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## Effect of ethylene induced degreening on shelf life of acid lime Cv. Balaji

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### Abstract

Degreening is the process of degradation of chlorophyll by ethylene. High doses of ethylene increase the respiration and shorten shelf life. Hence the present investigation was conducted to identify the best treatment regarding shelf life of Acid lime. Acid lime Cv. Balaji fruits were allowed to degreen in Low Cost Ripening Chamber with ethylene treatment. The investigation concluded that 15 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval followed by 15 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval can be recommended for Acid lime Cv. Balaji for uniform degreening and storage up to sixteen days in normal room temperature.

**Keywords:** Degreening, ethylene, acid lime, Cv. balaji, shelf life

### Introduction

Consumers prefer bright coloured citrus fruit and are willing to pay a premium for them. Green coloured fruits are considered unripe and fetch lower prices. Hence the colour of the rind is important for the aesthetic value and as such it is the most important factor determining marketability. Degreening is the process of degradation of chlorophyll by ethylene. The degreening process is carried out in special rooms designed to treat the fruit with air containing a low concentration of ethylene at controlled temperature and humidity. Despite citrus being a non-climacteric fruit, some aspects of its ripening could be still sensitive to external exposure to ethylene (Sdiri *et al*, 2012)<sup>[1]</sup> But high doses of ethylene increase the respiration and shorten shelf life. Hence the present investigation was conducted to identify the best treatment regarding shelf life of Acid lime. Experiment was designated with two factorial completely randomized design and executed with the objective: effect of ethylene induced degreening on shelf life of Acid lime. In the experiment, two factors *viz.*, (A) Ethylene concentrations, (B) Number of pulsings were taken for test. Acid lime Cv. Balaji fruits were allowed to degreen in Low Cost Ripening Chamber with ethylene treatment with different levels of ethylene concentrations *i.e.* (A<sub>1</sub>) 5ppm (A<sub>2</sub>) 10ppm (A<sub>3</sub>) 15ppm and (A<sub>4</sub>) 20ppm were given four levels of number of pulsings *viz.*, (B<sub>1</sub>) 6 pulsings in 24 hrs @ 4 hrs. interval (B<sub>2</sub>) 4 pulsings in 24 hrs @ 6 hrs. interval (B<sub>3</sub>) 2 pulsings in 24 hrs @ 12 hrs. interval and (B<sub>4</sub>) 1 pulsing in 24 hrs @ 24 hrs. interval. . The combination of 2 factors gives 16 treatments *viz.*, T<sub>1</sub>- 5ppm @ 6pulsings in 24 hrs; T<sub>2</sub>- 5ppm @ 4pulsings in 24 hrs; T<sub>3</sub>- 5ppm @ 2pulsings in 24 hrs; T<sub>4</sub>- 5ppm @ 1pulsing in 24 hrs; T<sub>5</sub>- 10ppm @ 6pulsings in 24 hrs; T<sub>6</sub>- 10ppm @ 4pulsings in 24 hrs; T<sub>7</sub>- 10ppm @ 2pulsings in 24 hrs; T<sub>8</sub>- 10ppm @ 1pulsing in 24 hrs; T<sub>9</sub>- 15ppm @ 6pulsings in 24 hrs; T<sub>10</sub>- 15ppm @ 4pulsings in 24 hrs; T<sub>11</sub>- 15ppm @ 2pulsings in 24 hrs; T<sub>12</sub>- 15ppm @ 1pulsing in 24 hrs; T<sub>13</sub>- 20ppm @ 6pulsings in 24 hrs; T<sub>14</sub>- 20ppm @ 4pulsings in 24 hrs; T<sub>15</sub>- 20ppm @ 2pulsings in 24 hrs; T<sub>16</sub>- 20ppm @ 1pulsing in 24 hrs.

### Materials and Methods

Acid lime (*Citrus aurantifolia* S.) Cv. Balaji fruits were collected from citrus orchard. Matured fruits (DA reading-2.02) are harvested manually and immediately transported to degreening chamber and subjected to the ethylene treatments. Ethylene release canisters named Ripylene, manufactured by chemtron science laboratories, Mumbai were used in the research. 15 grams of ethylene gas was filled in a cylinder with adjustable gauge. This was approved by NHB, FSSAI and FDA as a gas for ripening. The low-cost ripening chamber consists of 40mm PUF (Polyurethane Foam) insulated panels with PPGI Sheets (Pre painted Galvanised Iron)

lamination on either side, with flashings and swing Door - 300 x 600 mm with the capacity of 5 crates (100kg). The fruits of Acid lime Cv. Balaji were treated with 5 ppm, 10 ppm, 15 ppm and 20 ppm of ethylene. In low cost ripening chamber standardization of ethylene gas for different concentrations (5ppm, 10ppm, 15ppm and 20ppm) was carried out on the basis of bubble count (20 bubbles per 10 sec) using ethylene sensor (Table:1).

