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Effect of pre-harvest application of plant growth regulators and calcium salts on biochemical and shelf life of acid lime (*Citrus aurantifolia* Swingle)

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Abstract
The present study was undertaken to investigate "Effect of pre- harvest application of plant growth regulators and calcium salts on fruit quality and shelf life of acid lime (*Citrus aurantifolia* Swingle)'' was conducted in the *Instructional cum Research Fruit Orchard*, Department of Fruit Science, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during 2017-2018. In this experiments the treatments consisting of plant growth regulators and calcium salts *i.e.* Gibberellic acid (20 ppm, 40 ppm and 60 ppm), Napthalene acetic acid (10 ppm, 15 ppm, 20 ppm), Calcium Nitrate (0.5%, 1% and 1.5%) and Calcium Chloride (1%, 1.5% and 2%). The significant results showed minimum mean Total Soluble Solids (6.82 ^{0}brix), rag percentage (45.46%), TSS: acid ratio (0.98), mean decay loss (10.48%) and maximum mean acidity (6.95%), ascorbic acid (30.49 mg/100g), percentage of marketable fruits (89.52 was recorded in treatment (T_9) (Calcium Nitrate 1.5%). compared to control after harvest during the storage period upto the 15 days.

Keywords: Acid lime, GA_3, NAA, $CaCl_2$, biochemical and quality

Introduction
Citrus are the most important fruits of the world. Citrus is cultivated widely in the tropical and sub-tropical regions. It ranks third among the sub-tropical fruits of the world (Jagtap *et al.*, 2013) [5]. Acid lime *(Citrus aurantifolia* Swingle*)* belongs to the acid group of genus citrus and its family is Rutaceae. It is also called as Kagzi lime in the northern India. The word Kagzi being derived from the world Kagaj meaning paper, as the rind of the fruit is very thin. Fruits of acid lime possess great medicinal and nutritional value. Lime is an appetizer, stomachic, antiscorbutic and anthelmintic (Shinde *et al.* 2008) [14]. It is a rich source of vitamin C and has good antioxidant properties. Fruits being acidic in nature, they are largely used for garnishing and flavouring several vegetarian and non- vegetarian dishes. Besides its value-added products like pickle, juice, squash etc., lime peel oil, peel powder are also in great demand in soap and cosmetic industry (Debaje *et al*., 2008) [3].

Citrus exceeds most other fruits in productivity and is highly remunerative. However, these acid lime orchards are declining in their fruit quality and self life. There is an urgent need for an alternative pre-harvest treatment to attain long term sustainability for fruit quality and shelf life. Under agro-climatic conditions of Madhya Pradesh, acid lime bears two crops in a year. Winter season crop, though good in quality and needs prolong storability. However, large quantity of fruit is lost after harvest due to inherent bio-chemical changes. In recent years, plant growth regulators (GA_3, NAA, 2,4-D) have been used for improving the quality, delaying deterioration in storage and thereby increasing shelf life of various fruit crops (Lal *et al*., 2015) [9].

GA_3 increases the fruit length, fruit diameter; fruit weight ultimately the yield was increased. NAA checking the fruit drops and increasing the fruit retention and also increasing the fruit weight and TSS of the fruits (Shinde *et al*., 2008) [14]. However, due to the high cost of plant growth regulators, it is imperative to find out some other {$Ca(NO_3)_2$, $CaCl_2$, $ZnSO_4$, KNO_3} chemicals which can be used with combination of PGR's to improve the shelf life and fruit quality. Some chemicals like calcium compounds with combination of PGR's reported to prolong shelf life by affecting the wide range of physiological processes in plants and also inhibit specific aspects of abnormal senescence in kinnow mandarin fruits (Chahal *et al*., 2012) [2].

The use of Ca compounds also enhance the shelf life of fresh fruits by reduction in respiration rate, delayed ripening, protein breakdown, reduced decay losses and disease incidence.

Calcium compound have shown promise in the quality retention of fruit also. (Sonkar and Ladaniya, 1999) [15].

