma *et al.* (14) in Kinnow. The ascertained delay of apparent maturity by the chemical treatments can be of great utilization to prolong the harvest period thereby avoiding gluts, leading to ensured marketing for the Kinnow growers of Punjab and the adjoining states.

REFERENCES

1. Bangerth, F., Dilley, D. R. and Dewey, D. H. (1972). Effect of post-harvest calcium treatments on internal breakdown and respiration of apple fruits. *J. Amer. Soc. Hort. Sci.,* **97 :** 679-682.
2. Brahmachari, V. S., Kumar, Naresh and Kumar, Rajesh (1997). Effect of foliar feeding of calcium, potassium and growth substances on yield and quality of guava (*Psidium guajava* L.). *Haryana J. Hortic. Sci.*, **26**(3-4) : 169-173.
3. Faust, M. and Klein, J. D. (1973). Levels and sites of metabolically active calcium in apple fruits. *J. Amer. Soc. Hort. Sci.,* **99 :** 93-94.
4. Godara, A. K., Chauhan, K. S. and Kumar, Ashwani (2002). Effect of various pre-harvest treatments on the quality of Thompson Seedless grapes. *Haryana J. Hortic. Sci*. **31**(3-4) : 164-167.
5. Goswami, A.K., Shukla, H.S., Kumar, P. and Misra, D.S. (2012). Effect of pre-harvest application of micro-nutrients on quality of guava (*Psidium guajava* L.) cv. Sardar *HortFlora Res. Spectrum,* **1**(1) : 60-63.

6. Joolka, N. K. and Awasthi, R. P. (1980). Studies on maturity standards of Kinnow in Himachal Pradesh. *The Punjab Hort. J.,* **20**(3-4) : 149-151.
7. Jones, Wyn, R. G. and Lunt, O. R. (1970). The function of calcium in plants. *Bot. Rev.*, **36** : 407-423.
8. Ladaniya, M. S. (1997) Response of Nagpur mandarin fruit to pre-harvest sprays of gibberellic acid and carbendazim. *Indian J. Hort.,* **54**(3) : 205-212.
9. Mukherjee, S. K. and Dutta, M. N. (1967). Physico-chemical changes in Indian guava (*Psidium guajava* L.) during fruit development. *Curr. Sci.,* **36 :** 675-676.
10. Ramakrishna, M., Haribabu, K., Reddy, Y. N. and Purushotam, K. (2001). Effect of pre-harvest application of calcium on physico-chemical changes during ripening and storage of papaya. *Indian J. Hort.*, **58**(1) : 228-231.
11. Sandhu, S. S., Randhawa, J. S. and Dhillon, B. S. (1989). Effect of different forms of calcium, diphenylamine and bavistin on the shelf life of kinnow fruits. *Indian J. Hort.,* **46**(1-4) : 327-331.
12. Sharma, R. M., Yamdagni, R., Gaur, H. and Shukla, R. K. (1996) Role of calcium in Horticulture–A Review. *Haryana J. Hort. Sci.,* **25**(4) : 205-212.
13. Singh, H. K., Singh, S. N. and Dhatt, A. S., (1998). Studies on fruit growth and development in Kinnow. *Indian J. Hort.,* **55**(3) : 177-182.
14. Singh, Shyam and Srivastava, A.K. (2004). Citrus industry of India and overseas. *Adv. in Citriculture* : 9.