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Effect of ultra-violet radiation, cytokinin and vapor gard on postharvest shelf life of kagzi lime (*Citrus aurantifolia* Swingle)

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Abstract

In order to study the effect of post harvest treatment *viz.*, cytokinin and vapor gard on shelf life of kagzi lime, uniformly matured fruits, stored at room temperature (20º C to 28.5º C) were exposed to different treatments. Among the different postharvest treatments UV radiation 5 min + BAP 100 ppm + vapor gard 4% was found most effective in reducing the physiological loss in weight (PLW), decay, reduction in diameter and juice content of lime fruits up to 24 days of storage.

Keywords: Kagzi lime, *Citrus aurantifolia*, ultra-violet radiation, cytokinin, vapor gard, postharvest shelf life

Introduction

The lime fruit has its own importance as it has several uses for culinary, beverage, industrial and medicinal purpose. The high acceptability is due to attractive colour and distinctive flavour and the fact that they are rich source of vitamin "C". Like most other fruits lime is seasonal and perishable in nature. It is also subjected to spoilage due to glut in the market. The post harvest deterioration of fruit occurs as a result of endogenous biochemical and physiological changes, microbiological and insect spoilage, dehydration and mechanical injury. Inadequate infrastructure for storage and improper handling of the produce during packing, transport, storage and marketing also causes considerable damage. Thus, the retention of quality of fruit for longer period is one of the most important aspects of postharvest handling and storage of fruit. Among the various plant growth regulators, cytokinins have been found very effective in prolonging the shelf life of fruits and vegetables (Ram Kishan and Godara, 1994).

Similarly, vapor gard (antitranspirant concentrate), a water emulsifiable organic concentrate is used to retard water transpiration from fruits. The active ingredient in this product is pinolene (di-1-p-menthene). The application of vapor gard to freshly harvested healthy and mature fruits and vegetables protects them against excessive moisture loss by formation of clear, glossy and protective film. As a result, texture and quality of the fresh produce is maintained as near the fresh condition for a long time.

More recently, the use of ultra-violet radiation on fruits was found to be promising alternative as postharvest treatment and quality was better at the end of storage (Hallewin *et al.*, 1993). However, no such work has been reported in case of Kagzi lime. Thus, present studies were undertaken to see the effect of these postharvest treatments on shelf life of Kagzi lime.

Materials and methods

The experiment was conducted at Department of Horticulture, Rajasthan College of Agriculture, Udaipur during the month of October and November, 1998 at the room temperature (20^{0}C to 28.5^{0}C). Fresh, fully ripe and uniform fruits of kagzi lime were selected, thoroughly washed with tap water and placed in different treatment after initial physico-chemical analysis. Three levels of UV radiation (0, 5 and 10 minutes), three levels of BAP (0, 50 and 100 ppm) and two levels of vapor gard (0 and 4%) and their combinations were tested. The observations were recorded on 4, 8, 12, 16, 20 and 24 days after treatment.

Physiological loss in weight and decay loss was estimated on weight basis as described by Srivastava and Tandon (1968). The diameter of fruit was measured prior to storage with the help of Vernier's callipers. Reduction in diameter was expressed as percentage on the basis of original diameter of fresh fruit. The juice of the fruit was extracted by cone electric juice extractor. It was strained, weighed and expressed on percentage basis.

The experiment was laid out in factorial CRD design. PLW, decay loss, reduction in diameter and juice content were analysed separately on each day of storage and expressed as cumulative loss.

Results and discussion

Physiological loss in weight: It is evident from the data, that the loss in weight of fruits increased with the advancement of storage period. On an average, highest weight loss of 15.28 per cent was recorded on 24th day of storage (Table 1). Different treatments significantly reduced the loss in weight over control during the storage. The mean maximum loss in weight of 12.55 per cent was recorded in control whereas, minimum was 5.32 per cent in $R_1G_2V_1$ treatment which was closely followed by $R_2G_2V_1$ (5.70%).

UV radiation significantly reduced PLW during storage period. This may be due to reduction in utilization of reserve food material in the process of respiration (Dharkar *et al.*, 1966). Similarly, the reduction in weight loss as a result of BAP treatment may be due to the fact that cytokinin slow down the process of senescence, rate of respiration, ethylene production and ripening (Wade and Brady, 1971).