Materials and Methods

In this investigation the pre harvest spray consist of Gibberelic Acid (GA_3), Napthalene acetic acid (NAA), Calcium nitrate ($Ca(NO_3)_2$) and Calcium chloride ($CaCl_2$). The experiment has 13 treatment including control. The details of the treatment which were compared among themselves during the period of experiment are given in Table-1. Bio-growth regulator GA_3, NAA and calcium salts were weight out according to required concentrations. Weighed calcium salts were first dissolved in small known quantity of distilled water and then volume is made up to required quantity by the distilled water for spray. For bio-growth regulator GA_3, NAA weighed quantity first dissolved in small amount of ethanol, after dissolving the volume is made up by distilled water as required for spray. Prepared solution of GA_3, NAA, $Ca(NO_3)_2$, $CaCl_2$ used for foliar spray as per treatment. First spray was done at Marvel stage and same spray was repeated after 20 days of the first spray. Spraying was started during early clear sunny morning and completed on the same day.

Table 1: Details of the treatments

S. No.	Treatments Notation	Treatments
1.	T_0	Control (Water spray)
2.	T_1	Gibberellic acid @ 20 ppm
3.	T_2	Gibberellic acid @ 40 ppm
4.	T_3	Gibberellic acid @ 60 ppm
5.	T_4	Napthalene acetic acid @10 ppm
6.	T_5	Napthalene acetic acid @15 ppm
7.	T_6	Napthalene acetic acid @20 ppm
8.	T_7	Calcium nitrate @ 0.5 %
9.	T_8	Calcium nitrate @ 1 %
10.	T_9	Calcium nitrate @ 1.5 %
11.	T_{10}	Calcium chloride @ 1%
12.	T_{11}	Calcium chloride @ 1.5%
13.	T_{12}	Calcium chloride @ 2%

Result and Discussion

It is clear from the data on quality and shelf life (Table 2 and 3) that various pre- harvest spray of phytohormone and calcium salts concentrations on biochemical and shelf life of acid lime gave significant variation in biochemical parameters. The data revealed that the significant minimum mean Total Soluble Solids (6.82 ^{0}brix), rag percentage (45.46%), TSS: acid ratio (0.98), mean decay loss (10.48%) and maximum mean acidity (6.95%), ascorbic acid (30.49 mg/100g), percentage of marketable fruits (89.52 was recorded in treatment (T_9) (Calcium Nitrate 1.5%). compared to control after harvest during the storage period upto the 15 days. The increase of TSS during storage might be due to the breakdown of complex polymers into simple substances by hydrolytic enzymes. Similar results had also been reported by Marzouk and Kassem (2011) [11] in navel orange, Chahal *et al*. (2012) [2], Kaur and Kumar (2014) [7] and Lal *et al.* (2015) [9] in kinnow mandarin. The production of fruits with lesser percentage of rag by the application of Calcium salts might be due to the increase in percentage of juice which is inversely proportional to the reduced rind thickness. Malaka and Bondak (1997) reported that application of NAA (500 ppm) had no effect on peel content of Balady mandarins. The decrease in acidity with Calcium Nitrate has also been reported in kinnow mandarin fruits by Chahal *et al.* (2012) [2], Kaur and Kumar (2014) [7], and Lal *et al.* (2015) [9]. It was obvious that the TSS content increased, while acidity decreased resulting in an increase in the TSS: acid ratio, during storage after fruit harvest. During the storage it was observed that there was a gradual increase in brix acid ratio during the period of storage in all the treatments. It might be due to inhibitory effect of chemical on enzyme responsible for degradation of acidity of fruit and also conversion of acids into sugars during the process of ripening. Abharam (2004) [1]. Calcium Nitrate treatment maintained the ascorbic acid content of fruits compared to control fruits. This might be a result of continued synthesis of L- ascorbic acid from its precursor glucose-6-phosphate and additive effect of slow rate of oxidation in respiration process. On contrast the decrease in ascorbic acid with calcium Nitrate has been reported in guava fruit by Jayachandran *et al*. (2004) [1]. Similar finding had been reported by kumar *et al*. (2005) [8] in anola fruits, Mahajan and Singh (2003) [10] and Ray *et al.* (2005) [13] in litchi fruits. The higher percentage of marketable fruits was obtained only when there was reduced loss in weight, spoilage and quality of the fruits with respect to chemical constituents. The significant impact of calcium nitrate on maintaining marketable fruits and edible quality of fruits have been reported by Marzouk and Kassem (2011) [11] in oranges. The reduction in the water loss and slowed ripening of fruits turn to higher shelf life Patel *et al.* (2015) [12] in mango. Rotting caused due to infection by fungus, mainly *Psedomos syringae and Penicillium digitatum* makes the fruit soft and affected fruits develop bad odour**.** The spray of GA_3, and Calcium Nitrate might have imparted some resistance to the fruit against the pathogens, which resulted in least decay loss. Rotting of fruits increased with the advancement of storage period Chahal *et al*. (2012) [2]. The role of calcium and GA_3 in reducing decay loss has been reported in navel orange by Marzouk and Kassem (2011) [11] and Goswami *et al.* (2012) [4] in guava.

