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Effect of different ethylene concentrations on ripening behaviour of banana (CV. GRAND NAINE)

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Abstract
The present investigation was undertaken to examine the influence of ethylene gas on the ripening behaviour of banana fruits. The study was carried out in the postharvest laboratory of the College of Horticulture, Rajendranagar, using a Factorial Completely Randomized Design comprising two factors with four levels each and three replications. Banana fruits harvested at 85 per cent maturity were treated with varying ethylene concentrations (50, 75, 100, and 125 ppm) combined with different pulsing frequencies in a low-cost ripening chamber. A consistent reduction in Differential Absorbance (DA) meter readings was observed with the progression of ripening.

Keywords: Differential Absorbance (DA meter), ripening, ethyelene, banana

Introduction
Banana is an important fruit crop contributing substantially to human nutrition. Ripening is a complex genetically regulated process that results in changes in colour, flavour, aroma, texture, and nutritional quality. As ripening progresses, chlorophyll degradation and sugar accumulation lead to softer and sweeter fruits.

Materials and Methods
Banana fruits of cv. Grand Naine were harvested at the green mature stage and subjected to ethylene treatments using Ripylene canisters. The experiment followed a Factorial Completely Randomized Design with three replications. DA meter readings were recorded daily.

Results and Discussion
The data pertaining to DA meter readings of banana fruits Cv. Grand Naine at ambient temperature as influenced by postharvest Ethylene concentrations, and number of pulsings are presented in tables.

It is evident from the data that, the DA reading showed significantly decreased as the ripening advanced during storage at ambient conditions. DA meter measures the chlorophyll content in a fruit and, as a consequence, its state of ripeness. The index of absorbance difference (IAD) decreases in value during ripening by absorbency properties of the fruit, until it reaches very low value (0.00), when ripening was complete. Each kind of fruit and cultivar has specific DA values according to the different phases of maturation. (Ziosi *et al*., 2008; Noferini *et al*., 2008) [1, 2].

It is evident from the data that, the DA meter reading showed decreasing trend as the ripening process advanced. Among different Ethylene concentrations on 1st day (Table 1) maximum was recorded in ethylene @ 50 ppm (1.80) and ethylene @ 75 ppm (1.80) while minimum was recorded in ethylene @ 125 ppm (1.66). On 2nd day (Table 2) highest was recorded in ethylene @ 100 ppm (1.65) and ethylene @ 50 ppm (1.64) while lowest was recorded in ethylene @ 75 ppm (1.44). On 3rd day (Table 3) highest was recorded in ethylene @ 100 ppm (1.45) and lowest was recorded in ethylene @ 75 ppm (1.09). On 4th day (Table 4) highest was recorded in ethylene @ 100 ppm (1.26) lowest was recorded in ethylene @ 75 ppm (0.95).

Among different number of pulsings on 1st day (Table 1) maximum was recorded in 6 pulsings in 24 hours @ 4 hrs. interval (1.85) while minimum was recorded in 1 pulsing in 24 hours @ 24 hrs. interval (1.72) and 2 pulsings in 24 hours @ 12 hrs. interval (1.72). On 2nd day highest was

recorded in 6 pulsings in 24 hours @ 4 hrs. interval (1.63) while lowest was recorded in 1 pulsing in 24 hours @ 24 hrs. interval (1.47). On 3rd day (Table 3) highest was recorded in 6 pulsings in 24 hours @ 4 hrs. interval (1.42) while lowest was recorded in 2 pulsings in 24 hours @ 12 hrs. interval (1.18). On 4th day (Table 4) highest was recorded in 6 pulsings in 24 hours @ 4 hrs. interval (1.26) and lowest was recorded in 2 pulsings in 24 hours @ 12 hrs. interval (1.00%).

The interaction between Ethylene concentrations and number of pulsings showed significant variation (Table 1 to 5). Significantly high DA reading was recorded on 1st day (Table 1) in 50ppm ethylene with 6 pulsings in 24 hours @ 4 hrs. interval (1.97) and 100 ppm ethylene with 4 pulsings in 24 hours interval @ 6 hrs. interval (1.97) while lowest was recorded in 100 ppm ethylene with 1 pulsing in 24 hours @ 24 hrs. interval (1.63).On 2nd day (Table 2) highest was recorded in 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.93) and lowest was recorded in 75 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (1.38).On 3rd day (Table 3) highest was recorded in 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.77) and lowest was recorded in 75 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (0.93). On 4th day (Table 4) highest was recorded in 100 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (1.58) and lowest was recorded in 75 ppm ethylene with 2 pulsings in 24 hours @ 12 hrs. interval (0.87) which is on par with 75 ppm ethylene with 4 pulsings in 24 hours @ 6 hrs. interval (0.88)

The mean values recorded among the bananas treated with ethylene concentrations and number of pulsings during 5th day of storage tabulated at Table 5. The similar decreasing trend in respect of DA meter reading with advancement of ripening during storage was observed.

