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EFFECT OF ETHREL ON POST HARVEST CHANGES IN PAPAYA (*Carica papaya* L.) FRUITS

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ABSTRACT: The present experiment entitled, "Studies on the effect of ethrel on post harvest changes in papaya (*Carica papaya* L.) fruits was carried out to investigate the effect of ethrel on bio-chemical changes occurred during its post harvest life. The objective of this work was to evaluate the effects of various concentrations of Ethrel (500 ppm, 750 ppm, 1000 ppm and 1500 ppm) on shelf life of papaya fruits when stored under ambient conditions. The treated fruits were assessed for physiological changes such as percentage of ripening, loss of fruit weight (kg), biochemical aspects such as TSS (°Brix), titratable acidity (%), total sugars (%), reducing sugar (%), ascorbic acid content (mg/100g), total carotenoids (mg/100g) along with organoleptic evaluation. The observations were recorded at 3, 6 and 9 days after storage and the experiment was laid down using Completely Randomized Design. From the experiment it was clear that the overall performance of the above characteristics was found the best when the fruits were treated with 1500 ppm ethrel followed by 1000 ppm ethrel.

Keywords: *Papaya, ethrel, ripening, shelf life.*

Papaya (*Carica papaya* L.) is one of the major fruit crops cultivated in tropical and subtropical zones of the world. India is the largest producer of papaya in the world contributing about 37% of the papaya produced in the world with a cultivated area of about 106 thousand hectare and the productivity of 39.6 metric tonnes per hectare. The latest production of papaya in India during the year 2010-2011 was 4196 thousand metric tonnes (Anon., 2). It is an abundant source of carotene (2020 I.U./100g), precursor of vitamin A. Papaya fruits are used for the treatment of piles, dyspepsia of spleen and liver, digestive disorders, diphtheria and skin blemishes. Ethrel (2, chloroethyl phosphonic acid) is one of the ethylene releasing substances, known mainly for its ability to induce fruit ripening. Aqueous solution of ethrel is stable below pH 3.5. Above pH 3.5, the hydrolysis of ethrel begins with the release of free ethylene along with chloride and phosphate ions. On dipping the mature fruits in ethrel, it enters into the fruit cells, releases ethylene and hastens the ripening process. Ethrel has been found very effective growth regulator in ripening and improving fruit quality in many climacteric fruits such as banana (Guerra *et al.,* 3), mango (Sampaio, 16), apple (Unreth, 20) and guava (Singh *et al.,* 19). However, very little work has been done so far to study the effect of ethrel on ripening and quality of papaya fruits.

Keeping in view the usefulness of ethrel treatments in fruits as revealed by various scientists, the present study was aimed to evaluate the effectiveness of postharvest immersion in different ethrel concentrations on the postharvest quality attributes of papaya fruit kept at ambient temperatures.

MATERIALS AND METHODS

The present investigation entitled "Effect of ethrel on post harvest changes in papaya (*Carica papaya* L.) fruits" was carried out at Laboratory of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow during the year 2010 and 2011. The fruits of papaya cv. Pusa Delicious which were physiologically mature and have attained the full size, light green with tinge of yellow at apical end were used for the study. The fruits were selected on the basis of uniformity, maturity, size and shape. The experiment was laid out in

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Completely Randomized Design (CRD) with five treatments and three replications.

The fruits were washed with clean water, dipped for 30 seconds in 0.01% Bavistin and dried with muslin cloth before use.The fruits were dipped for five minutes in the following concentrations of Ethrel solution. i.e. control (T_0), 500 ppm (T_1), 750 ppm (T_2), 1000 ppm (T_3) and 1500 ppm (T_4).

After each treatment, the fruits were air dried at ambient temperature for 30 minutes in an attempt to reduce possible chemical injury. The control fruits were dipped for five minutes in the distilled water without using the ethrel solution. The number of fruits treated under each treatment were twelve, out of which nine fruits were examined for their chemical composition in three replications at the interval of 3 days, 6 days and 9 days after storage. The remaining three fruits were tested for physical characters for the same intervals.

