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PLANT GROWTH REGULATORS FOR IMPROVED FLOWERING, FRUITING AND YIELD IN SAPOTA (*MANILKARA ACHRAS* MILL.) CV. KALIPATTI

K. Vasantha Kumari[1]*, P. Ashok[2], P. Vinaya Kumar Reddy[3] and D. R. Salomi Suneetha[4]

[1]Department of Fruit Science, College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem – 534101, A.P., India

[2]Department of Fruit Science, H.R.S., Dr. YSR Horticultural University, Ambajipeta – 533214, A.P., India

[3]Department of Fruit Science, College of Horticulture, Dr. YSR Horticultural University, Pulivendula – 516390, A.P., India

[4]Department of Biochemistry, College of Horticulture, Dr. YSR Horticultural University, Chinalataripi–524001, A.P., India

*Corresponding authors E-mail: Vasanthavassu248@gmail.com

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ABSTRACT

A field experiment conducted during 2024–2025 at the Horticultural Research Station, Venkataramannagudem, investigated the effects of plant growth regulators (PGRs) on flowering, fruiting, and yield of sixteen-year-old Kalipatti sapota trees planted at 10 × 10 /m spacing. The study was laid out in a randomized block design with three replications and eleven foliar treatments, including GA_3 (50–200 ppm), NAA (100–150 ppm), Brassinolide (1.5 ppm) combined with NAA (100–150 ppm), and an untreated control, applied at 50% flowering and pea stage. Among the treatments, NAA at 100 ppm (T5) significantly reduced flower drop (27.27%) and enhanced flower retention (72.72%), while improving fruit traits such as fruit length (6.03 cm), diameter (5.55 cm), fruit weight (119.21 g), pulp weight (104.22 g), firmness (4.40 kg/cm²), fruit drop (10.88 %), shelf life (9.70 days), fruit number per tree (556.66), and yield (66.36 kg/tree). These results demonstrate that targeted PGR applications can effectively enhance physical fruit characteristics in sapota cv. Kalipatti.

***Keywords* :** Plant growth regulators**,** Brassinolide, Flower retention.

Introduction

Sapota (*Manilkara achras* Mill.), belonging to the family Sapotaceae, is a tropical evergreen fruit tree native to South Mexico and Central America, with a chromosome number of 2n = 26. Popularly called 'Chiku' in India, it is also known as sapodilla or zapote worldwide. The crop has expanded rapidly, now covering 73,000 ha with a production of 889,000 metric tonnes, including 262,000 tonnes from Andhra Pradesh (Final Advance Estimate, 2023–24: Ministry of Agriculture and Farmers' Welfare). Despite its ability to flower year-round, only 50% of flowers set fruit and merely 10% mature, due to severe fruit drop. The cultivar 'Kalipatti' dominates Indian orchards, particularly in Gujarat, contributing more than 99% of the area with yields averaging 166 kg per tree (Patel et al., 2021; Shinde & More, 2022).

Recent advances underscore the potential of plant growth regulators (PGRs) like auxins, gibberellins, and brassinosteroids in modulating key physiological processes, enhancing fruit set and retention, improving fruit quality, and conferring tolerance to abiotic stresses (Ahanger *et al*., 2018). These insights highlight the scope for harnessing PGRs as precision tools to boost sapota productivity and sustainability.

Materials and Methods

The present investigation was carried out Horticultural research station, Dr. Y.S.R Horticultural university, venkataramannagudem, West Godavari district of Andhra Pradesh during the year 2024 -2025. The experiment was carried out with Randomized block design with three replications. The treatments involved GA_3 (50–200 ppm), NAA (100–150 ppm), Brassinolide (1.5 ppm) combined with NAA (100–150 ppm), and a control, were applied at 50% flowering and pea stage.

Methodology

For taking this observation sixty healthy shoots were selected from four directions of the tree. Flowers were tagged prior to reaching 50% flowering to facilitate subsequent data collection. Fruits from the tagged shoots fruits were harvested for various analyses once they reached harvestable maturity. Five randomly selected fruits from each of the four directions of tagged shoots were collected, cleaned, and analyzed in the laboratory.

