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Studies on the effect of ethylene concentrations on ripening behaviour of banana Cv. Grand naine in low cost ripening chamber

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Abstract
This study was conducted to assess the effect of ethylene gas on ripening behaviour of banana. The experiment was laid out in Factorial Completely Randomised Design consisting of two factors with four levels replicating thrice in postharvest laboratory at college of horticulture, Rajendranagar. Banana (fruits harvested at 85% maturity stage were collected from farmer's field were exposed to different ethylene concentrations (50 ppm, 75 ppm, 100 ppm and 125 ppm) along with different number of pulsings (6 pulsings in 24 hours @ 4 hrs. interval, 4 pulsings in 24 hours @ 6 hrs. interval, 2 pulsings in 24 hours @ 12 hrs. interval, 1 pulsing in 24 hours @ 24 hrs. interval.) in low cost ripening chamber. The increasing trend was observed in physiological loss in weight (PLW %), pulp to peel ratio, fruit colour score. Whereas decreasing trend was observed in fruit firmness, peel thickness. Among all the different treatments ethylene @ 100 ppm with 2 pulsings in 24 hours @ 12 hrs. interval resulted best.

Keywords: Banana, ripening, ethylene, low cost ripening chamber

Introduction
Banana is one of the most important fruit crops of tropical and subtropical India and the world. India is the largest producer of banana in the world, producing 30.80 million tons from an area of 0.88 million hectares with a productivity of 34.10 MT/ha (MT ha^{-1}) (NHB, 2018). At present to further enhance the production and quality of banana in India, an appropriate ripening techniques is urgently required to eliminate the traditional ripening method in which ripening is done through 'calcium carbide' and the use of this chemical is prohibited due to its carcinogenic nature (PFA, 2003).
Bananas have a pleasant sweet taste and soft texture. The starch is converted into soluble solids during ripening (Blankenship *et al.*, 1993) [1]. The use of ethylene gas in achieving faster and more uniform ripening of fruits was well documented (Kadar, 2002) [2].Therefore the present investigation were done to study the ripening techniques by using ethylene gas as an alternate measure for improving the ripening of banana fruits so that the quality fruits with uniform ripening are made available to consumers throughout the years.

Material and Methods
The fruits of banana cv. 'Grand Naine' were harvested at green mature stage when the angularity on fruit surface disappeared from farmer field and subjected to different ethylene concentrations. 20kgs of fruits were taken for every treatment. Fruits harvested at mature stage are ripened for 24 hours at ambient conditions by ethylene treatment in low cost ripening chamber. Low cost ripening chamber was made of 40 mm PUF insulated panels with PPGI sheets lamination on either sides, with flashings and swing Door – 300x600mm, size 1x1x1 cube meter. The capacity of ripening chamber is 5 crates (100 kgs). Ethylene release canisters named Ripylene, manufactured by Chemtron science laboratories, Mumbai were used in the research. There were 3 replications for each treatment and experiment was laid out in factorial completely randomized design.
The observations were recorded daily. The physiological loss in weight (PLW) of fruit during storage was calculated on initial weight basis and expressed in percent. The fruit firmness was measured with the help of 'texture analyzer using stainless steel probe of 2 mm diameter.

The colour of the fruits was determined by visual observation changes in colour (surface of fruit) was measured. Thickness of the peel of individual fruit was measured with Digital Vernier calipers after separating the peel from the pulp by cutting transversely at midpoint of fruit and expressed in mm. Pulp and peel of individual fruit was weighed individually and expressed as pulp to peel ratio.