Table 2: Effect of pre-harvest application of plant growth regulators and calcium salts on biochemical and shelf life of acid lime at different stages.

Treatments		Rag (%) per fruit					TSS (^{0}Brix)						Acidity (%)			
		0	5th	10th	15th	Mean	0	5th	10th	15th	Mean	0	5th	10th	15th	Mean
T_0	Control	53.98	54.74	56.17	58	55.73	7.73	7.99	8.46	8.72	8.23	6.63	6.57	5.93	5.77	6.23
T_1	Gibberellic acid@ 20ppm	49.58	50.55	51.74	53.27	51.29	7.77	7.93	8.13	8.37	8.05	6.53	6.47	6.33	6.15	6.37
T_2	Gibberellic acid@ 40ppm	47.42	47.74	49.38	51.53	49.02	7.6	7.67	7.9	8.2	7.84	6.62	6.5	6.33	6.18	6.41
T_3	Gibberellic acid@ 60ppm	45.95	46.76	47.77	50.64	47.78	7.47	7.6	7.94	8.28	7.82	6.68	6.62	6.55	6.38	6.56
T_4	Napthalene acetic acid@ 10ppm	51.53	52.94	53.03	55.25	53.19	7.8	8.03	8.32	8.55	8.18	6.53	6.38	6.29	6.13	6.33
T_5	Napthalene acetic acid@ 15ppm	49.54	50.42	52.21	54.22	51.6	7.67	7.92	8.2	8.53	8.08	6.51	6.45	6.29	6.16	6.35
T_6	Napthalene acetic acid@ 20ppm	48.31	48.73	50.56	51.67	49.82	7.77	7.87	8.03	8.4	8.02	6.56	6.43	6.31	6.18	6.37
T_7	Calcium Nitrate @0.5%	45.94	46.6	48.31	50.02	47.72	7.33	7.6	7.93	8.28	7.79	6.77	6.7	6.61	6.41	6.62
T_8	Calcium Nitrate @ 1%	43.86	44.78	46.28	48.28	45.8	7.07	7.37	7.77	8.1	7.57	6.86	6.83	6.82	6.72	6.81
T_9	Calcium Nitrate @1.5%	43.85	44.81	45.68	47.51	45.46	6.47	6.67	6.92	7.24	6.82	7.20	7.04	6.83	6.75	6.95

T_{10}	Calcium chloride @ 1%	46.96	47.96	48.93	50.92	48.69	7.53	7.73	7.89	8.18	7.84	6.65	6.55	6.42	6.26	6.47
T_{11}	Calcium chloride @ 1.5%	45.9	46.45	48.24	49.8	47.6	7.47	7.67	7.83	8.15	7.78	6.93	6.84	6.67	6.52	6.74
T_{12}	Calcium chloride @ 2%	45.04	45.89	46.74	49.19	46.72	7.27	7.57	7.83	8.01	7.67	6.87	6.82	6.78	6.63	6.78
	S. Em. ±	1.425	1.324	1.161	1.516		0.231	0.218	0.227	0.195		0.129	0.132	0.169	0.185	
	CD at 5% level	4.161	3.866	3.389	4.427		0.674	0.639	0.664	0.571		0.378	0.385	0.495	0.542	

