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Impact of growth retardants on yield and quality of papaya (*Carica papaya* L.) CV. GJP 1

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Abstract
The investigation titled "Effect of growth retardants on yield and quality of papaya (*Carica papaya* L.) cv. GJP 1" was conducted at Fruit Research Station, Lalbaug, Junagadh Agricultural University, Junagadh, during the year 2022-23. The experimental design followed a Randomized Block Design with three replications and included 10 treatments. The results of the investigation regarding the effect of growth retardants on yield and quality parameters showed that the treatment with ethrel 250 ppm resulted in the highest average fruit length (21.91 cm), average fruit circumference (44.25 cm), average fruit weight (1262.21 g), average pulp weight (1021.35 g), and average peel weight (160.65 g). Moreover, this treatment led to a higher pulp: peel ratio (6.36), total soluble solids (TSS) content of 9.10 °Brix, and total sugar content of 9.53%, which included reducing sugar content of 7.99% and non-reducing sugar content of 1.54%. Additionally, the treatment with ethrel 250 ppm resulted in the lowest average peel weight percentage (12.73%). In summary, the application of ethrel at 250 ppm showed promising results in enhancing various yield and quality attributes of papaya fruits, including size, weight, pulp-to-peel ratio, TSS content, and sugar composition.

Keywords: growth, retardants, papaya, *Carica papaya* L.

1. Introduction

In India, various fruit crops are cultivated in different regions based on climate conditions. In tropical regions, popular fruit crops include mango, banana, sapota, papaya, guava, pineapple, and jackfruit. In subtropical regions, mandarin, litchi, sweet orange, avocado, grape, rambutan, and loquat are commonly grown. In temperate regions, fruit crops like apple, pear, peach, plum, cherry, and strawberry thrive. Gujarat, particularly the Saurashtra region, is known for cultivating several fruit crops, including mango, papaya, custard apple, guava, black jamun, and pomegranate. Although papaya is typically considered a tropical fruit, it can adapt to subtropical conditions as well.

Carica papaya L. is the botanical name of papaya, and it belongs to the Caricaceae family, which consists of 48 species, with *Carica papaya* being the edible variety (Chadha, 1992) [6]. Originally from Mexico and tropical America, it was introduced to India during the 16th century through Malacca. Papaya plants are herbaceous and evergreen, with a single straight trunk and trifoliate leaves with long petioles. They can grow up to a height of 2.2 to 2.4 meters and tolerate low temperatures up to elevations of 1500-2000 meters. Papaya is renowned for its rapid growth and begins bearing fruit within eight months of transplantation, making it a highly profitable crop. The fruit is not only refreshing and delicious but also holds significant nutritive and medicinal value. It is rich in vitamins A and C, and the yellow pigment in papaya is due to Caricaxanthin. The fruit contains the valuable proteolytic enzyme papain, which aids in protein digestion, meat tenderization, and beer clarification. Additionally, papain is used for treating cuts, stings, burns, and in ointment production. Regular consumption of papaya is beneficial for heart health, diabetes management, and cancer prevention. Papaya is considered a "superfood" due to its numerous health benefits.

The experiment focused on the use of growth retardants, which are organic chemicals that regulate plant height by slowing down cell division and expansion in tissues without causing formative effects. Ethrel (2-Chloroethyl phosphonic acid or CEPA) releases ethylene gas upon contact with plant tissues, triggering the mechanism of flowering. Cycocel (CCC) (2-Chloroethyl trimethyl ammonium chloride or CCC or Chlormequat) acts as an anti-gibberellin (dwarfing agent) and can retard growth by reducing stem elongation and regulating plant height and cell division. Paclobutrazol inhibits gibberellin biosynthesis by blocking the conversion of Kaurene and Kaurenoic acid, leading to reduced cell elongation and internode extension, ultimately retarding plant growth. Gibberellins, on the other hand, stimulate cell elongation. When the production of gibberellins is inhibited, cell division still occurs, but the new cells do not elongate.

2. Materials and Methods

The experiment titled "Effect of growth retardants on yield and quality of papaya (*Carica papaya* L.) cv. GJP 1" was conducted at the Fruit Research Station, Lalbaug, Junagadh Agricultural University, Junagadh, from January 2022 to December 2022. The experimental design followed a Randomized Block Design (RBD) with ten treatments, including T_1- (Control), T_2- (Ethrel 150 ppm), T_3- (Ethrel 250 ppm), T_4- (Ethrel 350 ppm), T_5- (Cycocel 750 ppm), T_6- (Cycocel 1500 ppm), T_7- (Cycocel 3000 ppm), T_8- (Paclobutrazol 250 ppm), T_9- (Paclobutrazol 500 ppm) and T_{10}- (Paclobutrazol 1000 ppm). Each treatment had three replications.