The fruits sampled were assessed for percentage of ripening, weight loss, TSS, titratable acidity, total sugar, reducing sugar, ascorbic acid and total carotenoids and also evaluated by organoleptic test. Percentage of ripening (%) was calculated as per the formula : Ripening (%) = The number of ripe fruit/total number of fruit) x 100 and expressed as a percentage. Weight loss (%)was determined by weighing the fruit in each treatment at different intervals of storage and was expressed as percentage deviation in weight on the basis of initial weight. Titratable acidity, TSS, sugar and ascorbic acid were determined following the method described by Ranganna (13). Total carotenoids was measured by taking 5 grams of the sample, grounded with acetone and anhydrous sodium sulphate in a pestle and mortar (Ranganna, 13). Organoleptic evaluation of five treatment combinations were judged by a trained panel of ten members using a Nine Point Hedonic Scale ('9' Like Extremely and '1' Dislike extremely) following the method of Murray *et al.* (9) for skin colour, flavour, texture, aroma and overall acceptability and the experiment was designed under Completely Randomized Design (CRD) for necessary data collection and statistical analysis. Comparison of treatment means were made with the help of Critical Differences. Duncan Multiple Range Test (DMRT) was used to group the treatment means on the basis of C.D. The values were marked with English alphabets. The alphabet 'a' denoted the maximum value and subsequent lower values in decreasing order were marked alphabeti- cally. The values marked with same alphabet(s) indicated that they were statistically at par.

RESULTS AND DISCUSSION

Effect on Ripening : Present investiga- tion (Table 1) revealed that ethrel application enhanced the onset of ripening in papaya and the response varied according to the concentration. 100% ripening was found when the fruits were treated with ethrel @ 1500 ppm as early as three days after storage. Although it was found that increase in ethrel concentration hastened the ripening process but the effects of ethrel @ 500 ppm, 750 ppm and 1000 ppm were statistically similar with control. All the fruits were ripened at 6 DAS. The mode of action of ethylene on ripening of fruits is not clearly understood. However it was explained by Holl (5) that ethylene probably brings about the climacteric, since in many fruits the rise in respiration is directly preceded by an elevation in the ethylene concentration. This respiratory climacteric can be induced by ethylene treatment without a simultaneous change in tissue permeability. It has also been reported that ethylene alters the proportion of individual transfer RNA species. This effect of ethylene may influence the transfer of m RNA and thus initiate ripening.

Effect on weight loss : Table 1 indicated that the physiological loss in weight was significantly increased with the increase of ethrel concentrations. The maximum weight loss (24.49%) was observed at 1500 ppm where as it was only 14.30% in control at 9 DAS. Similar type of decrease in fruit weight during storage was also observed by Sharma and Singh (18) in dates and Gupta *et al.* (4) in citrus

Table 1: Effect of Ethrel on percentage of Ripening, Loss in weight , Titratable Acidity and T.S.S. of Papaya fruit during storage.

Treatments	Ripening(%)			Loss in weight (%)			Titratable Acid (%)			TSS (°Brix)		
	3DAS*	6 DAS	9DAS	3DAS	6 DAS	9DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	44.44a	100.00	N.A.	9.27e	12.60d	14.30d	0.400a	0.172a	0.111a	6.93d	11.73c	10.43c
Ethrel @ 500 ppm	44.44a	100.00	N.A.	10.28d	13.76cd	15.99cd	0.313b	0.157b	0.090b	7.07cd	11.90c	10.90b
Ethrel @ 750ppm	55.55a	100.00	N.A.	11.77c	14.75bc	16.80bc	0.267c	0.127c	0.080c	7.37bc	12.37b	11.07b
Ethrel @1000 ppm	61.11a	100.00	N.A.	13.09b	15.44b	18.47b	0.160d	0.104d	0.068d	7.60b	12.67a	11.47a
Ethrel @1500ppm	100.00b	N.A.	N.A.	14.47a	19.17a	24.49a	0.085e	0.064e	0.054e	11.70a	11.07d	8.30d
Mean	61.11	80.00		11.775	15.145	18.010	0.245	0.125	0.080	8.13	11.95	10.43
C.V.	25.39			5.747	6.798	9.202	7.268	1.880	3.199	3.225	1.582	2.052
C.D. (P=0.05)	28.594			0.805	1.261	1.900	0.021	0.003	0.003	0.312	0.225	0.255

*DAS-Days After Storage.
N.A. - not available for the study.
The Tables represent the pooled values of two years data.