Results and Discussion

Physiological loss in weight (PLW %): (Table 1) Significantly high physiological loss in weight reading was recorded on 1st day in 50 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.83%) followed by 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.26) and lowest was recorded in 75 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (0.52%). On 2nd day highest was recorded in 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (6.53%) followed by 125 ethylene ppm with 4 pulsings in 24 hours @ 6 hrs. interval (6.03%) and lowest was recorded in 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (2.73%) and 50 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (2.72%) were at par. On 3rd day highest was recorded in 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (10.52%) followed by 75 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (9.58%) and lowest was recorded in 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (5.03%). On 4th day highest was recorded in 125 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (15.23%) followed by 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (14.17%) and lowest was recorded in 50 ppm ethylene with 2 pulsings in 24 hours @ 4 hrs. interval (8.37%).This could be due to increased metabolic activities under the influence of ethylene (Sastry[3], 1970). Energy produced from the respiration process in the form of heat is released from the fruit by evaporation of water causing a weight loss (Dharmasenal and Kumari 2005) [4].

Fruit Colourscore: (Table 2) on 1st day 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (2.63) was found to be maximum followed by 125 ppm ethylene with 4 pulsings in 24 hours @ 24 hrs. interval (2.43) while 50 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. Interval (1.10) was found to be minimum. On 2ndday the highest was found in 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (4.53), lowest in 75ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (2.16).On 3rd day in 125 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (7.70) was found to be maximum while 100 ppm ethylene with4 pulsings in 24 hours @ 6 hrs. interval, 100 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval, 100 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval were on par (4.70) and 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (3.10) was minimum. On 4th day 125 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (8.70) was found to be maximum which was at par with 125 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (8.66) while 100 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (5.20) was found to be minimum. The fruits treated with ethylene developed uniform yellow colour. Similar findings have been reported earlier in banana fruits by (Mahajan *et al.*, 2010) [5]. Ethylene gas treatment are known to accelerate the chlorophyll degradation and induce yellowness in green tissues of many fruits (Mahajan *et al.*, 2008) [6].

Firmness (kg/cm^2): (Table 3) On 1st day highest was recorded in 50 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (5.43) followed by 50 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (4.97) while lowest was recorded in 125 ppm ethylene with4 pulsings in 24 hours @ 6 hrs. interval (2.53).On 2nd day highest was recorded in 50 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (3.62) while lowest was recorded in 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.66).On 3rd day highest was recorded in 125 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.87) while lowest was recorded in 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (1.07).On 4th day highest was recorded in 50 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.22) while lowest was recorded in 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (0.11).Similar results were reported by Thompson (1996) [7] who stated that the softening of banana fruit during ripening is associated with three processes firstly, the conversion of starch to soluble carbohydrates, since starch granules have a structural function in the cell secondly, the breakdown of pectin substances and the third possibility is the movement of water from the peel of the banana to its pulp during ripening.

Peel Thickness (mm): (Table 4) On 1st day 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval recorded maximum value (3.93) while 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval recorded the minimum value (2.06). On 2nd day 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (2.68) while 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval recorded the lowest (1.92). On the 3rd day 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval recorded highest (2.42) while 125 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval recorded the minimum value (1.32).On 4th day 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval recorded the maximum value (2.02) while 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval and 125 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval recorded the minimum value (1.02) which was on par with 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.03) , 125 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.03).In present study, significant decrease in peel thickness. This is due to the modification of cell wall of peel which may affect firmness loss and ultimately lead in vanishing void space and hence reduction in peel thickness. Parker and Maluku (2013) [8] observed that, peel thickness and the cell layer number decreased continuously when banana ripening was initiated.

Pulp to Peel ratio : (Table 5) On 1st day maximum pulp to peel ratio was noticed in 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval number of pulsings (1.68) while minimum was noticed in 50 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (0.67).On 2nd day highest pulp to peel ratio was observed in 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (2.27) which was at par with 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (2.23), 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (2.18) while minimum was observed in 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.32). On 3rdday maximum pulp to peel was noticed in 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (2.77) while lowest was recorded in 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.48). On 4thday

highest pulp to peel to ratio was observed in 125 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (3.37) which was on par with 75 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (3.12) and 100 ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (3.06) while lowest was observed in 100 ppm ethylene with 4 pulsing in 6 hours @ 24 hrs. interval (1.62).The increase in the pulp to peel ratio might be due to the change in sugar concentration in the pulp compared to the peel thus contributing to different change in osmotic pressure. Water might be lost from the peel of banana both by transpiration and osmosis due to which the peel weight was reduced and pulp to peel ratio increased. The increase in pulp to peel ratio during ripening was observed by Simmonds (1996) [9] and Krishnamurthy (1993) [10].