The objective of the experiment was to investigate the impact of growth retardants on various yield and quality parameters of papaya, such as days to maturity, number of fruits per plant, average fruit length, average fruit circumference, average fruit weight, average pulp weight, average peel weight, pulp: peel ratio, average seed weight, yield, Total Soluble Solids (TSS), total sugar, reducing sugar, and non-reducing sugar. Collected data were subjected to statistical analysis using the method provided by Panse and Sukhatme (1985) [22]. All characters were examined for significance using the "F" test. The Standard Error of Mean (SEm ±) and Critical Difference (CD) were calculated at the 5 percent level of significance.

3. Result and Discussion

The data presented in Tables 1, 2 and 3 observed that growth retardants were produce a significant effect on yield and quality parameters in papaya studied in this experiment.

3.1 Yield parameters

The investigation of data demonstrated that the application of different treatments of growth retardants had a significant impact on fruit yield parameters such as days to maturity, number of fruits per plant, average fruit length, average fruit circumference, average fruit weight, average pulp weight, average peel weight, pulp: peel ratio, yield and non-significant effect on seed weight.

Early maturity was noted in plants that were treated with growth retardants and minimum days to maturity (120.33) was noted with the application of cycocel 3000 ppm (T_7). It was at par with T_5 (cycocel 750 ppm), T_6 (cycocel 1500 ppm), T_9 (Paclobutrazol 500 ppm) and T_{10} (Paclobutrazol 1000 ppm) treatments (129.32, 124.47, 130.53 and 129.93, respectively). Likewise, the maximum number of fruits per plant (25.29) was noted with the application of cycocel 3000 ppm (T_7). It was at par with T_5 (cycocel 750 ppm) and T_6 (cycocel 1500 ppm) treatments (22.23 and 23.46, respectively). The maximum average fruit length (21.91 cm) recorded in ethrel 250 ppm (T_3). It was at par with T_2 (ethrel 150 ppm), T_4 (ethrel 350 ppm), T_6 (cycocel 1500 ppm), T_7 (cycocel 3000 ppm), T_9 (Paclobutrazol 500 ppm) and T_{10} (Paclobutrazol 1000 ppm) treatments (20.59, 21.73, 19.72, 20.43, 19.73 and 19.55 cm, respectively). The maximum fruit circumference (44.25 cm) was found in ethrel 250 ppm (T_3). It was at par with T_2 (ethrel 150 ppm) and T_7 (cycocel 3000 ppm), treatments (42.31 and 41.80 cm, respectively). Significantly, the maximum average fruit weight (1262.21 g) and pulp weight (1021.35 g) were found in ethrel 250 ppm (T_3).

The minimum average peel weight (112.19 g from 773.64 g fruit) was found in the control (T_1). It was at par with T_8 (Paclobutrazol 250 ppm) treatment (124.16 g from 882.39 g fruit). The pulp: peel ratio (6.36) of fruit was higher in ethrel 250 ppm (T_3). Treatment T_3 remained at par with T_4 (ethrel 350 ppm) and T_7 (cycocel 3000 ppm) treatments (6.15 and 6.06, respectively). Significantly, the maximum average yield per plant (29.86 kg) and yield ton per hectare (92.15 t/ha) yield ton per hectare was recorded in cycocel 3000 ppm (T_7). The yield increase might be due to inhibition of vegetative growth, resulting in better flowering, fruit set and ultimately higher fruit retention as well as translocation of extra metabolites towards the reproductive growth or sink i.e., fruits. This result in agreement with the finding Brahamchari *et al*. (1995) [5] in guava, Sarkar *et al*. (1998) [16] in mango, Nath and Baruah (1999) [13] in lemon, Kumar *et al*. (2005) [10] in peach, Agrawal and Dikshit (2008) [1] in sapota, Kumar *et al.* (2012) [11] in strawberry, Patil *et al.* (2016) [15] in mango, Subrata *et al*. (2019) [17] in wood apple, Varu (2019) [19], Varu (2020) [20] in papaya, Parsana *et al*. (2023) [14] in custard apple.

3.2 Quality parameters

The data revealed that the application of different growth retardants produced a significant effect on quality parameters such as TSS, total sugar, reducing sugar and non-reducing sugar.

