Plant Archives Vol. 25, No. 2, 2025 pp. 2352-2356 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.334

MITIGATION OF FLOWER AND FRUIT DROP IN PAPAYA (*CARICA PAPAYA* L.) DURING SUMMER BY USING DIFFERENT BIOREGULATORS

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(Date of Receiving-18-07-2025; Date of Acceptance-25-09-2025)

ABSTRACT

The present investigation entitled “Mitigation of flower and fruit drop in papaya (*Carica papaya* L.) during summer byusing different bioregulators” was conducted from December 2024 to September 2025 at the Horticultural Research Station, Anantharajupeta, Annamayya District, Andhra Pradesh. The experiment wascarried out to know the influence of foliar application of different bioregulators onflowering, fruit drop, growth and yield attributes of papaya cv. Red Lady during the summer season. The study was laid out in a Randomized Block Design (RBD) comprising eleven treatments: T_1 - Homobrassinolide @ 1 ml/L, T_2- Ortho silicic acid @ 2 g/L, T_3- Humic acid @ 2 ml/L, T_4- Seaweed extract @ 2 ml/L, T_5- Salicylic acid @ 200 ppm, T_6- Ethrel @ 150 ppm, T_7- GA3 @ 200 ppm, T_8- Glucose @ 1.5 g/L, T_9- Sodium nitrophenolate @ 2 ml/L, T_{10}- Urea @ 1%, and T_{11}- Control, each replicated thrice.

Among the treatments, foliar application of Homobrassinolide @ 1 ml/L (T_1) recorded the highest values for key growth and yield parameters, including plant height (114.37 cm), collar diameter (42.28 mm), number of marketable fruits per plant (36.55), fruit weight per plant (40.57 kg), fruit weight per plot (365.13 kg) and estimated yield per hectare (93.90 tonnes), followed closely by Salicylic acid @ 200 ppm and GA3 @ 200 ppm. These findings suggest that Homobrassinolide is highly effective in mitigating flower and fruit drop, thereby significantly enhancing the productivity of papaya under summer stress conditions.

Key words: Papaya, Red Lady, Bioregulators, Growth, Yield

Introduction

Papaya (*Carica papaya*) is a tropical fruit of high nutritional and medicinal value, originally cultivated in southern Mexico and Costa Rica.India is the leading global producer, contributing over 5.9 million tonnes annually from 138,000 hectares, with Andhra Pradesh consistently ranking first. The state produces around 1.78 million tonnes, with high productivity levels, especially in districts like Kadapa, Kurnool, and Anantapur (NHB, 2018).

Papaya is a highly valued fruit for its year-round yield, adaptability and fast economic returns. Consumed fresh, processed into jams and syrups, or used as a vegetable when green, it also provides papain, an enzyme widely utilized in pharmaceuticals, cosmetics and food industries. The fruit is considered as a low calorie (100 gm of ripe fruits contains only 32 kcal) nutrient rich fruit and is used as a diuretic, antiseptic and stomachic, overall it performs the function of detoxifier, activator of metabolism, body

Table 1: Effect of different bioregulators on plant height, collar diameter, fruit weight, total number of marketable fruits, fruit weight per plant, fruit weight per plot and yield per hectare in papaya cv. Red Lady.

Treat-ments	Plant height (cm)	Collar diameter (mm)	Fruit weight (kg)	Total no. of marketable fruits/plant	Fruit weight/plant (kg)	Fruit weight/ plot (Kg)	Yield/ hectare (tonnes)
T_1	277.98	114.37	1.11	36.55	40.57	365.13	93.90
T_2	262.08	103.09	1.02	31.52	32.15	323.11	83.09
T_3	259.74	108.30	0.94	32.54	30.59	307.50	79.08
T_4	260.85	107.58	1.05	32.89	34.54	331.58	85.27
T_5	274.53	112.03	1.09	35.12	38.28	352.90	90.75
T_6	271.99	109.51	0.99	33.44	33.10	325.80	83.78
T_7	266.03	110.84	1.07	34.11	36.50	345.16	88.77
T_8	263.30	100.56	0.93	31.44	29.24	304.60	78.33
T_9	264.10	108.68	0.95	33.17	31.51	313.84	80.71
T_{10}	259.05	102.97	0.92	31.22	28.72	300.54	77.29
T_{11}	257.94	100.23	0.90	30.87	27.78	295.64	76.03
SE(m)±	3.35	1.77	0.02	0.47	1.03	5.85	1.07
C.D 5%	9.94	5.26	0.05	1.39	3.04	17.39	3.18