Table 1: Physiological loss in weight (%) of banana fruits Cv. Grand Naine at ambient temperature as influenced by Ethylene concentrations and number of pulsings

		Day 1	Day 2	Day 3	Day 4	Day 5
E_1	N_1	0.93	2.73	5.03	8.57	10.47
	N_2	0.62	3.14	8.03	12.33	-
	N_3	0.28	4.63	5.77	8.37	10.67
	N_4	1.83	2.72	5.67	9.30	11.07
E_2	N_1	0.72	5.09	9.58	10.73	-
	N_2	1.26	6.53	9.32	12.70	-
	N_3	0.52	5.23	8.37	12.62	-
	N_4	0.91	5.82	8.52	12.39	-
E_3	N_1	0.57	4.33	6.28	11.42	12.17
	N_2	1.08	4.98	7.47	9.48	13.18
	N_3	0.62	3.73	6.02	9.22	11.82
	N_4	0.65	4.37	8.33	13.13	16.02
E_4	N_1	0.67	5.88	9.50	13.67	-
	N_2	0.63	6.03	8.22	15.23	-
	N_3	0.92	5.08	10.52	14.17	-
	N_4	0.64	5.33	9.07	12.52	-
CD (5%)		0.02	0.48	0.03	0.03	
SE (m) ±		0.08	0.17	0.01	0.01	

E_1= ethylene @ 50 ppm, E_2 = ethylene @ 75 ppm,
E_3 = ethylene @ 100 ppm, E_4 = ethylene @ 125 ppm
N_1 = 6 pulsings in 24 hours @ 4 hrs. interval, N_2 = 4 pulsings in 24 hours @ 6 hrs. interval
N_3 = 2 pulsings in 24 hours @ 12 hrs. interval, N_4 = 1 pulsing in 24 hours @ 24 hrs. interval

Table 2: Colourscore of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings

		Day 1	Day 2	Day 3	Day 4	Day 5
E_1	N_1	1.13	2.20	3.10	7.26	8.66
	N_2	1.10	2.23	3.70	8.26	-
	N_3	1.50	2.60	3.26	7.26	8.26
	N_4	1.40	2.60	3.30	7.70	8.36
E_2	N_1	1.33	2.70	3.70	7.30	-
	N_2	1.43	2.16	4.06	8.20	-
	N_3	1.20	2.40	3.80	8.70	-
	N_4	1.66	2.50	4.06	8.70	-
E_3	N_1	1.40	2.53	3.66	7.16	8.40
	N_2	2.13	3.26	4.70	5.70	8.20
	N_3	2.30	3.40	4.70	5.30	8.73
	N_4	1.26	3.56	4.70	5.20	8.30
E_4	N_1	2.20	3.56	7.13	8.66	-
	N_2	2.43	4.23	7.70	8.70	-
	N_3	2.63	4.53	7.20	8.30	-
	N_4	2.16	3.56	7.63	8.13	-
CD (5%)		0.26	1.39	0.25	0.23	
SE (m) ±		0.06	0.05	0.06	0.06	

E_1= ethylene @ 50 ppm, E_2 = ethylene @ 75 ppm,
E_3 = ethylene @ 100 ppm, E_4 = ethylene @ 125 ppm
N_1 = 6 pulsings in 24 hours @ 4 hrs. interval, N_2 = 4 pulsings in 24 hours @ 6 hrs. interval
N_3 = 2 pulsings in 24 hours @ 12 hrs. interval, N_4 = 1 pulsing in 24 hours @ 24 hrs. interval