Data collection on physical aspects such as flower drop and flower retention (%) were taken at fortnight interval following the first application of plant growth regulators at the 50% flowering stage. Observations on fruit drop percentage were recorded after spraying during the pea stage until harvest at fortnight interval. Data was recorded on physical characteristics including fruit length(cm), diameter(cm), weight (g), firmness (Kg/cm^2), pulp weight (g), fruit drop (%), shelf life(days), number of fruits per tree and yield per tree (kg/tree).

Results and Discussion

The results obtained in Table 1 and Figure 1 revealed that flower drop and retention % were significantly influenced by the treatments. The lowest flower drop (27.27%) and highest flower retention (72.72%) were recorded in T5 (NAA @ 100 ppm), while the control (T11) exhibited the highest flower drop (52.40%) and lowest retention (47.59%). Treatments T4, T2, and T6 were statistically comparable. Overall, flower drop and retention ranged from 27.27 to 52.40% and 47.59 to 72.72%, respectively, which aligns with the findings of Nagargoje *et al*. (2007).

NAA reduces flower drop by maintaining high auxin levels in the pedicel, which suppresses ethylene synthesis and delays cell wall degradation in the abscission zone. It also enhances sink strength, promoting assimilate translocation to developing flowers, thereby improving retention and fruit set.

The perusal of data Table 2, Figure 2 and plate 1 indicated that fruit size was significantly influenced by the treatments. Maximum fruit length (6.03 cm) and diameter (5.55 cm) were recorded in T5 (NAA @ 100 ppm), which were statistically comparable to T4 (length 5.80 cm; diameter 5.05 cm), while the minimum values were observed in the control (T11) with fruit length 4.16 cm and diameter 4.10 cm. Overall, fruit length and diameter ranged from 4.16 to 6.03 cm and 4.10 to 5.55 cm, respectively, aligning closely with the observations of Agarwal *et al*. (2010).

Exogenous NAA enhanced fruit length and diameter by stimulating cell division, elongation, and wall plasticity, while promoting efficient assimilate translocation to developing fruits. This coordinated cellular and physiological effect drives superior fruit growth, as reported in sapota, loquat, and rambutan (Patel *et al*., 2020; wang *et al*., 2021; Nguyen *et al*., 2019).

The findings recorded in Table 2 and Figure 3 showed maximum fruit weight was recorded in NAA @ 100 ppm T5 (119.21 g), comparable to T4 (115.26 g) and T2 (111.40 g), while the control (T11) recorded the minimum (87.06 g).The enhanced fruit weight may be attributed to exogenous NAA elevating endogenous auxin levels, which improved assimilate partitioning and nutrient mobilization to developing fruits, strengthening them as metabolic sinks (Rathod, 1977; Katiyar *et al*., 2008;Agarwal and Dikshit, 2010; Sharma & Tiwari, 2015; Kaur *et al*., 2005; Taghipour *et al*., 2011; Abbas *et al*., 2014).

The results furnished in Table 2 revealed that maximum fruit firmness recorded in T5 NAA @ 100 ppm (4.40 kg/cm^2), on par with T4 and T2, while the control lagged at (2.45 kg/cm^2). NAA bolstered firmness by suppressing ethylene, curbing cell wall degrading enzymes, and stabilizing membranes, effectively slowing softening and preserving structural integrity echoing findings in guava and strawberry (Martinsson *et al*., 2006; Mandal *et al*., 2012; Pathak *et al*., 2017).

It is evident from Table 2 indicated that T5 (NAA @ 100 ppm) produced the highest pulp weight (104.22 g), while the control (T11) recorded the lowest (70.94 g), with several other treatments being comparable T4, T7, T8, T2 and T6 statistically. The range of pulp weight varied from 70.94 to 104.22 g. NAA likely enhanced pulp weight by stimulating cell division, elongation, and expansion, increasing intracellular spaces and promoting accumulation of sugars, water, and soluble solids via improved metabolite translocation to developing fruits, strengthening them as metabolic sinks. These results align with Tripathi *et al*. (2024) in ber and Abdel-Sattar *et al*. (2023) in Anna apples.