Table 1. Effect of ultra-violet radiation, benzylaminopurine and vapor gard on physiological loss in weight (PLW) of Kagzi Lime fruits during storage

Treatments	Storage period						Mean
	4	8	12	16	20	24	
$R_0G_0V_0$	2.70	5.20	10.85	15.35	18.35	22.83	12.55
$R_0G_0V_1$	1.95	4.22	8.11	11.42	15.19	18.82	9.95
$R_0G_1V_0$	1.47	4.32	8.34	12.35	16.45	19.75	10.45
$R_0G_1V_1$	1.89	4.24	7.95	11.32	13.22	18.22	9.47
$R_0G_2V_0$	1.73	4.42	7.32	12.45	13.85	18.42	9.70
$R_0G_2V_1$	1.86	4.11	6.13	10.54	12.54	17.33	8.75
$R_1G_0V_0$	2.06	4.13	5.11	11.12	11.19	17.11	8.45
$R_1G_0V_1$	1.96	4.03	6.99	9.19	11.44	14.56	8.03
$R_1G_1V_0$	1.87	3.84	6.81	9.44	11.24	15.80	8.16
$R_1G_1V_1$	1.36	3.73	6.51	9.24	11.12	13.13	7.57
$R_1G_2V_0$	1.42	3.94	6.72	9.72	11.72	13.12	7.77
$R_1G_2V_1$	0.63	1.65	3.81	7.51	8.51	9.81	5.32
$R_2G_0V_0$	1.60	3.45	6.71	11.64	12.80	13.83	8.33
$R_2G_0V_1$	1.39	2.35	5.65	10.89	12.42	13.42	7.69
$R_2G_1V_0$	1.03	2.81	6.63	9.59	10.59	13.26	7.32
$R_2G_1V_1$	1.13	2.92	5.45	9.42	10.42	12.42	6.96
$R_2G_2V_0$	1.21	2.90	5.62	9.62	10.62	12.62	7.10
$R_2G_2V_1$	0.72	1.82	4.65	7.65	8.753	10.64	5.70
Mean	1.56	3.56	6.63	10.47	12.24	15.28	

	Treatments (T)	Storage days (D)	T X D
CD (p = 0.05)	0.25	0.15	0.62

R_0 - Ultra-violet radiation 0 minute G_0 -Benzylaminopurine 0 ppm
R_1 - Ultra-violet radiation 5 minute G_1 - Benzylaminopurine 50 ppm
R_2 - Ultra-violet radiation 10 minute G_2 - Benzylaminopurine 100 ppm
V_0 - 0% Vapor gard V_1 - 4% Vapor gard

Likewise, the reduction in weight loss in vapor gard treated fruits can be attributed to effect of treatment on water loss from fruit surface through the partial film which inhibits transpiration (Trout *et al.*, 1953).

Decay loss: The decay loss was significantly affected by various postharvest treatments. The mean highest decay loss of 17.29 per cent was recorded in control, which was significantly higher over all other treatments. However, none of fruits in $R_1G_2V_1$ and $R_2G_2V_1$ treatments exhibited rotting during the period of storage indicating that these treatments are significantly superior among all the treatments (Table 2).

The reduction in decay loss, as a result of UV radiation may be due to ionizing radiation caused morphological abnormalities as well as genetic mutation and altered physiology of pathogen leading to death (Atwood and Pittenger, 1955 and Burns, 1955).

Similarly, the decay loss of fruits was also reduced by the application of BAP. This might be due to retardation of senescence (Lipton and Ceponis, 1962). Similar results were recorded by Wade and Brady (1971) and Rao and Chundawat (1984) in banana.

The application of vapor gard, as a coating material reduced the decay loss by providing a protective covering which resulted reduced rate of respiration and microbial activity, responsible for rotting. These findings are in confirmity with those of Lazen *et al.* (1989) in mango and Soni *et al.* (1972) in banana.