Table 3: Effect of Pre-harvest application of plant growth regulators and calcium salts on biochemical and shelf life of acid lime at different stages

	TSS: acid ratio					**Ascorbic acid**					**Marketable fruits (%)**				**Decay loss (%)**			
Treatments	**0**	**5^{th}**	**10^{th}**	**15^{th}**	**Mean**	**0**	**5^{th}**	**10^{th}**	**15^{th}**	**Mean**	**5^{th}**	**10^{th}**	**15^{th}**	**Mean**	**5^{th}**	**10^{th}**	**15^{th}**	**Mean**
T_0	1.17	1.22	1.43	1.51	1.33	26.62	26.19	25.58	24.88	25.82	92.67	74.78	61.77	82.3	7.33	25.22	38.23	17.7
T_1	1.19	1.23	1.28	1.36	1.27	28.82	28.66	28.23	27.11	28.2	94.72	81.63	69.25	86.4	5.28	18.37	30.75	13.6
T_2	1.15	1.18	1.25	1.33	1.23	28.94	28.8	28.22	27.49	28.36	95.43	82.19	69.49	86.78	4.57	17.81	30.51	13.22
T_3	1.12	1.15	1.22	1.3	1.2	29.5	29.27	28.63	27.96	28.84	95.91	83.23	70.06	87.3	4.09	16.77	29.94	12.7
T_4	1.19	1.26	1.32	1.4	1.29	28.07	27.91	27.52	26.9	27.6	94.11	80.63	65.11	84.96	5.89	19.37	34.89	15.04
T_5	1.18	1.23	1.3	1.39	1.28	27.99	27.71	27.19	26.31	27.3	94.33	81.57	68.63	86.13	5.67	18.43	31.37	13.87
T_6	1.19	1.22	1.27	1.36	1.26	28.9	28.7	28.19	27.49	28.32	94.81	82.03	69.34	86.55	5.19	17.97	30.66	13.45
T_7	1.09	1.14	1.2	1.3	1.18	29.59	29.4	28.81	27.97	28.94	96.4	83.34	70.59	87.58	3.6	16.66	29.41	12.42
T_8	1.03	1.08	1.14	1.21	1.11	30.95	30.69	29.87	29.08	30.14	97.26	85.29	74.18	89.18	2.74	14.71	25.82	10.82
T_9	0.9	0.95	1.01	1.07	0.98	31.19	30.92	30.33	29.51	30.49	97.6	85.68	74.82	89.52	2.4	14.32	25.18	10.48
T_{10}	1.13	1.18	1.23	1.31	1.21	29.4	29.21	28.72	27.95	28.82	96.29	83.33	70.25	87.47	3.71	16.67	29.75	12.53
T_{11}	1.08	1.12	1.18	1.25	1.16	29.92	29.66	28.97	28.09	29.16	96.81	84.07	72.63	88.38	3.19	15.93	27.37	11.62
T_{12}	1.06	1.11	1.16	1.21	1.14	30.26	30.05	29.34	28.61	29.57	97.1	84.44	72.64	88.54	2.9	15.56	27.36	11.46
S. Em. ±	0.043	0.034	0.046	0.05		0.84	0.773	0.629	0.574		0.703	1.864	1.916		0.703	1.864	1.916	
CD at 5% level	0.125	0.098	0.135	0.146		2.452	2.256	1.836	1.677		2.053	5.441	5.591		2.053	5.441	5.591	

Conclusion

On the basis of results obtained in the present investigation, it can be concluded that pre-harvest application of plant growth regulators and calcium salts (Gibberellic acid, Napthalene acetic acid, Calcium Nitrate and Calcium Chloride) alone might be used for extending post-harvest shelf life and biochemical quality parameters of acid lime during storage. Out of these of PGRs and calcium salts (*i.e.* Gibberellic acid, Napthalene acetic acid, Calcium Nitrate and Calcium Chloride), Calcium Nitrate 1.5% was found more beneficial as compared to others.