The results obtained in Table 2 showed T5 (NAA @ 100 ppm) recorded the lowest fruit drop (10.88%), comparable to T4, while the control peaked at 39.18%. Fruit drop % varied from 10.88 to 39.18%. NAA reduced fruit drop by modulating abscission, suppressing hydrolytic enzymes like cellulase, and preventing abscission layer formation, thereby enhancing fruit retention, consistent with Kadam *et al.* (2005), Nagargoje *et al.* (2007), Bhujbal *et al.* (2013).

The perusal of data in Table 2 indicates that maximum T5 (NAA @ 100 ppm) recorded the longest shelf life (9.70 days), while the control (T11) had the shortest (5.96 days), with T4, T2, and T6 being comparable. Shelf life was distributed in the range of 5.96 to 9.70 days. NAA likely extended shelf life by reducing physiological weight loss, delaying spoilage, and minimizing shrivelling through modulation of ascorbic acid biosynthesis and inhibition of oxidative enzymes, aligning with findings in mandarin, ber, and grape (Thapa and Gautam, 2002; Kaur *et al.*, 2009; Meena *et al.*, 2012).

The results obtained in Table 3 and Figure 4 showed T5 (NAA @ 100 ppm) produced the highest number of fruits per tree 556.66 and maximum yield 66.36 kg as showed in (Figure 5), while the control (T11) recorded the lowest (403.33 fruits; 35.11 kg/tree), with T4 being statistically comparable. The number of fruits per tree and yield per tree ranged from 403.33 to 556.66 fruits and 35.11 to 66.36 kg/tree. The enhanced fruit number and yield under NAA can be attributed to improved flower induction, higher fruit set, reduced pre-harvest drop, and increased individual fruit weight. Auxin-mediated regulation likely enhanced source-to-sink translocation of assimilates, water, and nutrients, supporting developing fruits and overall yield. These results align with findings in sapota, papaya, mango, guava, and other fruit crops (Chavan *et al.*, 2009; Agrawal and Dikshit, 2010; Syamal *et al.*, 2010; Bhowmick and Banik, 2011; Bhujbal *et al.*, 2013; Abbas *et al.*, 2014).

From the present study, it was concluded that foliar application of NAA @ 100 ppm during 50% stage and pea stage resulted in improvement in flowering, fruiting and yield in sapota cv. Kalipatti.

Table 1: Effect of plant growth regulators on flower characters of sapota (*Manilkara achras* Mill.) cv. Kalipatti

S. No	Treatments	Flower drop (%)	Flower retention (%)
1	T1 GA_3 50 ppm	43.55 (41.27)	57.22 (49.13)
2	T2 GA_3 100 ppm	28.12 (32.00)	71.87 (57.95)
3	T3 GA_3 150 ppm	36.63 (37.23)	63.36 (52.72)
4	T4 GA_3 200 ppm	28.06 (31.97)	71.93 (57.98)
5	T5 NAA 100 ppm	27.27 (31.44)	72.72 (58.51)
6	T6 NAA 125 ppm	29.65 (32.98)	70.34 (56.97)
7	T7 NAA 150 ppm	41.93 (40.33)	58.06 (49.62)
8	T8 Br 1.5 + NAA 100 ppm	35.39 (36.46)	64.60 (53.49)
9	T9 Br 1.5 + NAA 125 ppm	40.83 (39.69)	59.16 (50.26)
10	T10 Br 1.5 + NAA 150 ppm	40.57 (39.52)	59.42 (50.42)
11	T11 control	52.40 (46.35)	47.59 (43.59)
	SEM ±	0.90	0.896
	CD%	2.69	2.66

Data on flower drop % and flower retention % of sapota cv. Kalipatti values in parentheses are angular transformed.