Reduction in diameter: It is evident from the data, that the rate of reduction in diameter was significantly affected as a result of various treatments during storage. The mean maximum reduction in diameter (13.15%) was recorded in control, while it was minimum (4.67%) in $R_2G_2V_1$ followed by $R_1G_2V_1$ (4.67%). However, the difference between these two treatments was found

Table 2. Effect of ultra- violet radiation, benzylaminopurine and vapor gard on decay loss (%) of Kagzi lime fruits during storage

Treatments	Storage days						Mean
	4	8	12	16	20	24	
$R_0G_0V_0$	0.0 (0.0)	4.53 (12.28)	16.35 (23.84)	26.51(30.98)	36.59 (37.20)	46.64 (43.05)	17.29 (24.56)
$R_0G_0V_1$	0.0 (0.0)	1.14 (6.14)	4.53 (12.28)	10.00 (18.42)	13.10 (21.13)	16.35 (23.84)	5.56 (13.63)
$R_0G_1V_0$	0.0(0.0)	0.0 (0.0)	1.14 (6.14)	4.53 (18.42)	10.00 (18.42)	16.35 (23.84)	3.08 (10.11)
$R_0G_1V_1$	0.0 (0.0)	0.0 (0.0)	1.14 (6.14)	1.14 (6.14)	4.53 (12.28)	13.01 (21.13)	1.75 (7.61)
$R_0G_2V_0$	0.0 (0.0)	1.14 (6.14)	10.0 (18.42)	13.01(21.13)	16.35 (23.84)	26.51 (30.98)	8.31 (16.75)
$R_0G_2V_1$	0.0 (0.0)	0.0 (0.0)	1.14 (6.14)	4.53 (12.28)	10.0 (18.42)	16.35 (23.84)	3.08 (10.1)
$R_1G_0V_0$	0.0 (0.0)	1.14 (6.14)	4.53 (12.28)	10.0(18.42)	13.01(21.13)	20.00(26.55)	5.93(14.09)
$R_1G_0V_1$	0.0 (0.0)	1.14 (6.14)	1.14 (6.14)	4.53 (12.28)	10.01 (18.42)	16.35 (23.84)	3.73 (11.14)
$R_1G_1V_0$	0.0 (0.0)	0.0 (0.0)	0.0 (0.6)	4.53 (12.28)	10.00(18.42)	16.35(25.84)	2.49(9.09)
$R_1G_1V_1$	0.0 (0.0)	0.0 (0.0)	0.0(0.0)	1.14(6.14)	4.53(12.28)	16.35(23.84)	1.50(7.04)
$R_1G_2V_0$	0.0(0.0)	0.0 (0.0)	1.14(6.14)	4.53(12.28)	10.00(18.42)	16.35(23.84)	3.08(10.11)
$R_1G_2V_1$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
$R_2G_0V_0$	0.0 (0.0)	0.0 (0.0)	1.14(6.14)	4.53(12.28)	10.00(18.42)	16.35(23.84)	3.08(10.11)
$R_2G_0V_1$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.14(6.14)	4.53(12.28)	10.00(18.42)	1.14(6.14)
$R_2G_1V_0$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.14(6.14)	4.53(12.28)	13.01(21.13)	1.31(6.59)
$R_2G_1V_1$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.14(6.14)	10.00(18.42)	0.51(4.09)
$R_2G_2V_0$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.14(6.14)	4.53(12.28)	16.35(23.84)	1.58(7.04)
$R_2G_2V_1$	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Mean	0.0 (0.0)	0.12 (2.04)	1.00 (5.76)	3.47 (10.74)	7.27(15.63)	13.93(21.90)	

	Treatments (T)	Storage days (D)	T X D
CD (p= 0.05)	3.876	2.23	9.493

Table 3. Effect of ultra- violet radiation, benzylaminopurine and vapor gard on reduction in diameter (%) of Kagzi lime fruits during storage