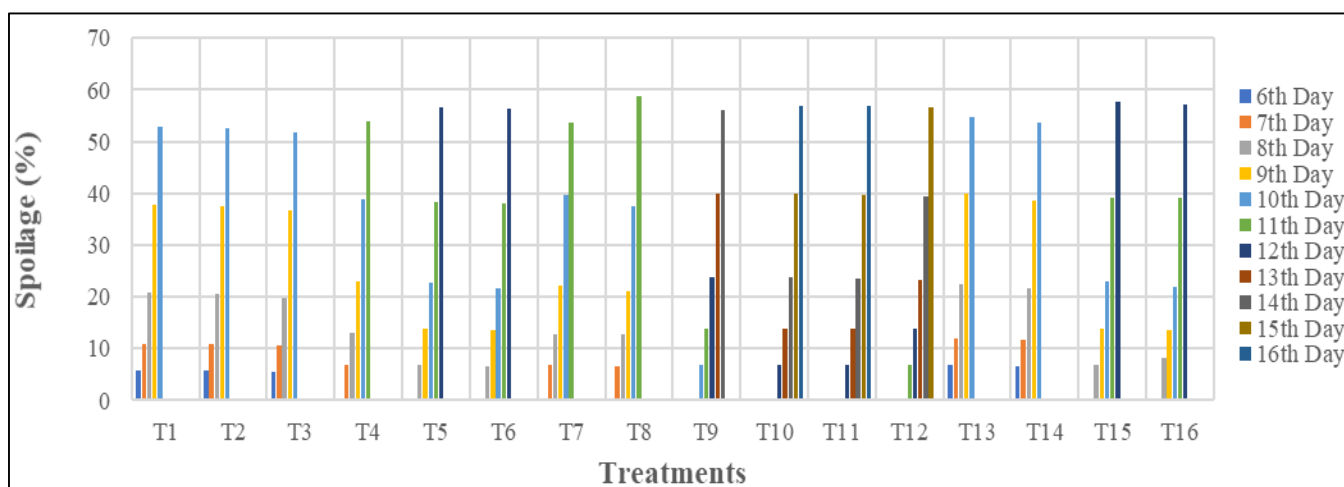
Spoilage (%): The number of fruits spoiled in the replication were counted and expressed in percentage. The spoilage determined based on the following visual observations. 1) Shrivelling of the fruit and hardening of the rind. 2) Fungal infection and subsequent rotting.

$$\text{Spoilage (\%)} = \frac{\text{No. of spoiled fruits in a replication}}{\text{Total no. of fruits in a replication}} \times 100$$

Shelf life (days): When more than 50 percent of fruits became unfit for consumption, that stage was considered as the end of shelf life. The number of days taken by the fruits was counted in each treatment and recorded as shelf life.

**Table 2:** Spoilage (%) of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature during storage days 6-16<sup>th</sup> day.

	6 <sup>th</sup> day	7 <sup>th</sup> day	8 <sup>th</sup> day	9 <sup>th</sup> day	10 <sup>th</sup> day	11 <sup>th</sup> day	12 <sup>th</sup> day	13 <sup>th</sup> day	14 <sup>th</sup> day	15 <sup>th</sup> day	16 <sup>th</sup> day
T <sub>1</sub>	5.88	10.85	20.88	37.87	52.86						
T <sub>2</sub>	5.62	10.78	20.63	37.63	52.67						
T <sub>3</sub>	5.44	10.59	19.85	36.84	51.87						
T <sub>4</sub>	-	6.88	12.95	22.85	38.75	52.60					
T <sub>5</sub>	-	-	6.82	13.82	22.83	38.26	56.65				
T <sub>6</sub>	-	-	6.64	13.65	24.68	38.17	56.44				
T <sub>7</sub>	-	6.83	12.88	22.27	39.64	53.68					
T <sub>8</sub>	-	6.62	12.83	21.17	37.48	58.89					
T <sub>9</sub>	-	-	-	-	6.96	13.92	23.86	39.87	56.07		
T <sub>10</sub>	-	-	-	-	-	-	6.84	13.84	23.84	39.84	56.87
T <sub>11</sub>	-	-	-	-	-	-	6.75	13.77	23.64	39.63	56.83
T <sub>12</sub>	-	-	-	-	-	6.95	13.87	23.31	39.45	56.60	
T <sub>13</sub>	6.83	11.82	22.48	39.86	54.83						
T <sub>14</sub>	6.62	11.68	21.67	38.63	53.67						
T <sub>15</sub>	-	-	6.87	13.85	22.87	39.26	57.63				
T <sub>16</sub>	-	-	8.19	13.67	21.85	39.23	57.25				



**Fig 1:** Spoilage (%) of Acid lime Cv. Balaji as influenced by interaction between ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature on 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup>, 15<sup>th</sup> and 16<sup>th</sup> day.