Similar results were reported by Peter, (2011) [3] who noticed a decreasing trend in DA reading with degradation of chlorophyll content in Apple and in Mango Cv. Manila (Maria Soledad, 2014) [4]. The results reported by Lorenzo *et al*. (2012) [5] stated that the DA index allows separation of the fruits in different categories of maturation in Mango. Similar results were demonstrated by Noferini *et al.* (2008) [2] who reported that in Apple, the DA was found to be a reliable parameter for monitoring on tree apple ripening decreasing index ranges corresponded to increasingly advanced stages of ripening.

Table 1: DA (Differential Absorbance) meter reading of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings at ambient temperature on 1st day.

Ethylene concentrations	Number of pulsings in 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @ 50ppm	1.97	1.68	1.73	1.83	1.80[a]
Ethylene @ 75 ppm	1.87	1.69	1.72	1.73	1.80[a]
Ethylene @ 100 ppm	1.87	1.97	1.83	1.63	1.82[b]
Ethylene @ 125 ppm	1.67	1.72	1.58	1.68	1.66[c]
Mean	1.85[A]	1.77[B]	1.71[C]	1.71[C]	
FACTORS	CD (5%)		SE (m) ±		
Ethylene concentrations (A)	0.013		0.045		
Number of pulsings (B)	0.013		0.045		
Factor A X B	0.026		0.009		

Table 2: DA (Differential Absorbance) meter reading of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings at ambient temperature on 2nd day.

Ethylene concentrations	Number of pulsings in 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @ 50ppm	1.87	1.53	1.62	1.52	1.64[a]
Ethylene @ 75 ppm	1.47	1.48	1.38	1.42	1.44[c]
Ethylene @ 100 ppm	1.61	1.93	1.57	1.47	1.65[a]
Ethylene @ 125 ppm	1.57	1.47	1.42	1.47	1.48[b]
Mean	1.63[A]	1.60[B]	1.50[C]	1.47[D]	
FACTORS	CD (5%)		SE (m) ±		
Ethylene concentrations (A)	0.014		0.005		
Number of pulsings (B)	0.014		0.005		
Factor A X B	0.027		0.009		

Table 3: DA (Differential Absorbance) meter reading of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings at ambient temperature on 3rd day**.**

Ethylene concentrations	Number of pulsings in 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @ 50ppm	1.66	1.32	1.42	1.15	1.39[b]
Ethylene @ 75 ppm	1.17	1.12	0.93	1.13	1.09[d]
Ethylene @ 100 ppm	1.47	1.77	1.23	1.33	1.45[a]
Ethylene @ 125 ppm	1.37	1.32	1.12	1.37	1.30[c]
Mean	1.42[A]	1.38[B]	1.18[D]	1.24[C]	
FACTORS	CD (5%)		SE (m) ±		
Ethylene concentrations (A)	0.015		0.005		
Number of pulsings (B)	0.015		0.005		
Factor A X B	0.031		0.010		

Table 4: DA (Differential Absorbance) meter reading of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings at ambient temperature on 4th day.

Ethylene concentrations	Number of pulsings in 24 hrs.				
	6 pulsings	4 pulsings	2 pulsings	1 pulsing	Mean
Ethylene @ 50ppm	1.43	1.17	1.12	0.77	1.12^{c}
Ethylene @ 75 ppm	0.96	0.88	0.87	1.08	0.95^{d}
Ethylene @ 100 ppm	1.37	1.58	0.94	1.13	1.26^{a}
Ethylene @ 125 ppm	1.22	1.07	1.06	1.24	1.15^{b}
Mean	1.26^{A}	1.18^{B}	1.00^{D}	1.05^{C}	

FACTORS	CD (5%)	SE (m) ±
Ethylene concentrations (A)	0.015	0.005
Number of pulsings (B)	0.015	0.005
Factor A X B	0.030	0.010

Table 5: DA (Differential Absorbance) meter reading of banana fruits Cv. Grand Naine as influenced by postharvest Ethylene concentrations, and number of pulsings at ambient temperature on 5th day

Ethylene concentrations	Number of pulsings in 24 hrs.			
	6 pulsings	4 pulsings	2 pulsings	1 pulsing
Ethylene @ 50ppm	1.22	-	0.82	0.57
Ethylene @ 75 ppm	-	-	-	-
Ethylene @ 100 ppm	1.27	1.32	0.80	1.03
Ethylene @ 125 ppm	-	-	-	-

Conclusion

Ethylene concentration and pulsing frequency significantly influenced banana ripening. Ethylene at 100 ppm with two pulsings at 12-hour intervals or one pulsing at 24-hour intervals resulted in uniform and desirable ripening.

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