Treatments	Storage days						Mean
	4	8	12	16	20	24	
$R_0G_0V_0$	3.80 (11.24)	8.08 (16.51)	11.89 (20.17)	14.85 (22.65)	19.90 (26.48)	25.71 (30.45)	13.15 (21.25)
$R_0G_0V_1$	1.97 (8.08)	6.90 (15.23)	8.89 (17.34)	11.83 (20.11)	14.57(22.43)	19.88 (26.47)	9.84 (18.27)
$R_0G_1V_0$	1.31 (6.56)	7.24 (15.60)	9.69 (18.13)	12.99 (21.11)	15.25 (22.97)	20.90 (27.19)	10.18 (18.59)
$R_0G_1V_1$	1.29 (6.54)	6.81 (15.120	8.76 (17.21)	11.66 (19.96)	14.55 (22.42)	19.41 (26.13)	9.45 (17.90)
$R_0G_2V_0$	1.13 (6.10)	6.55 (14.82)	9.39(17.84)	11.67(19.97)	14.81 (22.62)	18.80 (25.68)	9.39 (17.84)
$R_0G_2V_1$	0.93 (5.55)	5.68 (13.78)	8.81 (17.25)	10.89(19.26)	15.44 (23.13)	20.18 (26.68)	9.16 (17.61)
$R_1G_0V_0$	0.91 (5.48)	4.15 (11.74)	7.2 (15.55)	11.81(20.09)	13.75 (21.76)	18.55 (25.50)	8.25 (16.69)
$R_1G_0V_1$	0.27 (3.01)	3.82 (11.27)	6.99 (15.33)	9.79 (18.23)	13.99 (21.96)	16.79 (24.18)	7.29 (15.66)
$R_1G_1V_0$	0.0 (0.0)	3.94 (11.44)	6.85 (15.16)	10.60 (18.99)	13.79 (21.79)	17.73 (24.89)	7.04 (15.38)
$R_1G_1V_1$	0.0 (0.0)	3.44 (10.68)	6.79 (15.10)	9.28 17.73)	12.92 (21.06)	16.66 (24.08)	6.51 (14.77)
$R_1G_2V_0$	0.0 (0.0)	3.52 (10.81)	6.67 (14.97)	9.64(18.08)	13.21 (21.30)	18.04 (25.12)	6.74 (15.05)
$R_1G_2V_1$	0.0(0.0)	2.60 (9.29)	4.75 (12.59)	6.15 (14.36)	9.33 (17.78)	13.53 (21.57)	4.76 (12.60)
$R_2G_0V_0$	0.0 (0.0)	3.75 (11.16)	6.75 (15.06)	9.19 (17.64)	12.19 (20.43)	16.61 (24.04)	6.46 (14.72)
$R_2G_0V_1$	0.0 (0.0)	3.44 (10.68)	5.74 (13.86)	8.32 (16.76)	11.39 (19.71)	15.51 (23.18)	5.88 (14.03)
$R_2G_1V_0$	0.0 (0.0)	3.11 (10.15)	6.24 (14.46)	8.80 (17.25)	12.02 (20.28)	16.18 (23.71)	6.11 (14.31)
$R_2G_1V_1$	0.0 (0.0)	3.90 (11.39)	5.85 (14.00)	8.09 (16.52)	11.16 (19.51)	15.63 (23.28)	5.95 (14.12)
$R_2G_2V_0$	0.0 (0.0)	3.12 (10.17)	6.25 (14.49)	8.55 (17.00)	11.87 (20.14)	15.74 (23.36)	6.01 (14.19)
$R_2G_2V_1$	0.0 (0.0)	2.49 (9.08)	4.71 (12.53)	6.01 (14.18)	9.25 (17.70)	13.33 (21.40)	4.67 (12.48)
Mean	0.26 (2.92)	4.44 (12.16)	7.25 (15.61)	9.89 (18.33)	13.21 (21.30)	17.65 (24.83)	
		Treatments (T)	Storage days (D)		T X D		
CD (p= 0.05)		0.09634	0.05562		0.236		

Table 4. Effect of ultra- violet radiation, beneylaminopurine and vapor gard on juice content (%)* of Kagzi lime fruits during storage.

Treatments	Storage days						Mean
	4	8	12	16	20	24	
$R_0G_0V_0$	50.67	48.77	45.61	43.02	40.11	37.04	44.20
$R_0G_0V_1$	52.21	50.31	48.31	46.41	44.21	42.51	47.33
$R_0G_1V_0$	51.91	49.85	47.82	44.90	42.11	40.92	46.25
$R_0G_1V_1$	52.50	50.61	48.72	46.62	44.52	42.82	47.63
$R_0G_2V_0$	51.51	49.50	47.52	45.72	43.22	41.21	46.44
$R_0G_2V_1$	52.97	50.87	48.92	46.99	44.82	42.98	47.92
$R_1G_0V_0$	52.11	50.11	48.03	46.11	44.29	42.86	47.25
$R_1G_0V_1$	53.91	51.82	49.72	47.80	45.62	43.52	48.75
$R_1G_1V_0$	52.81	50.81	48.61	46.50	44.71	42.61	47.67
$R_1G_1V_1$	53.83	51.83	49.92	47.82	45.92	43.82	48.86
$R_1G_2V_0$	52.91	50.91	48.90	46.83	43.80	41.57	47.49
$R_1G_2V_1$	55.63	53.63	51.73	49.53	47.72	45.90	50.69
$R_2G_0V_0$	53.22	51.21	49.33	47.53	45.23	43.13	48.27
$R_2G_0V_1$	55.03	53.11	51.02	49.11	47.24	45.24	50.12
$R_2G_1V_0$	54.11	52.22	50.23	48.50	46.21	44.42	49.28
$R_2G_1V_1$	54.80	52.95	50.99	49.21	46.62	44.87	49.90
$R_2G_2V_0$	53.63	51.73	49.81	47.72	45.41	43.50	49.30
$R_2G_2V_1$	56.22	54.22	52.44	50.04	48.12	47.05	51.35
Mean	53.33	51.58	49.31	47.24	44.99	43.11	
		Treatments (T)	Storage days (D)		T X D		
CD (p = 0.05)		0.49	0.28		1.20		

