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Effect of plant growth regulators on fruit size and yield of sapota (*Achras zapota* L.) CV. Kalipatti

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Abstract
Present research was conducted during 2017 – 18 to examine the influence of plant growth regulators on fruit size and yield in sapota CV. Kalipatti. The experimental design is Randomised Block Design with ten treatments, replicated thrice on 15-year-old sapota orchard of HRS, Konda Mallepally, Nalgonda. Treatments are *viz*., T_1 -Control, T_2 -NAA 250 ppm, T_3 -NAA 300 ppm, T_4 -NAA 350 ppm, T_5 -2,4-D 40 ppm, T_6 -2,4-D 50 ppm, T_7 -2,4-D 60 ppm, T_8 -Ethephon 350 ppm, T_9 -Ethephon 400 ppm and T_{10} -Ethephon 450 ppm. Time of spraying of growth regulators is 1st spray at flowering stage and 2nd spray is at one week of fruit set. The maximum fruit weight (105.28 g), fruit length (4.99 cm), fruit diameter (62.42 mm) and volume of fruit (102.91 ml) was found in the treatment with foliar application of NAA at 350 ppm. The highest fruit yield per tree (23.52 kg/tree) and yield per hectare (26.13 t/ha) was recorded in the treatment with foliar application of NAA at 350 ppm, followed by Ethephon at 450 ppm 21.02 kg per tree and 23.36 tonnes per hectare, respectively. Hence, it can be concluded that foliar spray of NAA at 350 ppm recorded maximum fruit size and yield.

Keywords: Sapota, NAA, fruit yield, fruit size, plant growth regulators

Introduction
Sapota (*Achras zapota* L.) is a native of Mexico belongs to the family Sapotaceae. It is a delicious fruit mainly introduced in India for its fruits. It is also known by several names such as chiku, sapodilla, zapota or sapodilla plum in different regions of the world. Sapota produces a large number of flowers throughout the year in different flushes. But flowers and fruits tend to drop in different stages of development right from its setting to maturity.

The application of growth hormones can help stimulate plant growth and fruit production, especially when plants are receiving adequate nutrition, water and sunlight. Larger fruits, faster growth, and stronger plants are all possible under hormone therapies. NAA and 2, 4-D, are growth regulators which belong to auxin group, influence the crop production. NAA is thought to enhance early fruit drop by decreasing competition between fruits and increasing production of abscission inducing ethylene, both encouraging greater physiological drop. 2, 4 - D also plays major role in enhancing fruit drop in fruit crops.

Material and Methods
The present study was held during 2017-2018 on 15-year-old sapota orchard of Horticultural Research Station, Konda Mallepally, Nalgonda, Telangana. The experimental site comes under semi-arid, sub-tropical climate zone with an average rainfall of 700 mm per annum.

The experiment was conducting by adopting Randomized Block Design comprising of 10 treatments (T_1 -control, T_2 NAA -250 ppm, T_3 NAA -300 ppm, T_4 NAA -350 ppm, T_5 2,4-D - 40 ppm, T_6 2,4-D -50 ppm, T_7 2,4-D -60 ppm, T_8 Ethephon -350 ppm, T_9 Ethephon -400 ppm and T_{10} -Ethephon 450 ppm) with three replications. The different concentration of NAA, 2, 4-D and Ethephon solutions were prepared and all the treatments were sprayed twice once during the month of September at flowering stage and second one at one week of fruit setting. Fruits were harvested based on their maturity indices.

The individual five fruits from each treatment were taken randomly after the harvest. The weight was measured on digital analytical balance and average weight was expressed in grams. Five fruits from each treatment were brought to laboratory and volume of the fruits was recorded by water displacement method and expressed in milliliter. The five fruits from each treatment were taken randomly and the distance between the stalk end and floral end of the fruit was measured with the help of digital vernier caliper where the average value was

expressed in centimeters. Diameter was measured with the help of digital vernier caliper at widest middle point where maximum diameter was noticed. The average value was expressed in millimeters. Fruits were harvested when they were fully matured. Number of fruits and fruit weight were recorded at every harvest. The total yield was calculated by adding the values obtained in different harvesting and it is expressed in kilogram per tree. The yield per hectare was computed by multiplying the yield per plant with the number of plants accommodated in one hectare and was expressed in tonnes per hectare.