Table 2 : Effect of plant growth regulators on fruit characters of sapota (*Manilkara achras* Mill.) cv. Kalipatti

S.No	Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit firmness (kg/cm^2)	Pulp weight (g)	Fruit drop (%)	Shelf life (days)
1	T1 GA_3 50 ppm	5.37	4.46	96.02	3.80	88.53	16.70 (24.10)	7.33
2	T2 GA_3 100 ppm	5.57	4.88	111.40	4.10	97.11	13.85 (21.83)	9.20
3	T3 GA_3 150 ppm	4.89	4.60	96.09	3.50	81.77	14.10 (22.04)	7.24
4	T4 GA_3 200 ppm	5.80	5.05	115.26	4.30	102.87	12.68 (20.85)	9.50
5	T5 NAA 100 ppm	6.03	5.55	119.21	4.40	104.22	10.88 (19.24)	9.70
6	T6 NAA 125 ppm	4.99	4.85	97.40	4.00	88.89	14.03 (21.97)	9.00
7	T7 NAA 150 ppm	4.77	4.47	105.45	3.90	97.92	25.28 (30.16)	8.00
8	T8 Br 1.5 + NAA 100 ppm	4.85	4.58	103.84	2.90	93.40	22.59 (28.35)	6.67
9	T9 Br 1.5 + NAA 125 ppm	5.32	4.70	93.48	3.20	83.04	37.82 (37.89)	7.00
10	T10 Br 1.5 + NAA 150 ppm	4.79	4.75	89.20	3.60	75.00	37.84 (37.93)	7.10
11	T11 control	4.16	4.10	87.06	2.45	70.94	39.18 (38.73)	5.96
	SEM ±	0.13	0.18	4.60	0.16	5.16	0.94	0.31
	CD%	0.40	0.52	13.66	0.48	15.33	2.80	0.93

Data on fruit drop % of sapota cv. Kalipatti parenthetical data indicate angular transformed values.

Table 3: Effect of plant growth regulators on yield attributes of sapota (*Manilkara achras* Mill.) cv. Kalipatti

S. No	Treatments	Number of fruits/ tree	Yield kg/tree
1	T1 GA_3 50 ppm	500.66	48.07
2	T2 GA_3 100 ppm	486.00	54.14
3	T3 GA_3 150 ppm	525.33	50.48
4	T4 GA_3 200 ppm	548.66	63.24
5	T5 NAA 100 ppm	556.66	66.36
6	T6 NAA 125 ppm	509.33	49.61
7	T7 NAA 150 ppm	452.66	47.73
8	T8 Br 1.5 + NAA 100 ppm	556.66	57.79
9	T9 Br 1.5 + NAA 125 ppm	538.66	50.35
10	T10 Br 1.5 + NAA 150 ppm	550.00	49.06
11	T11 control	403.33	35.11
	SEM±	12.19	1.24
	CD%	35.98	3.67