rejuvenator and also helps in maintenance of body homeostasis because it is rich in antioxidants, folate, magnesium, fibre and traces of vitamin B complex.100 gm of edible papaya contains 89.6 % moisture, 9.5 % carbohydrate, calcium 0.1%, phosphorus 0.1%, minerals 0.4%, Iron 0.4mg and protein 0.5%. It also contains Vitamin A (carotene) - 2020 IU, Vitamin B1 (thiamine) - 40 IU, Vitamin B2 (riboflavin) - 250 IU, as well as Vitamin B3 (niacin) - 0.2 IU. The calorific value of papaya is 4.0% (Maurya *et al.,* 2023)

The Red Lady variety leads commercial cultivation due to its sweet flavour, vibrant red-orange flesh, large fruit size, and extended shelf life.

Bioregulators are organic or synthetic compounds that influence plant physiological processes such as growth, flowering, fruit development and stress tolerance. Foliar application of bioregulators can enhance nutrient uptake, improve hormonal balance and mitigate the adverse effects of abiotic stress. Growth bioregulators play a vital role in enhancing flowering, fruiting and overall quality, with environmental factors influencing plant sex and fruit morphology. The use of plant growth regulators has assumed an integral part of modern fruit production to improve the quality and production of fruits and it has resulted in outstanding achievements in a number of fruit crops with regard to improvements in yield and quality (Jain and Dashora 2011).

Materials and Methods

The field experiment entitled "Mitigation of flower and fruit drop in papaya (*Carica papaya* L.) during summer by using different bioregulators"was conducted during December 2024 and September 2025 at the Horticulture Research Station, Dr. YSR Horticultural University, located in Anantharajupeta, Annamayya district, Andhra Pradesh.

Seed material (Red Lady F1 Hybrid) was brought from KNOWN-YOU SEED (INDIA) PVT. LTD. The seedlings were raised at the Horticultural Research Station, Anantharajupeta. The field experiment was laid out using a Randomized Block Design (RBD), comprising eleven treatments,replicated thrice. The treatment details are T_1 - Homobrassinolide @ 1 ml/L, T_2 - Ortho silicic acid @ 2 g/L, T_3 - Humic acid @ 2 ml/L, T_4 - Seaweed extract @ 2 ml/L, T_5 - Salicylic acid @ 200 ppm, T_6 - Ethrel @ 150 ppm, T_7 - GA3 @ 200 ppm, T_8 - Glucose @ 1.5 g/L, T_9 - Sodium nitrophenolate @ 2 ml/L, T_{10} - Urea @ 1%, and T_{11}– Control. The total number of plants are 396 and each treatment contains 12 plants and is replicated three times. The Planting was done at a spacing of 1.8m × 1.8m. Foliar application is given twice, first spray at the second fortnight of March and second spray at the first fortnight of May.

Plate 1: Field view of an experimental block of papaya.

Observations recorded are plant height, collar diameter, days to flower initiation, days to 50% flowering, days to 1st fruit set, days to 1st harvest, Fruit weight, Total no. of marketable fruits/plant, fruit weight per plant, fruit weight per plot and yield per hectare.

Results and Discussion

Significant differences among treatments were recorded for growth, yield, and reproductive parameters of papaya. At harvest, the tallest plants were observed in T_1 (Homobrassinolide @ 1 ml/l – 277.98 cm), which was comparable with T_5 (Salicylic acid @ 200 ppm – 274.53 cm) and T_6 (Ethrel @ 150 ppm – 271.99 cm), while the shortest plants were in the control (T_{11} – 257.94 cm). Collar diameter was highest in T_1 (114.37 mm), on par with T_5 (112.03 mm) and T_7 (GA3 @ 200 ppm – 110.84 mm), followed by T_9 (108.68 mm), whereas the lowest was in the control (100.23 mm).