**Shelf life:** The data pertaining to shelf life of Acid lime Cv. Balaji at ambient temperature as influenced by ethylene concentrations and number of pulsings in table (3) and illustrations (2 and 3). In present investigation, shelf life was

**Table 1:** Standardisation of ethylene Dose for degreening of Acid lime (*Citrus aurantifolia* S.) Cv. Balaji in Low Cost Ripening Chamber.

Ethylene dose	No. of bubbles/10sec	Time of ethylene gas to be released
5ppm	20	1 min.
10ppm	20	1.30 sec.
15ppm	20	1.45 sec.
20ppm	20	2 min.

## Results and Discussion

### Spoilage (%)

The data pertaining Spoilage (%) of Acid lime Cv. Balaji at ambient temperature as influenced by ethylene concentrations and number of pulsings in table (2) and illustration (1). An increasing trend of spoilage with increased ripeness was observed. This study was similar to results reported by Gupta and Jawandha (2010) [2] for peaches. Ladaniya and Singh (2001) [3] reported that, no difference due to ethylene treatment but spoilage was higher in non-degreened citrus fruits.

diminished with the prolongation of storage at ambient temperatures and decreased with increased in ethylene dose. Nevertheless, besides the beneficial effect in enhancing citrus fruit colour change, exposure to ethylene carries certain

disadvantages, including acceleration of senescence, button abscission, stem end rot decay and development of physiological disorders leads to reduce the shelf life. Therefore, degreening must be performed under appropriate conditions, using the lowest possible levels of ethylene and shortest possible exposure times (Ron 2008)<sup>[4]</sup>.

Among the ethylene concentrations significantly highest shelf life was noticed with ethylene @ 15 ppm (15.56 days) followed by 10ppm (11.82 days) while, lowest with 5ppm (10.53 days). Among the number of pulsings significantly highest shelf life was noticed with 1 pulsing in 24 hrs @ 24 hrs interval (13.04 days) followed by 4 pulsings in 24 hrs @ 6 hrs interval (12.02 days) while, lowest with 6 pulsings in 24 hrs @ 4 hrs interval (11.54 days). 2 pulsings in 24 hrs @ 12 hrs interval (13.02 days) was at par with 1 pulsing in 24 hrs @ 24 hrs interval (13.04 days). According to research data interaction between ethylene concentration and number of pulsings were significantly differed. Highest shelf life was noticed in 15ppm ethylene with 4 pulsings @ 6 hrs interval (16.45 days) followed by 15ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval (16.33). 20ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval (13.15 days) was at par

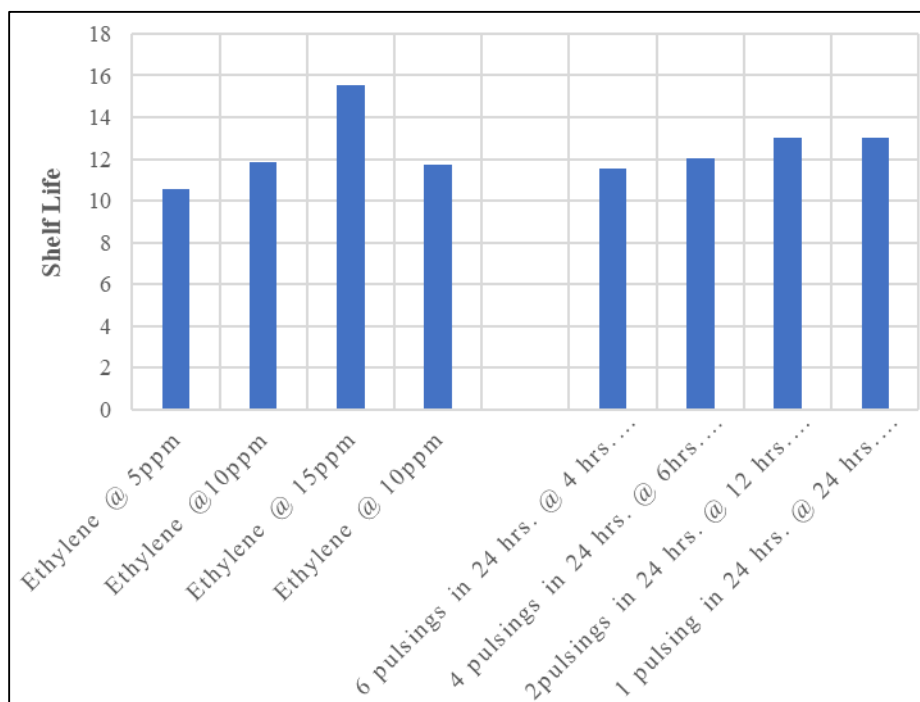
with 20ppm ethylene with 1 pulsing in 24 hrs @ 24 hrs interval (13.32 days). 10ppm ethylene with 4 pulsings in 24 hrs @ 6 hrs interval (11.20 days) and 10ppm ethylene with 6 pulsings in 24 hrs (11.27 days) was at par with 5ppm ethylene with 2 pulsing in 24 hrs @ 12 hrs interval (11.38 days) while, lowest in 5ppm ethylene with 2 pulsings in 24 hrs @ 12 hrs interval (10.11 days).