The maximum TSS (9.10 °Brix) was found in ethrel 250 ppm (T_3). It was at par with T_2 (ethrel 150 ppm) and T_4 (ethrel 350 ppm), treatments (8.40 and 8.80, °Brix respectively). Similarly, the highest level of total sugar (9.53%) was found in ethrel 250 ppm (T_3). It was at par with T_2 (ethrel 150 ppm) and T_4 (ethrel 350 ppm), treatments (9.09 and 9.24%, respectively). The reducing sugar (7.99%) was higher in ethrel 250 ppm (T_3). It was at par with T_2 (ethrel 150 ppm), T_4 (ethrel 350 ppm), T_5 (cycocel 750 ppm), T_6 (cycocel 1500 ppm) and T_7 (cycocel 3000 ppm), treatments (7.74, 7.80, 7.34, 7.54 and 7.63%, respectively). The maximum non-reducing sugar (1.54%) was found in ethrel 250 ppm (T_3). It was at par with T_4 (ethrel 350 ppm) treatment (1.44%). The increase in sugar content in ethrel-treated plants might be due to the rapid ripening of fruits and accelerated activities of hydrolytic enzymes, which is associated with high metabolic changes in fruits, leading to the conversion of complex polysaccharides and organic acids into simple sugars through higher respiration and carbon assimilation activity. These results are in line with earlier findings of Syamal *et al*. (2010) [18], Kacha *et al*. (2014) [9] in phalsa, Hazarika *et al*. (2016) [7], Bhadarka *et al*. (2022) [3], Makwana *et al*. (2023) [12] in papaya and Vasava *et al*. (2023) [21] in brinjal.

Table 1: Effect of growth retardants on yield parameters of papaya (*Carica papaya* L.) cv. GJP 1

Treat. No.	Treatments	Days to maturity	Number of fruits per plant	Average fruit length (cm)	Average fruit circumference (cm)	Average fruit weight (g)
T_1	Control	141.27	18.80	17.04	33.89	773.64
T_2	Ethrel 150 ppm	133.62	19.75	20.59	42.31	1139.03
T_3	Ethrel 250 ppm	131.40	19.65	21.91	44.25	1262.21
T_4	Ethrel 350 ppm	131.20	20.12	21.73	40.06	1158.10
T_5	Cycocel 750 ppm	129.32	22.23	18.93	38.30	1024.54
T_6	Cycocel 1500 ppm	124.47	23.46	19.72	39.99	1115.02
T_7	Cycocel 3000 ppm	120.33	25.29	20.43	41.80	1144.83
T_8	Paclobutrazol 250 ppm	130.60	21.09	18.34	35.82	882.39
T_9	Paclobutrazol 500 ppm	130.53	21.22	19.73	36.10	970.38
T_{10}	Paclobutrazol 1000 ppm	129.93	21.90	19.55	39.18	1013.79
SEm±		3.449	1.038	0.808	1.271	27.481
C. D. at 5%		10.25	3.08	2.40	3.78	81.65
C. V.%		4.59	8.43	7.07	5.62	4.54

Table 2: Effect of growth retardants on yield parameters of papaya (*Carica papaya* L.) cv. GJP 1

Treat. code	Treatments	Average pulp weight (g)	Average peel weight (g)	Pulp: Peel ratio	Average seed weight (g)	Average yield /plant (kg)	Yield (t/ha)
T_1	Control	592.33	112.19	5.28	68.78	13.94	43.01
T_2	Ethrel 150 ppm	911.75	156.13	5.84	70.78	24.14	74.50
T_3	Ethrel 250 ppm	1021.35	160.65	6.36	80.18	23.82	73.52
T_4	Ethrel 350 ppm	933.67	151.89	6.15	71.67	22.74	70.19
T_5	Cycocel 750 ppm	810.67	141.74	5.72	71.62	21.84	67.42
T_6	Cycocel 1500 ppm	889.47	153.81	5.78	70.15	23.40	72.23
T_7	Cycocel 3000 ppm	919.10	151.65	6.06	73.95	29.86	92.15
T_8	Paclobutrazol 250 ppm	683.68	124.16	5.51	74.31	18.69	57.67
T_9	Paclobutrazol 500 ppm	758.53	138.53	5.48	73.21	19.62	60.55
T_{10}	Paclobutrazol 1000 ppm	799.33	140.66	5.68	73.13	20.84	64.31
SEm ±		23.759	4.833	0.156	2.139	1.323	4.084
C. D. at 5%		70.59	14.36	0.46	NS	3.93	12.13
C. V.%		4.95	5.85	4.66	5.09	10.47	10.47