Results and Discussion

Fruit weight (g): The data on fruit weight is presented in Table 1, revealed that effect of plant growth regulators on the fruit weight of sapota cv. Kalipatti was significant among the treatments. The maximum fruit weight (105.28 g) was observed in the treatment T_4 (NAA 350 ppm), which was statistically on par with T_{10} (Ethephon 450 ppm) with 102.13 g and minimum fruit weight (62.91g) was observed in the T_1 (control).

Increase in fruit weight might be attributed to the exogenous supply of NAA which might have helped in strengthening of middle lamella and consequently cell wall and might have increased the mobilization of food materials and minerals from other part of the plant towards developing fruits that are extremely active metabolic sink which, in turn could have increased the fruit weight. These results were in conformity with the findings of Kaur *et al.* (2005) [4] in Kinnow mandarin, Katiyar *et al.* (2009) [5] in guava, Taghipour *et al.* (2011) [6] in apricot and Abbas *et al.* (2014) [1] in guava**.**

Fruit volume (ml): The influence of foliar application of growth regulators on volume of fruit differed significant and the data is presented in Table 1. The maximum volume of fruit (102.91 ml) was recorded in treatment T_4 (NAA 350 ppm) followed by treatments T_{10} (Ethephon 450 ppm; 97.30 ml). However, the minimum volume of fruit (50.65 ml) was recorded in treatment T_1 (control).

The application of NAA might have a role in increasing the auxin level of fruits, which in turn, might have helped in the development of fruit components as there is a direct correlation between auxin content and fruit growth. Similar results were obtained by Yadav *et al.* (2001) [7], and Dubey *et al.* (2002) [8] in Guava, Agarwal and Dikshit (2010) [2] in sapota, Taghipour *et al.* (2011) [6] in apricot and Agnihotri *et al.* (2013) [3] in guava.

Fruit Length (cm): The date of effect of plant growth regulators on fruit length of Sapota are furnished in Table 1. The fruit length differed significantly among the treatments. The treatment T_4 (NAA 350 ppm) resulted in the maximum fruit length (4.99 cm) followed by T_{10} (Ethephon 450 ppm; 4.72 cm) and T_9 (Ethephon 400 ppm; 4.50 cm) whereas, the minimum fruit length (3.9 cm) was observed in the T_1 (control).

The optimum supply of plant growth regulators in right amount during the entire crop growth resulted in causing vigorous vegetative development of the plant, there by ultimately leading to production of more photosynthates. This might be due to immediate absorption of auxins, which increased the endogenous auxin level that resulted in cell division and cell elongation which accelerated the development of fruit. Similar findings were reported by Dubey *et al.* (2002) [8] in guava, Kaur *et al.* (2005) [4] and Awasthi and Lal (2009) [9] in Kinnow mandarin, Agarwal and Dikshit (2010) [2] in sapota and Agnihotri *et al.* (2013) [3] in guava.

Fruit Diameter (mm): The variation in diameter of the fruit was significant and is presented in the Table 1. The maximum diameter (62.42 mm) was noticed in the treatment T_4 (NAA 350 ppm) followed by treatment T_{10} (Ethephon at 450 ppm) and T_9 (Ethephon 400 ppm) which were found to be 60.13 mm and 56.04 mm. However, the minimum diameter of the fruit (45.26 mm) was recorded in the treatment T_1 (control).

The increased fruit diameter might be due to exogenous application of NAA at pea nut stage of the fruit caused cell elongation by enlargement of vacuoles and loosening of cell wall after increasing its plasticity. The present findings were in agreement with the reports of Dubey *et al.* (2002) [8] in guava, Reyes *et al.* (2008) [10] in apple and Agarwal and Dikshit (2010) [2] in sapota.