* Juice content was 58.85% at 0 day

to be non-significant (Table 3). This reduction in diameter of the fruits, as a result of advancement in storage period is associated with weight loss at reduced rate.

Juice content: After 24 days of storage, the mean maximum reduction in juice content (58.85 to 44.20) was recorded in control ($R_0G_0V_0$). However, the minimum reduction was recorded in $R_2G_2V_1$ *i.e.*, from 58.85 to 51.35%. This was closely followed by $R_1G_2V_1$ (50.69%) (Table 4). The higher retention of juice as a result of UV radiation may be due to the fact that this treatment was able to effectively check the loss of moisture from the fruits. Similarly, the influence of vapor gard can be attributed to effect of treatment on reducing water loss from fruit surface through the partial film which inhibits transpiration (Trout *et al.*, 1953).

References

Atwood, K.C and T.H. Pittenger, 1955. X-ray induced mutations in growing mycelium of *Neurospora*. *Radiation Research,* 3:212.

Burns, V.W. 1955. X-ray induced division delay of individual yeast cells. *Radiation Research*, 3:217.

Dharkar S.D., A.N. Srirangarajan and A. Sreenivasan, 1966. Radiation of managoes II. Radiation effects on skin coated Alphonso mangoes. *J. Food Sci.,* 31:870-877.

Hallewin, D., G. Arras, T. Casita and A. Piga, 1993. Reducing of guava mandarin fruits by the use of ultra-violet heat and thiobendazole treatments. In International Symposium on Postharvest Treatment of horticultural crops. *Kecskemet Hungry*, 30th Aug.-3rd sept. 1993. *Acta Hortic*., 368:236-238.

Lazen, H., Z.M. Ali and H.A. Soni, 1989. Effect of vapor gard on polygalacturonase, malic enzymes and ripening of Harumanis mango. *Acta Hort*ic., 269:359-366.

Lipton, W.J. and M.J.Ceponis, 1962. *Proc. Amer. Soc. Hort. Sci.,* 81:379.

Ram Kishan and N.R.Godara, 1994. Physical and chemical parameters as influenced by post-harvest treatment of different chemical on the shelf life of Gola ber (*Zizyphus mauritiana* Lamk) fruits. *Haryana Agril. Univ. J. Res*., 24 (2/3):111-114.

Rao D.V.R. and B.S. Chundawat, 1984. A note on retardation of ripening in Basrai bananas stored in carton. *Prog. Hort.,* 16(3-4):295-297.

Soni, S.L., K.S. Chauhan and S.C. Jain, 1972. Effect of Plant growth regulators, wax emulsion and their combination on the storage behaviour and physio-chemical changes during storage of bananas, *Proc. 3rd Int. Symp. on Subtrop & Trop. Hort.,* p. 77 (Abst.).

Srivastava, M.P. and R.N. Tandon, 1968. Influence of temperature in Botryodiplodia rot of citrus and sapodila. *Indian Phytopath.*, 21:195-97.

Trout, S.A., E.G. Halland and S.M. Sykas, 1953. Effect of skin coating on the behaviour of apples in storages. I. Physiological and biochemical investigation. *Aust. J. Agric. Res.,* 4:57-81.

Wade, N.L. and C.J. Brady, 1971. Effect of Kinetic respiration, ethylene production and ripening of banana fruit slices. *Aust. J. Biol. Sci*., 24:105-107