Table 3: Effect of growth retardants on quality parameters of papaya (*Carica papaya* L.) cv. GJP 1

Treat. No.	Treatments	TSS (°Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
T_1	Control	6.69	7. 73	6.82	0.91
T_2	Ethrel 150 ppm	8.40	9.09	7.74	1.35
T_3	Ethrel 250 ppm	9.10	9.53	7.99	1.54
T_4	Ethrel 350 ppm	8.80	9.24	7.80	1.44
T_5	Cycocel 750 ppm	7.57	8.58	7.34	1.25
T_6	Cycocel 1500 ppm	7. 80	8.77	7.54	1.23
T_7	Cycocel 3000 ppm	7.90	8.80	7.63	1.18
T_8	Paclobutrazol 250 ppm	6.92	8.22	7.06	1.16
T_9	Paclobutrazol 500 ppm	7.07	8.28	7.12	1.16
T_{10}	Paclobutrazol 1000 ppm	7.27	8.49	7.26	1.23
SEm ±		0.283	0.212	0.230	0.057
C. D. at 5%		0.84	0.63	0.68	0.17
C. V.%		6.32	4.24	5.37	7.95

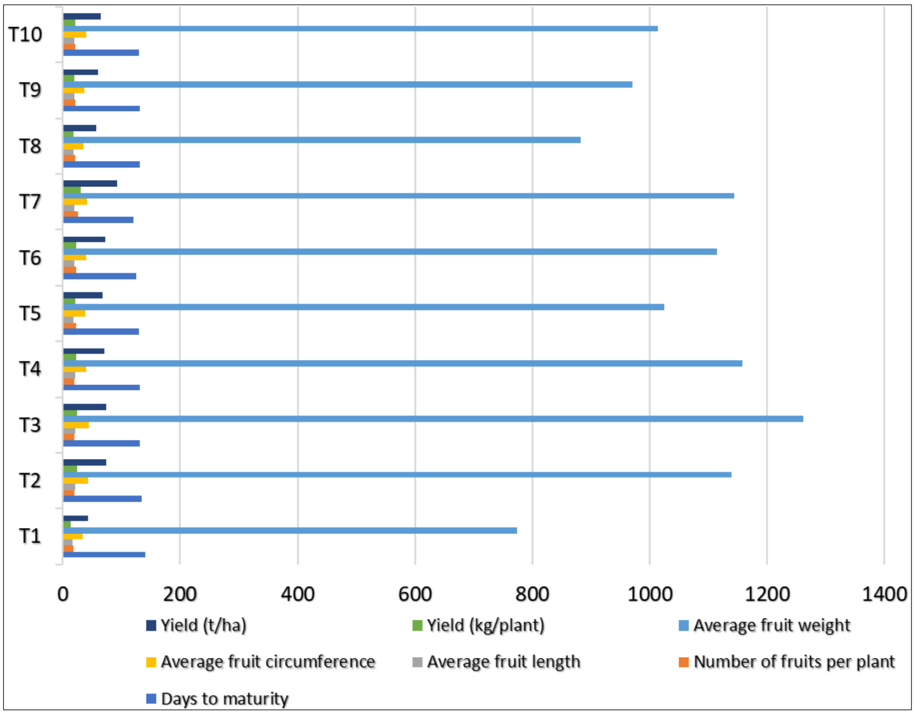

Fig 1: Effect of growth retardants on yield of papaya (*Carica papaya* L.) cv. GJP 1

4. Conclusion

The results of the investigation indicate that the application of ethrel at 250 ppm (0.64 ml/liter of water) had a significant impact on various yield-related characteristics of papaya fruits. It resulted in fruit with shorter fruit lengths, smaller fruit circumferences, lower fruit weight, and reduced pulp weight. The pulp-to-peel ratio was also higher in these fruits, indicating a higher proportion of edible pulp. Additionally, the fruits treated with ethrel at 250 ppm exhibited favorable biochemical parameters. Notably, the percentage of peel weight was the least among all treatments.

However, it is worth noting that the number of fruits was relatively lower in the ethrel-treated group compared to other treatments. Despite this, the findings suggest that ethrel at 250 ppm can be effective in enhancing certain quality aspects of papaya fruits, making them more suitable for certain purposes or specific market demands.