Yield per tree (kg/tree): The foliar spray of plant growth regulators had significant influence on the yield per tree among the treatments in sapota and data is presented in Table 2. The maximum yield per tree (23.52 kg/tree) was noticed in T_4 (NAA 350 ppm), which was significantly on par with T_{10} (Ethephon 450 ppm) with 21.02 kg/tree. The minimum yield per tree (9.57 kg/tree) was recorded in the treatment T_1 (Control).

This may be due to the better physiology of developing fruits in terms of better supply of water, nutrients and other compounds vital for their proper growth and development which resulted in improved size and ultimately grater yield as compare to other growth regulators. NAA has a positive effect on growth and yield of fruit. The yield increase could be attributed to higher percentage of fruit set and retention achieved by the application of NAA. These results are relevant to Abbas *et al.* (2014) **[1]** in guava.

Yield per hectare (t ha^{-1}): The data pertaining on the effect of plant growth regulators on yield per hectare of Sapota is furnished in Table 2. The yield per hectare differed significantly among the treatments. The highest yield (26.13 t ha^{-1}) was obtained in treatment T_4 (NAA 350 ppm), which was statistically on par with T_{10} (Ethephon 450 ppm) was 23.36 t ha^{-1}. However, the minimum yield per hectare (10.63 t ha^{-1}) was recorded in T_1 (Control).

The NAA mediates process for faster translocation and mobilization of stored metabolites or photosynthates from source to sink. The spray of NAA at pea stage of fruit development retained more number of fruits than lag phase. Increase in the number of fruits, low percentage of fruit drop, more fruit retention promoted fruit size and weight. As result of fruit thinning the tree did not become exhausted due to use of energy in fruit development and ripening, the prepared food remain reserved which might have helped to increase yield and improved the fruit quality. These results are relevant to Abbas *et al.* (2014) **[1]** in guava.

Table 1: Effect of plant growth regulators on fruit weight (g) of Sapota

Treatment No.	Treatment details	Fruit weight (g)	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (mm)
T_1	Control	62.91	50.65	3.90	45.26
T_2	NAA 250 ppm	81.82	83.27	4.08	50.24
T_3	NAA 300 ppm	84.82	85.23	4.14	51.69
T_4	NAA 350 ppm	105.28	102.91	4.99	62.42
T_5	2,4-D 40 ppm	76.50	54.17	4.18	48.47
T_6	2,4-D 50 ppm	77.82	73.13	4.02	47.99
T_7	2,4-D 60 ppm	80.04	75.90	4.00	47.91
T_8	Ethephon 350 ppm	88.80	87.23	4.18	52.98
T_9	Ethephon 400 ppm	92.01	94.26	4.50	56.04
T_{10}	Ethephon 450 ppm	102.13	97.30	4.72	60.13
Mean		85.21	80.40	4.27	52.31
S. Em±		2.14	1.86	0.07	1.77
CD @ 5%		6.30	5.53	0.21	5.27

Table 2: Effect of plant growth regulators on yield per tree (Kg) of sapota

Treatment No	Treatment details	Yield/tree (kg)	Yield/ha (tones)
T_1	Control	9.57	10.63
T_2	NAA 250 ppm	16.95	18.83
T_3	NAA 300 ppm	17.87	19.86
T_4	NAA 350 ppm	23.52	26.13
T_5	2,4-D 40 ppm	15.81	17.57
T_6	2,4-D 50 ppm	16.06	17.84
T_7	2,4-D 60 ppm	17.04	18.93
T_8	Ethephon 350 ppm	17.66	19.62
T_9	Ethephon 400 ppm	19.77	21.96
T_{10}	Ethephon 450 ppm	21.02	23.36
Mean		17.52	19.47
S. Em±		1.11	1.23
CD @ 5%		3.30	3.67

Conclusion

The plants treated with foliar spray of growth regulators (NAA, Ethephon and 2, 4-D) significantly influenced the yield and fruit size parameters of Sapota. The treatment T_4 with foliar spray of NAA at 350 ppm recorded maximum fruit size and yield and followed by treatment T_{10} with foliar spray of Ethephon at 450 ppm. While, minimum was recorded with control treatment.

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