Fruit weight was maximum in T_1 (1.11 kg), statistically at par with T_5 (1.09 kg) and T7 (1.07 kg). Fruit yield per plant was highest in T_1 (40.57 kg), at par with T5 (38.28 kg), while the lowest was in the control (27.78 kg). Similarly, fruit yield per plot was greatest in T_1 (365.13 kg) and least in the control (295.64 kg). Marketable fruits were also maximum in T_1 (36.55), followed by T_5 (35.12). Yield per hectare was highest under T_1 (93.90 t/ha), on par with T_5 (90.75 t/ha), while the minimum was obtained in the control (76.03 t/ha).

With respect to reproductive traits, the earliest flower initiation was promoted by T_7 (GA_3 @ 200 ppm – 101.84 days), which was on par with T_1 (104.84 days), while the latest occurred in the control (118.80 days). For 50% flowering, the minimum duration was noted in T_7 (129.11 days) followed by T_1 (133.11 days), compared to the longest duration in the control (152.33 days). Fruit set was also advanced under T_7 (151.83 days) and T_1 (152.56 days). The earliest harvest was recorded in T_7 (128.33 days) and T_1 (129.16 days), whereas the control (144.17 days) was the latest. Fruit retention was best in T_7 (14.55% fruit drop), followed by T_1 (17.92%) and T_5 (18.91%), while the control (36.84%) showed the highest fruit drop.

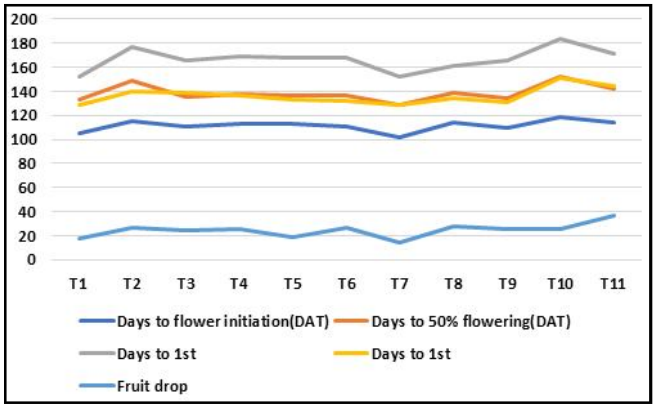

Fig. 1: Effect of different bioregulators on days to flower initiation, Days to 50% flowering, Days to 1st fruitset, days to 1st harvest and Fruit drop (%).

Table 2: Effect of different bioregulators on days to flower initiation, Days to 50% flowering, Days to 1st fruit set, days to harvest and Fruit drop (%).

Treat-ments	DFI	DF	DF1	DH1	FD
T_1	104.84	133.11	152.56	129.16	17.92
T_2	115.34	148.44	176.52	139.33	26.23
T_3	110.85	135.66	165.35	138.33	24.86
T_4	112.94	137.11	169.42	137.00	25.85
T_5	112.64	136.66	168.23	133.17	18.91
T_6	111.00	136.55	167.33	131.50	26.82
T_7	101.84	129.11	151.83	128.33	14.55
T_8	113.85	138.89	161.17	134.50	28.03
T_9	109.20	134.22	165.35	130.67	25.90
T_{10}	118.80	152.33	183.38	150.50	25.72
T_{11}	114.44	142.22	170.67	144.17	36.84
SE(m)±	1.72	0.64	1.80	0.53	0.35
C.D 5%	5.11	1.91	5.35	1.59	1.03

DFI: Days to flower initiation(DAT); **DF:** Days to 50% flowering(DAT); **DF1:** Days to 1st fruitset (DAT); **DH1:** Days to 1st harvest(DAA); **FD:** Fruit drop(%)

The present study revealed that foliar application of Homobrassinolide @ 1 ml/L substantially improved the vegetative growth and yield performance of papaya grown under summer stress conditions. Plants receiving this treatment recorded maximum values for plant height, collar diameter, average fruit weight, yield per plant, yield per plot, number of marketable fruits, and yield per hectare. These enhancements can be linked to Homobrassinolide's ability to stimulate cell division, elongation, and vascular differentiation (Ahammed *et al.*, 2020; Kumar, 2022), its gibberellin-like action in promoting stem elongation and leaf expansion (Huang *et al.*, 2023), and its role in improving photosynthetic activity and stress