Table 3: Firmness (kg/cm^2) of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings

		Day 1	Day 2	Day 3	Day 4	Day 5
E_1	N_1	3.63	2.27	1.07	0.97	0.42
	N_2	3.90	2.07	1.72	1.17	-
	N_3	5.43	3.62	1.68	1.01	0.27
	N_4	4.97	3.42	1.66	1.22	1.02
E_2	N_1	3.92	1.73	1.48	0.58	-
	N_2	4.51	2.03	1.47	0.11	-
	N_3	4.32	2.17	1.38	0.73	-
	N_4	3.22	1.66	1.13	0.66	-
E_3	N_1	4.33	2.22	1.27	0.96	0.82
	N_2	4.31	1.72	1.37	0.92	0.62
	N_3	3.67	1.67	1.26	0.71	0.56
	N_4	3.88	2.13	1.52	1.03	0.67
E_4	N_1	3.33	2.11	1.27	1.07	-
	N_2	2.53	1.93	1.87	1.17	-
	N_3	3.97	2.17	1.12	0.71	-
	N_4	3.52	2.20	1.47	0.96	-
CD (5%)		0.07	0.03	0.02	0.02	
SE (m) ±		0.02	0.01	0.01	0.008	

E_1= ethylene @ 50 ppm, E_2 = ethylene @ 75 ppm,
E_3 = ethylene @ 100 ppm, E_4 = ethylene @ 125 ppm
N_1 = 6 pulsings in 24 hours @ 4 hrs. interval, N_2 = 4 pulsings in 24 hours @ 6 hrs. interval
N_3 = 2 pulsings in 24 hours @ 12 hrs. interval, N_4 = 1 pulsing in 24 hours @ 24 hrs. interval

Table 4: Peel thickness (mm) of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations and number of pulsings

		Day 1	Day 2	Day 3	Day 4	Day 5
E_1	N_1	3.51	3.12	2.42	2.02	1.48
	N_2	3.58	2.47	2.07	1.62	-
	N_3	3.41	2.63	1.57	1.48	1.12
	N_4	3.12	2.53	1.97	1.47	1.03
E_2	N_1	3.17	2.44	1.52	1.23	-
	N_2	2.61	1.92	1.47	1.22	-
	N_3	3.07	2.47	1.58	1.17	-
	N_4	2.06	1.98	1.38	1.03	-
E_3	N_1	3.52	2.53	2.22	1.73	1.22
	N_2	3.93	2.68	1.93	1.52	1.12
	N_3	2.78	2.23	1.83	1.37	1.18
	N_4	3.38	2.48	1.67	1.27	1.01
E_4	N_1	3.62	2.57	1.32	1.26	-
	N_2	2.98	2.23	1.53	1.02	-
	N_3	3.02	2.71	1.17	1.02	-
	N_4	3.76	2.52	2.07	1.03	-
CD (5%)		0.027	0.131	0.031	0.030	
SE (m) ±		0.009	0.145	0.011	0.011	

E_1= ethylene @ 50 ppm, E_2 = ethylene @ 75 ppm,
E_3 = ethylene @ 100 ppm, E_4 = ethylene @ 125 ppm
N_1 = 6 pulsings in 24 hours @ 4 hrs. interval, N_2 = 4 pulsings in 24 hours @ 6 hrs. interval
N_3 = 2 pulsings in 24 hours @ 12 hrs. interval, N_4 = 1 pulsing in 24 hours @ 24 hrs. interval

Table 5: Pulp to peel ratio of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings

		Day 1	Day 2	Day 3	Day 4	Day 5
E_1	N_1	0.67	1.47	2.17	2.38	2.47
	N_2	1.62	1.82	2.27	3.13	-
	N_3	1.47	1.57	1.87	2.22	2.72
	N_4	1.31	1.42	1.72	1.87	2.32
E_2	N_1	1.38	1.52	2.28	2.38	-
	N_2	1.51	2.18	2.52	2.87	-
	N_3	1.32	1.82	2.27	2.88	-
	N_4	1.68	2.23	2.72	3.12	-
E_3	N_1	1.17	1.62	1.87	3.06	1.67
	N_2	1.08	1.32	1.48	1.62	1.82
	N_3	1.52	1.92	2.18	2.52	2.70
	N_4	1.22	1.52	1.68	2.22	2.48
E_4	N_1	1.53	1.51	2.32	2.57	-
	N_2	1.52	1.82	2.32	2.83	-
	N_3	1.62	2.27	2.77	3.37	-
	N_4	1.38	1.72	1.92	2.37	-
CD (5%)		0.03	0.162	0.032	0.48	
SE (m) ±		0.01	0.056	0.012	0.16	

E_1= ethylene @ 50 ppm, E_2 = ethylene @ 75 ppm,
E_3 = ethylene @ 100 ppm, E_4 = ethylene @ 125 ppm
N_1 = 6 pulsings in 24 hours @ 4 hrs. interval, N_2 = 4 pulsings in 24 hours @ 6 hrs. interval
N_3 = 2 pulsings in 24 hours @ 12 hrs. interval, N_4 = 1 pulsing in 24 hours @ 24 hrs. interval

Conclusion

From the results, it can be concluded that ethylene concentrations (50 ppm, 75 ppm, 100 ppm and 125 ppm) and number of pulsings 6 pulsings in 24 hours @ 4 hrs. interval, 4 pulsings in 24 hours @ 6 hrs. interval, 2 pulsings in 24 hours @ 12 hrs. interval and 1 pulsing in 24 hours @ 24 hrs. interval enhanced the fruit ripening. Fruits treated with ethylene @100 ppm with 2 pulsings in 24 hours @ 12 hrs. interval and ethylene @ 100 ppm 1 pulsing in 24 hours @ 24 hrs. interval resulted good in uniform ripening, less spoilage, least PLW, high pulp to peel ratio and more shelf life when compared with all the treatments. Whereas control fruits remained unripen for 7 days without losing its firmness and colour.

References

1. Blankenship SM, Ellsworth DD, Powell RL. A ripening index for banana fruit based on starch content. Horticultural Technology. 1993; 3(3):338-339.
2. Kadar A. Postharvest Technology of Horticulture Crops. 3rd edition Coorperative Extension, Division of Agriculture and Natural Resources, University of California. 2002; 33(3):535.
3. Sastry MV. Biochemical studies in the physiology of sapota. Indian Food Packer, 1970, 24-26.
4. Dharmasenal DA, Kumari AH. Suitability of charcoal-cement passive evaporative cooler for banana ripening. Journal of Agricultural Sciences. 2005; 1:1-10.

5. Mahajan BC, Kaur T, Gill MS, Dhaliwal HS, Ghuman BS, Chahil BS. Studies on optimization of ripening techniques for banana. Journal of Food Science and Technology. 2010; 47(3):315-319
6. Mahajan BC, Singh G, Dhat AS. Studies on ripening behaviour and quality of winter guava with ethylene gas and ethephon treatment. Journal of Food Science and Technology. 2008; 45(1):81-84.
7. Thompson AK. Postharvest technology of fruits and vegetables. Blackwell Science, Oxford, 1996, 226-228
8. Parker R, Maalekuu BK. The effect of harvesting stage on fruit quality and shelf life of four tomato cultivars (*Lycopersicon esculentum* Mill). Agriculture and Biology Journal of North America. 2013; 4(3):252-259.
9. Simmonds NW. Bananas. Longman Green and Co. Ltd, London, 1996, 466.
10. Krishnamurthy S. Harvesting, Handling and storage of fruits. Postharvest Horticultural Conference on Science and Technology for the Fresh Foods Revolution, 1993, 1748-1757.