Table 2: Effect of Ethrel on Per cent reducing and total sugar, Ascorbic Acid and Total Carotenoids of Papaya fruit during storage.

Treatments	Per cent reducing Sugar (%)			Total sugar (%)			Ascorbic Acid(mg/100g)			Total carotenoids (mg/100g)		
	3DAS	6 DAS	9DAS	3DAS	6 DAS	9DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	3.55e	5.75c	3.77c	3.55e	5.75c	3.77c	27.20d	42.37c	29.63d	2.34e	2.89c	1.99d
Ethrel @ 500 ppm	4.08d	6.75b	4.19bc	4.08d	6.75b	4.19bc	28.00d	44.59b	36.15c	2.48d	2.91c	2.12c
Ethrel @ 750ppm	4.34c	7.04ab	4.30b	4.34c	7.04ab	4.30b	29.78c	46.22ab	39.70b	2.66c	2.98b	2.21b
Ethrel @1000 ppm	5.40b	7.25a	5.16a	5.40b	7.25a	5.16a	33.33b	47.67a	44.74a	2.75b	3.117a	2.38a
Ethrel @1500ppm	6.36a	5.70c	4.03bc	6.36a	5.70c	4.03bc	44.44a	39.41d	27.56d	2.88a	2.780d	1.86c
Mean	4.75	6.50	4.29	4.75	6.50	4.29	32.55	44.05	35.566	2.622	2.935	2.11
C.V.	3.779	5.983	8.609	3.779	5.983	8.609	4.416	3.296	4.933	1.171	0.886	1.785
C.D. (P=0.05)	0.213	0.462	0.439	0.213	0.462	0.439	1.709	1.727	2.085	0.037	0.031	0.045

Table 3: Effect of Ethrel on Sensory Evaluation on Papaya fruit during storage.

Treat-ment	Colour			Flavour			Texture			Aroma			Overall Acceptability		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	3.83d	6.90c	4.83	4.40d	7.43c	5.57c	4.37c	7.43b	5.43c	4.33c	7.40c	5.47a b	4.13d	6.83d	5.30c
Ethrel @ 500 ppm	3.97c d	7.17b c	5.03	4.57d	7.63b c	5.83b	4.60c	7.60a b	5.67c	4.50c	7.53b c	5.63a	4.27c d	7.13b c	5.70b
Ethrel @ 750ppm	4.50b c	7.40a b	5.33	4.93c	7.83a b	6.10a	5.10b	7.83a b	6.03b	4.60b c	7.70b	5.87a	4.43c	7.30b	5.80b
Ethrel @ 1000 ppm	4.93b	7.84a	5.50	5.27b	8.00a	6.27a	5.33b	8.03a	6.33a	4.83b	8.03a	6.00a	4.70b	7.67a	6.17a
Ethrel @ 1500ppm	8.20a	7.37b	4.80	8.17a	7.13d	5.30d	7.80a	6.80c	5.47c	8.03a	6.97d	5.00b	8.00a	7.00c d	5.20c
Mean	5.09	7.33	5.10	5.47	7.61	5.81	5.44	7.54	5.79	5.26	7.53	5.59	5.11	7.19	5.63
C.V.	9.187	5.117	15.339	3.895	2.967	3.077	5.584	4.934	3.765	4.840	2.286	8.075	3.757	3.476	3.466
C.D. (P=0.05)	0.556	0.446	NS	0.087	0.092	0.213	0.361	0.442	0.259	0.303	0.205	0.537	0.228	0.297	0.232

fruits when dipped in 250-500 ppm ethrel for 5 minutes.

Effect on Titratable Acidity : It is obvious from the present finding (Table 1) that acidity of the papaya fruit was decreased by post harvest application of ethrel and the response varied within the concentrations. Maximum decrease (0.054%) in total acidity was found in fruits treated with 1500 ppm ethrel after 9 days of the treatment.Similar finding was also noted in guava (Singh *et al.,* 19) and in date (Sharma and Singh, 18). Riberau-Gayon (14) suggested that transformation of organic acids into sugars was one of the reasons for deceasing organic acids during fruit ripening. Therefore, another possibility seemed that ethrel might enhance the conversion of organic acids to sugars since present findings revealed that sugar content was increased and acidity was decreased following ethrel application.