Ladaniya and Singh (2001)<sup>[3]</sup> reported that, in Sweet orange optimum response of degreening was recommended at 5-10ppm ethylene concentrations, although higher concentrations (100-250) of ethylene treatments increased the rate of post-harvest degreening decay losses. Similar results were reported by Yadava *et al* (2007)<sup>[5]</sup>, in Sweet orange. The decay loss was significantly affected by ethephon concentration. Rotting during the storage period indicating that, decay loss increases with increase in ethephon concentration.

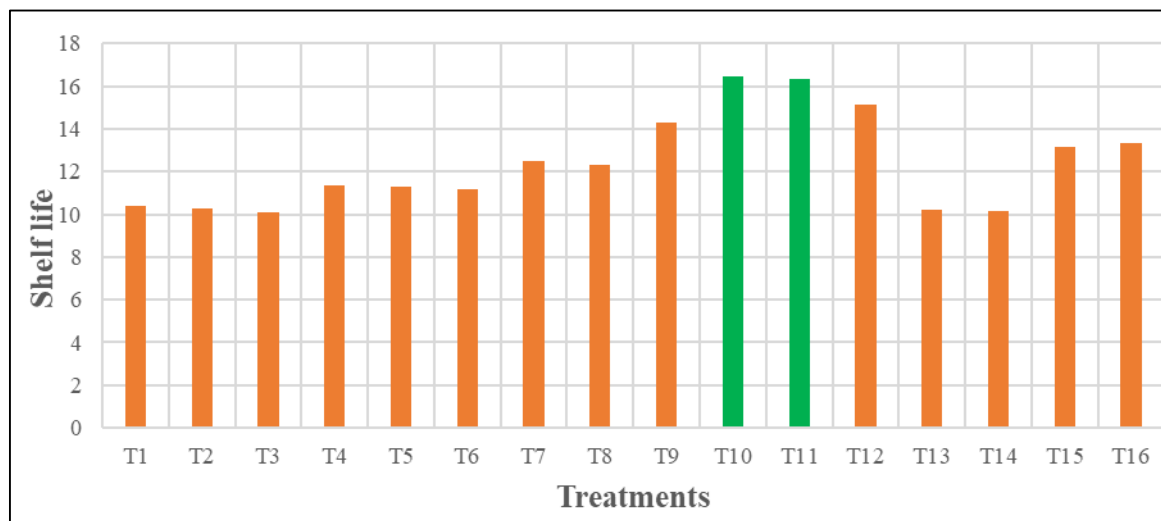
Rokaya *et al.* (2016)<sup>[6]</sup> conducted experiments on shelf life of Mandarin fruits and concluded that, the fruits treated with wax and with Bavistin can be stored up to four weeks at the condition of 14 °C – 18 °C temperature and 45% - 73% RH.

**Table 3:** Shelf life of Acid lime Cv. Balaji as influenced by ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature

Ethylene concentrations	Number of pulsings per 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @ 5ppm	10.39	10.25	10.11	11.38	10.53 <sup>D</sup>
Ethylene @ 10ppm	11.27	11.20	12.47	12.33	11.82 <sup>B</sup>
Ethylene @ 15ppm	14.30	16.45	16.32	15.15	15.56 <sup>A</sup>
Ethylene @ 20ppm	10.22	10.16	13.15	13.32	11.74 <sup>C</sup>
Mean	11.54 <sup>c</sup>	12.02 <sup>b</sup>	13.02 <sup>a</sup>	13.04 <sup>a</sup>	
Factors		CD (5%)		SEM±	
Ethylene concentrations (A)		0.09		0.03	
Number of pulsings (B)		0.09		0.03	
Factor A × B		0.17		0.06	



**Fig 2:** Shelf life (days) of Acid lime Cv. Balaji as influenced by different ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature



**Fig 3:** Shelf life (days) of Acid lime Cv. Balaji as influenced by interaction between ethylene concentrations and number of pulsings per 24 hrs. at ambient temperature

### Conclusion

15 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval followed by 15 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval can be recommended for Acid lime Cv. Balaji for uniform degreening and storage up to sixteen days in normal room temperature.

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