References

1. Abraham AM. Growth, developent and post harvest behaviour in fruit of acid lime (*Citrus aurantifolia* Swingle) as influenced by pre-harvest of certain minerals and growth regulatores. Thesis deaprtment of horticulture, S.V. Agriculture College, Tirupati, Acharya N.G.Ranga Agri. University, Hyderabad, 2004, 101-111.
2. Chahal TS, Bal JS, Kour K. Effect of foliar feeding of GA3, Triacontanol and calcium salts on shelf-life in Kinnow mandarin. Ind. J Eco. 2012; 39(1):23-26.
3. Debaje PP, Shinde Ekta D, Ingale HV. Effect of plant growth regulators and nutrients on quality of acid lime (*Citrus aurantifolia* Swingle). Asian J Horti. 2011; 6(1):253-255.
4. Goswami AK, Shukla HS, Kumar P, Mishra DS. Effect of pre-harvest application micro-nutrients on quality of guava cv. Sardar. Hort. Flora Res. Spectrum 2012; 1(1):60-63.
5. Jagtap VM, Patel HC, Nehete DS, Godage SS. Effect of foliar application of plant growth regulators and micronutrients on yield and quality of acid lime cv. Kagzi (*Citrus aurantifolia* Swingle). Asian J Horti. 2013; 8(1):57-59.
6. Jayachandran KS, Srihari D, Reddy YN, Rao CLN. Influence of post-harvest calcium treatment on storage quality of Lucknow-49 guavas. Crop Res. (Hisar). 2004; 28(1/3):60-62.
7. Kaur N, Kumar A. Impact of post harvest treatments on shelf life of Kinnow mandarin International Journal of Advanced Research. 2014; 2(5):290-295.
8. Kumar S, Kumar A, Baig MG, Chaubey BK. Effect of calcium on physico-chemical changes in aonla (*Embilica officinalis* Gaertn) fruits. Indian. J Hort. 2005; 62(4):324-326.
9. Lal Deppa, Tripathi VK, Kumar S, Nayyer Abu. Effect of pre-harvest application of gibberellic acid, NAA, and calcium nitrate on fruit drop, maturity and storage quailty of kinnow mandarin. Res. Environ. Life Sci. 2015; 8(4):561-564.
10. Mahajan BVC, Dhall AS, Dhall RK, Sharma RC. Effect of sulphur dioxide fumigation on the colour retention sand quality of litchi cv. Calcuttia during old storage. Haryana J Hort. Sci. 2003; 32:47-49.
11. Marzouk HA, Kassem HA. Extending harvest season and enhancing shelf life of navel oranges by preharvest treatments with different bioregulators. American Eurasian J Agri. Env. Sci. 2011; 10(3):396-403.
12. Patel Urvish, Varu DK, Chaudhari J. Effect of pre-harvest spray of chemicals on shelf life and quality oh mango *cv*. kesar. The Asian J of Hort. 2015; 10(2):187-193.
13. Ray PK, Ruby R, Singh SK. Effect of sulphur dioxide fumigation and low temperature storage on post harvest browning and quality of litchi fruits. Food Sci. Tech. 2005; 42:226-230.
14. Shinde BB, Ingle HV, Dhawale DU, Hajare AR, Dhobe SG. Effect of plant growth regulators on size, yield and quality of acid lime. J Soil & Crops. 2008; 18(1):117-120.
15. Sonkar RK, Ladaniya MS. Effect of pre-harvest spray of ethephon, calcium acetate and carbendazim on rind colour, abscisson and shelf life of Nagpur mandarin. Indian J Agri. Sci. 1999; 69:130-135.