Effect on Total Soluble Solids : The maximum T.S.S. (11.87°Brix) was observed in 1500 ppm after 3 days of the treatment which was at par with in 1000 ppm treated fruits (12.67%) after 6 days of the treatment. Similarly, increased total soluble solids due to post harvest application of ethrel was also reported by Singh *et al.* (19) in guava, Sharma and Singh (18) in date, Sandhu and Singh (15) in peaches and Abbas *et al.* (1) in orange. Declining trend was noted thereafter irrespective of the treatments. A much reduced T.S.S. was noted on nine days after storage. The initial increased rate of T.S.S. might be due to rapid loss of water from the fruits and the conversion of starch in to sugar at a faster rate (Pool *et al.*, 12). The decreased T.S.S. content at later stage of storage might be due to exhaustion of substrate of conversion i.e. starch (Leopold, 8).

Effect on Reducing sugars and Total sugars: The present investigation revealed that the total sugars and reducing sugar increased with increasing ethrel concentration (Table 2).The maximum total sugar (8.11%) and reducing sugar (6.36%) was observed in 1500 ppm treated fruits as early as three days after storage. The values of sugar content increased upto 6 days after storage and declined thereafter except in 1500 ppm treated fruits where the value decreased on 6 days after storage. In the present experiment, ethrel enhanced the rate of accumulation of reducing sugar in papaya fruits. Similarly, high percentage of reducing sugar with ethrel application in dates was observed by Sharma and Singh (18). The finding is corroborated with the result of Kumar and Singh (7) who observed that higher percentage of sugar in ethrel (750 and 500 ppm) treated mango fruits over control).

Effect on Ascorbic Acid : the ascorbic acid (Table 2) increased significantly up to 6 days after storage for all the treatment (except 1500 ppm) and declined thereafter but the maximum ascorbic acid was observed in 1500 ppm (44.44mg per 100g) as early as 3 days after storage. The fruits during storage, in general showed a declining trend in ascorbic acid content significantly irrespective of the treatments applied but the value was increased with corresponding increase in the concentration of ethrel. A reduction in ascorbic acid content with the subsequent prolongation of storage might be due to rapid oxidation phenomenon of organic acid in later storage of storage (Orzolek and Argel, 11).

Effect on Total Carotenoids : A significant increase in total carotenoids (Table 3) was observed upto six days after storage in all the treatment and declined thereafter except in 1500 ppm where decline in total carotenoids occurs on 6 days after storage. The maximum total carotenoids was observed in 6 DAS in 1000ppm (3.12 mg per 100g) while 2.88 mg per 100g of total carotenoids was observed in 1500ppm treated fruits an early as 3 days after storage.Ethylene might increase the carotenoid through its synthesis. This fact was established by Young and Jahn (21) while working in citrus.

Effect on the Organoleptic evaluation : Present investigation (Table 3) revealed that ethrel application had significantly influenced the sensory evaluation scores for flesh colour, flavour, texture, aroma and overall acceptability scores. In support

of the present study, the colour development in papaya fruits was remarkably affected by post-harvest application of ethrel. Out of all the concentrations of ethrel tried, 1500 ppm gave the most attractive and deep coloured fruits. The findings of Shanmugavelu *et al.* (17) in mango and papaya support the contention that ethrel treated fruits develop attractive colour. However, the specific mode of action of ethrel in accelerating colour development is not clearly understood. Nour and Goukh (10) observed that peel colour score progressively increased during ripening of guava fruits. They observed that fruits treated with ethrel (250-1000 ppm) reached the full yellow stage 3, 4 and 6 days earlier than untreated fruits respectively. They also reported ethrel treated fruits had reached the soft stage 2-6 days earlier than the control. The study was also supported by Jayawickrama *et al.* (6) observed that sensory evaluation scores recorded for flesh colour, aroma ,taste and overall acceptability were significantly higher in ethrel treated papaya fruits as compared to control.

CONCLUSION

It can be concluded from the present investigation that use of ethrel had a significant impact on the shelf life of the papaya fruits because the ethrel treated fruit could retain the characters like T.S.S., acidity, sugar, ascorbic acid, total carotenoids and organoleptic characters for a longer duration than control. Among the treatments ethrel application @1000 ppm was the best for retaining the various physical, chemical and sensory attributes followed by ethrel application @ 750 ppm till the end of storage studies whereas ethrel @ 1500 ppm was the best for inducing the earliness of ripening in fruits and preserving efficiently various physical, chemical and sensory attributes till 6 DAS.