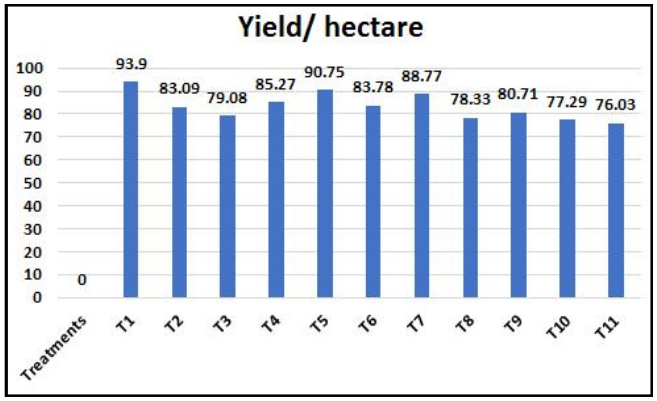

Fig. 2: Effect of different bioregulators on yield per hectare.

tolerance (Mahati *et al.*, 2025). The observed increase in collar diameter further reflects better plant structural strength and nutrient transport efficiency (Dubey, 2020; Pavani *et al.*, 2023). In addition, Homobrassinolide enhanced reproductive efficiency by supporting fruit development, improving assimilate distribution, and minimizing flower abscission (Patel *et al.*, 2021; Badhe *et al.*, 2022). Its broad influence on flowering, fruit set, and ripening contributed to higher yield and fruit quality (Ghosh *et al.*, 2022), while enhanced antioxidant defense and stress adaptation improved fruit retention and post-harvest stability (Hasan *et al.*, 2020; Kour *et al.*, 2021; Kaur *et al.*, 2022).

Application of GA_3 @ 200 ppm also proved highly effective in boosting reproductive traits by advancing flowering, fruit set, and harvesting time while reducing fruit drop. These outcomes may be attributed to its role in stimulating cell elongation, breaking bud dormancy, and modulating hormonal balance (Srivastava, 2002; Rademacher, 2015). The promotion of early flowering and fruit set could be due to improved assimilate transport, greater nutrient allocation to reproductive structures, and better pollen viability and stigma receptivity (Gupta and Chakrabarty 2013). Advancement of harvest has been associated with GA_3 's ability to shorten the juvenile phase and accelerate fruit growth (Maurya *et al.*, 2025). Reduced fruit drop may result from improved assimilate movement and regulation of the abscission process (Taiz and Zeiger 2010; Gupta and Chakrabarty 2013).

Conclusion

The study clearly showed that different bioregulators had a significant influence on the growth, yield and reproductive traits of papaya under summer stress. Among the treatments, Homobrassinolide @ 1 ml/L (T_1) consistently produced the best vegetative growth, recording maximum plant height (277.98 cm), collar diameter (114.37 mm), fruit weight (1.11 kg), fruit yield per plant (40.57 kg), fruit yield per plot (365.13 kg), number of marketable fruits (36.55), and yield per hectare (93.90 t/ha). This performance is linked to its role in promoting cell division, elongation, vascular development and stress resilience.

GA3 @ 200 ppm (T_7) was most effective in advancing reproductive events, with earliest flower initiation (101.84 days), early 50% flowering (129.11 days), first fruit set (151.83 days), and earliest harvest (128.33 days). GA_3 also recorded the lowest fruit drop (14.55%), indicating its effectiveness in improving fruit retention through better assimilate mobilization and hormonal regulation. Salicylic acid @ 200 ppm (T_5) also showed notable improvements in growth and yield traits, though its effects were slightly lower than those of T_1 and T_7.

The findings confirm that Homobrassinolide @ 1 ml/L is highly effective in enhancing vegetative growth, structural strength, and yield potential of papaya under summer stress, while GA_3 @ 200 ppm primarily improves reproductive efficiency by promoting early flowering, fruit set, and reducing fruit drop. Both regulators, along with salicylic acid, contributed to improved yield stability and fruit retention compared to the control. Overall, Homobrassinolide emerged as the most promising treatment for maximizing papaya productivity and resilience under adverse summer conditions, with GA_3 providing complementary benefits in advancing reproductive events and reducing fruit losses.

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