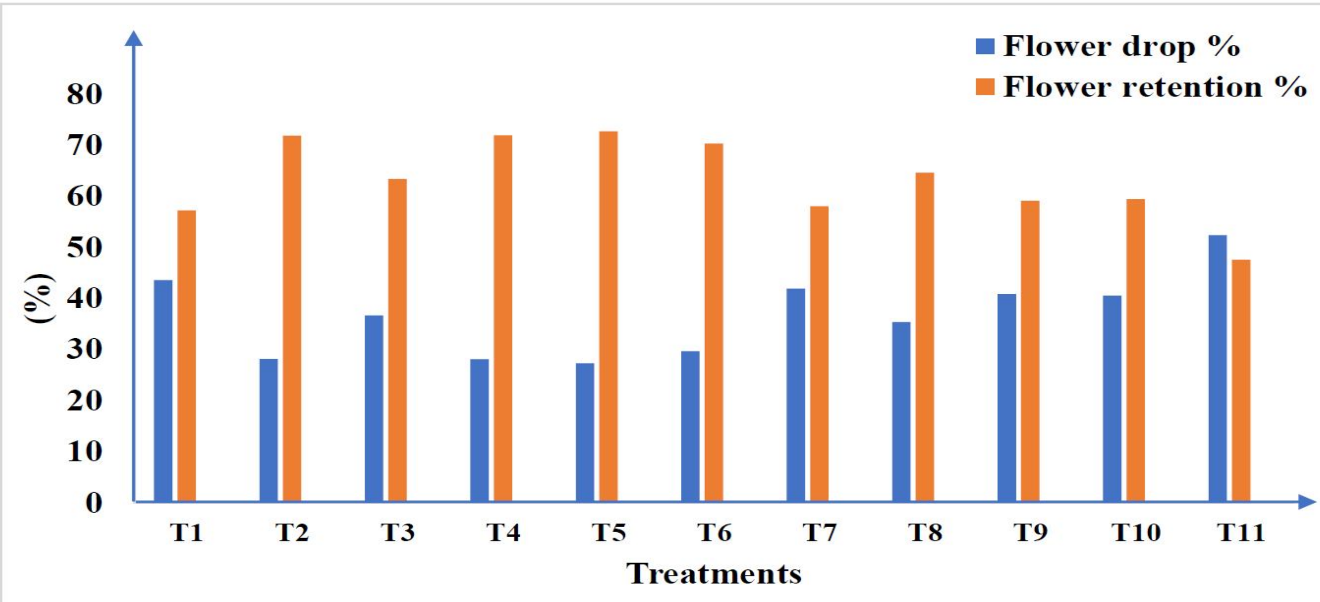

Fig. 1: Effect of plant growth regulators on flower characters of sapota (*Manilkara achras* Mill.) cv. Kalipatti

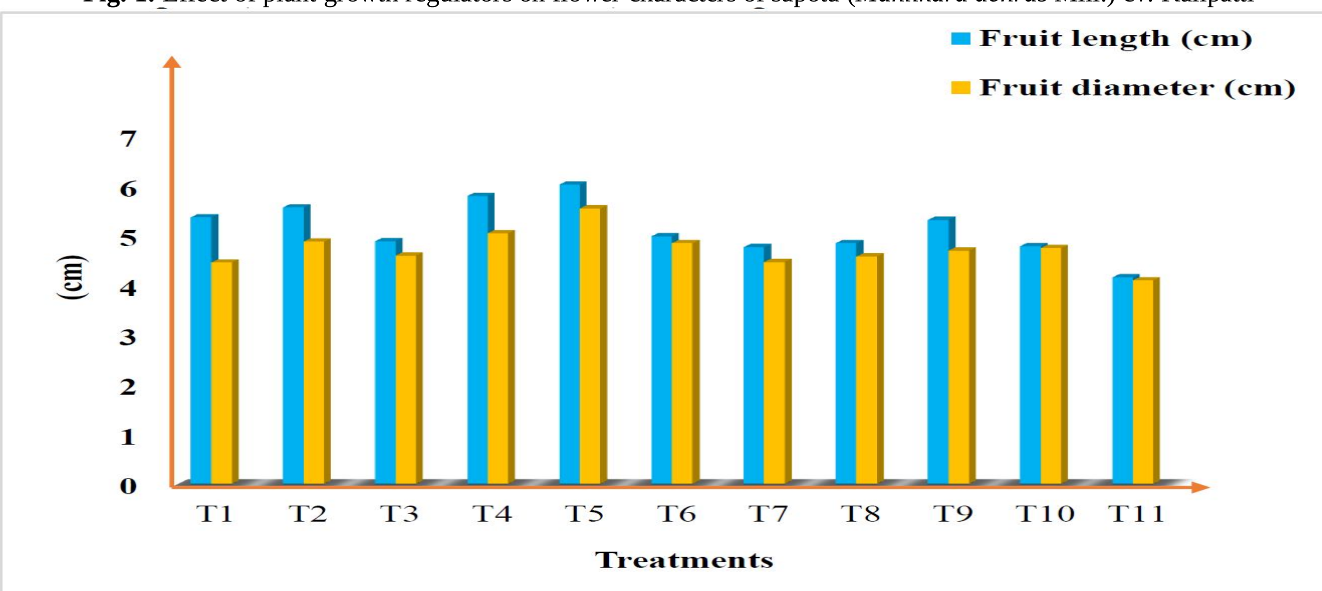

Fig. 2 : Effect of plant growth regulators on fruit length (cm) and fruit diameter (cm) of sapota (*Manilkara achras* Mill.) cv. Kalipatti