5. References

1. Agrawal S, Dikshit SN. Studies on the effect of plant growth regulators on growth and yield of sapota (*Achras sapota* L.) cv. Cricket ball. Indian J Agric. Res. 2008;42(3):207-211.
2. Arrilia MC, De JF, Mencha JF, Rolz CS. Tropical sub-tropical fruits. AVI. West part, connection, USA; c1980. p. 316-340.
3. Bhadarka Chandni, Kanzaria DR, Karmur NN, Muskan Sandh, Parsana JS, Patel HN, *et al*. Effect of sowing time on papaya seedlings. The Pharma Innovation Journal. 2022;SP-11(8):1416-1420.
4. Bhgawat S, Haytowitz DB, Holden JM. USDA database for the flavonoid content of selected foods. US Department of Agriculture, Beltsville, MD, USA; c2011.
5. Brahamchari VS, Mandal AK, Kumar R, Rani R. Effect of growth substance on fruit-set and Physico-chemical characteristics of 'Sardar' guava (*Psidium guajava* L.). Recent Hort. 1995;2(2):127-131.
6. Chadha KL. Scenario of papaya production and utilization in India. Indian J Hort. 1992;49(2):97-119.
7. Hazarika TK, Balsri DS, Mandal D, Nautiyal BP, Shukla AC. Effect of plant growth regulators on growth, yield and quality of tissue cultured papaya (*Carica papaya* L.) cv. Red Lady. Indian J. Hortic. Sci. 2016;86(3):404-408.
8. Heywood VH, Brummitt RK, Culham A, Seberg O. Flowering plant families of the world. Firefly Books; c2007. ISBN 9781554072064.
9. Kacha HL, Jat G, Patel SK. Performance of various plant growth regulators on yield and quality of phalsa (*Grewia asiatica* L.). Hort Flora Res. Spectrum. 2014;3(3):292-294.
10. Kumar R, Rai RM, Singh RB, Pant N. Effect of growth retardants on vegetative growth, yield and fruit quality of high-density peach tree. J Appl. Hortic. 2005;7(2):139-141.
11. Kumar R, Sharma N, Jamwal M, Sharma RM, Singh DB, Parmar AM. Production and economic studies of PGRs treated strawberry (*Fragaria x ananassa* Duch.) cv. Sweet Charlie. American-Eurasian J Agriculture and Environment Sci. 2012;12:1543-1547.
12. Makwana PC, Kanzaria DR, Chitroda RL, Kavad MH, Thumar KP. Effect of pre and post-harvest treatments on papaya and banana. Research matrix International Multidisciplinary Journal. 2023;3(6):51-55.
13. Nath JC, Baruah K. Regulation of flowering time, plant growth and yield in Assam lemon (*Citrus limon*) with the help of pruning and growth regulators. Ind. J Agril. Sci. 1999;69(4):292-294.
14. Parsana JS, Varu DK, Parmar VM, Shivani Patel, Kanzaria DR, Subhrajyoti Mishra. Influence of Pruning and integrated nutrient management on Custard Apple (*Annona squamosa* L.) Agricultural Mechanization in Asia, Africa and Latin America. 2023;54(04):12865-12874.
15. Patil SR, Ganvir MM, Nagdeve MB, Patode RS. Effect of growth regulators on flower regulation in mango var. Pairi. 3rd National Conference on Water, Environment

and Society (NCWES - 2016); c2016. p. 2-76.
16. Sarkar SK, Gautam B, Srihari D, Seethambaram Y. Regulation of tree vigour in mango. Ind. J Hort. 1998;55(1):37-41.
17. Subrata M, Subham G, Ghosh SN. Effect of CCC, KNO_3, $ZnSO_4$ and MAP on flowering and yield of wood apple (*Feronia limonia* Swingle). Int. J Chem. Stud. 2019;7(2):2069-2071.
18. Syamal MM, Bordoloi B, Pakkiyanathan K. Influence of plant growth substances on vegetative growth, flowering, fruiting and fruit quality of papaya. Indian J Hort. 2010;67(2):173-176.
19. Varu DK. Response of different selections and variety on growth, flowering, yield and quality in papaya. AGRES – An International e. Journal. 2019;8(2):109-119.
20. Varu DK. Evaluation of various selections on growth, flowering, yield and quality in papaya. International Journal of Chemical Studies. 2020;8(1):1105-1111.
21. Vasava HV, Tejal M Chaudhari, Parasana JS, Varu DK, Shivani Patel, Subhrajyoti Mishra. Performance of different grafted variety and mulching in brinjal (*Solanum melongena* L). Agricultural Mechanization in Asia, Africa and Latin America. 2023;54(04):12981-12988.
22. Panse VG, Sukhatme PV. Statistical methods for agricultural research. ICAR, New Delhi. 1985;8:308-18.