REFERENCES

1. Abbas, M.F., Jassim, A. M. and Taha, A. H. A.(1984). The effect of Ethephon on ripening of cv.Mahaley orange. *J. Hort. Sci.,* **59**: 127-129.
2. Anonymous (2010). *Indian Horticulture Database,* NHB, Gurgoan.
3. Guerra, M.P., Pedrotti, E.L. and Reis, M.S.D.(1984). Ripening of bananas (*Musa accuminata* Simm. and Shep.) of cultivar Nanicao treated with different ethephon concentrations. *Empresa,* **1:**183-201.
4. Gupta, O.P., Chauhan, K. S. and Daulta, B. S. (1983). Effect of ethrel on the storage life of citrus fruits. *Res. H.A.U.,* **13:** 458-463.
5. Holl,W.(1977). Fruit tipening. *Plant Res. Dev.*, **5:**117-126
6. Jayawickrama, F., Wijeratnam, R.S.W. and Perera, S. (2001). The effect of selected ripening agents on organoleptic and physico-chemical properties of papaya, *Acta Hort.*, **533 :** 275-281.
7. Kumar, P. and Singh, S. (1993). Effect of GA_3 and ethrel on ripening and quality of mango cv. Amrapali. *The Hort. J.,* **6**(1):19-23.
8. Leopold, A.C. (1964). *Plant Growth and Development.* Mc Graw Hill Publication.New York.
9. Murray, J.M., Belahunty, C.M. and Baxter, A. (2001). Descriptive sensory analysis-past, present and future. *Food Res. Int.,* **34:** 461-471.
10. Nour, I.A.M. and Goukh, A.B.A. (2010) Effect of ethrel in aqueous solution and ethylene released from ethrel on guava fruit ripening. *Agric. Biol. J. N. Amer.,* **1**(3): 232-237
11. Orzolek, M.D. and Argell, F.F. (1974). Effect of ethephon on ascorbic acid and soluble solids in processing tomato cultivars. *Hort. Sci.*, **9**:306.
12. Pool, R.M., Weaver, R.J. and Kliever, W.M. (1972). The effect of growth regulators on change in fruits of Thompson seedless during cold storage. *J. Am. Soc.,* **97:** 67-70
13. Ranganna,S.(2007). *Handbook of analysis and quality control of fruits and vegetables products,* TataMcGraw Hill Publ. Co. Ltd. New Delhi, 1, 12-16,105-106.
14. Ribereau Gayon, G. (1968). Etudedes mechanisms synthese at de transformation delacide mailique,de l' acide tartique at de I' acide mailique,chaz *Vitis vinifera* L. *Phytochem.,* **7:**1471-1482.

15. Sandhu, A.S. and Singh, Z. (1983). Effect of ethephon on maturation and fruit quality of peach. *Punjab Hort. J.,* **23:** 172-175
16. Sampio, V.R. (1981). Effect of 2-chloro-ethylphosphonic acid on mango ripening. Luiz de *queniroz.,* **38:** 85-91.
17. Shanmugavelu, K.G., Selvaraj, P. Veerannah, L. and Chittarichelvam, R. (1976). Effect of ethephon on the pipening of fruits. *Prog. Hort.*, **8:** 89-96.
18. Sharma, R.K. and Singh, I.S. (1981). Effect of preharvest application of ethephon on ripening and quality of two cultivars of date.First National Workshop on Arid Zone Fruit Research held at H.A.U., Hissar.
19. Singh, H.K., Singh, I.S. and Chauhan,K.S. (1979). Effect of pre-harvest application of ethephon on ripening and quality of guava cv. Sardar. *Udyanika,* **2:** 117-120.
20. Unreth, C.R.(1971). Apple maturity and quality as affected by harvested by harvested application of ethephon (2-chloroethyl phosphonic acid). *Hort. Sci.,* **6:** 303
21. Young, R. and Jahn, O. (1972). Ethylene induced carotenoids accumulation in citrus rind. *J. Amer. Soc. Hort. Sci.,* **97:** 258-261.