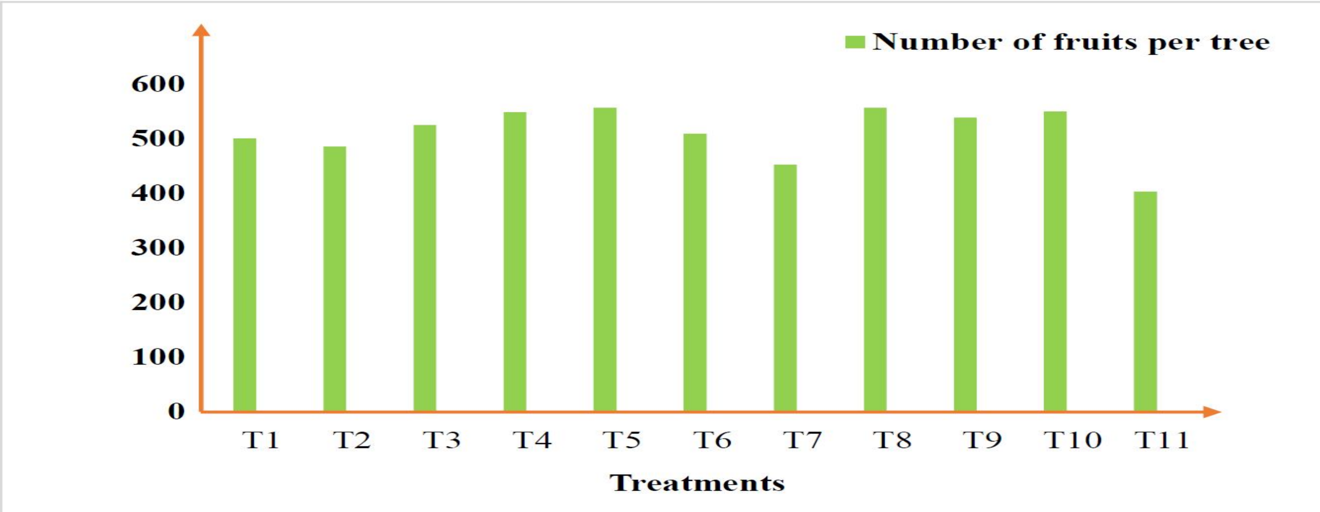

Fig. 3 : Effect of plant growth regulators on fruit weight (g) of sapota (*Manilkara achras* Mill.) cv. Kalipatti

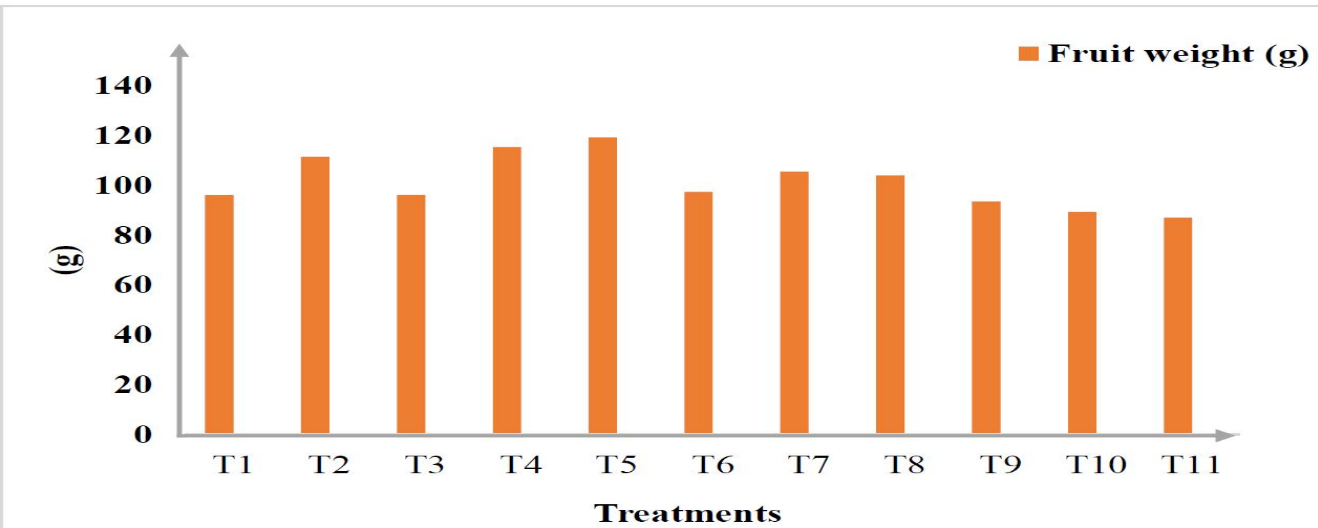

Fig. 4 : Effect of plant growth regulators on number of fruits per tree of sapota (*Manilkara achras* Mill.) cv. Kalipatti

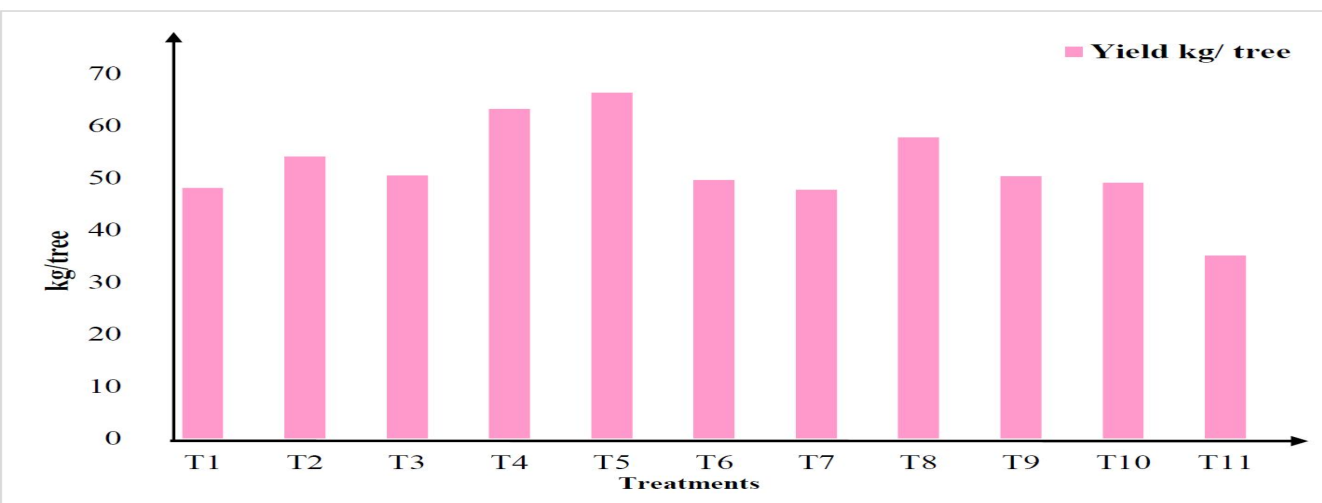

Fig 5: Effect of plant growth regulators on yield kg per tree of sapota (*Manilkara achras* Mill.) cv. Kalipatti

PLATE 1

Effect of plant growth regulators on fruit length (cm) and fruit diameter (cm) of sapota (*Manilkara achras* Mill.) cv. Kalipatti

Fruit length (6.03) cm

Fruit diameter (5.55) cm

Fruit length (4.16) cm

Fruit diameter (4.10) cm

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