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Effect of foliar spray of plant growth regulators on yield of sapota [*Manilkara achras* (Mill.) Forsberg] Cv. Kalipatti

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Abstract
The experiment entitled, Effect of plant growth regulators on yield and quality of sapota [*Manilkara achra*s (Mill.) Forsberg] Cv. Kalipatti was carried out in Fruit Research Station, Himayat bagh, Aurangabad during 2018-19. The experiment was laid out in Randomized Block Design with three replications and ten treatments. During investigation the sapota trees were sprayed with different plant growth regulator treatments *viz*. T1 i.e. SADH 50 ppm, T2 i.e. SADH 100 ppm, T3 i.e. SADH 150 ppm, T4 i.e. NAA 150 ppm, T5 i.e. NAA 200 ppm, T6 i.e. NAA 250 ppm, T7 i.e. GA3 50 ppm, T8 i.e. GA3 100 ppm, T9 i.e. GA3 150 ppm and T10 i.e. control. The effects of these treatments were noted on fruit quality and yield attributes of sapota. The results of experimentation confirmed the efficiency of plant growth regulators for better fruit growth attributes, yield and quality of sapota variety Kalipatti. The study revealed that GA3 at 150 ppm significantly increased the fruit size and yield of the fruits and GA3 at 100 ppm significantly increased the quality of fruits. Among various concentrations of plant growth regulators the treatment GA3 at 150 ppm was found significantly superior over all other treatments.

Keywords: NAA, GA3, Sapota

1. Introduction
Sapota or sapodilla [*Manilkara achras* (Mill.) Forsberg] is commonly known as chiku in India. Sapota is an evergreen fruit crop and belongs to the family Sapotaceae and is native to tropical America especially the Central America or South Mexico. It is commercially grown in Indonesia, Philippines, Florida (USA), Malaysia, India, Caribbean Islands and Sri Lanka. Sapota is sixth important commercial fruit crop of India after mango, banana, citrus, apple and guava. In India sapota plantation was first introduced at Gholvad village of Thane district in Maharashtra state in 1898 (Chadha 1992) [5].

Sapota is cultivated for its delicious fruits. The fruit is good source of digestible sugar (12 to 18%). Sapota fruits are the source of energy 98 Ecals, moisture 74 g, protein 1 g, fat 1 g, fibre 3 g, carbohydrate 21 g, calcium 28 mg, phosphorus 27 mg, Iron 1 mg. Some another minerals (mg/100 g) like potassium 26 mg, magnesium 25 mg, iron 1.25 mg, sodium 5.9 mg, copper 0.08 mg and vitamins *viz*., carotene 97 mg, thiamine 0.02 mg. Riboflavin 0.03 mg, vitamin 'C' 6.0 mg per 100 g of fruit. (Shanmungavelu and Shrinivasan, 1973) [18].

The area under sapota cultivation in India is increasing day by day due to its continuous fruiting habit throughout the year and its hardy nature against many biotic and abiotic stresses (Chundawat 1998) [6]. The crop of July-August is harvested in the month of April- May when the price is relatively high and the ripe sapota fruit is generally consumed as a dessert fruit. The peel of fruit can be eaten along with the pulp as it is rich in nutrition than the pulp alone (Gupta *et al.* 1981) [9].

In Maharashtra area under sapota is about 73000 ha with first rank in the production of sapota with a production of 4,74,500 MT and productivity is 6.5 MT/ha. Maharashtra is highest producer of sapota in India. However, in Maratha Wada area, under this crop is increasing recently at rapid rate and it is 0.11 ha with production of 41,072 metric tonnes (Anonymous 2006). Out of several cultivars, Kalipatti is the main variety grown and more than 99% areas under sapota in Maharashtra is of this cultivar, which account to monoculture. It has dark green, broad and thick leaves and spreading branches. Fruits are oval shaped, less seeded with sweet mellow flesh of excellent quality. Fragrance is mild, each fruit has 1-4 seeds. Fruits appear singly (Chundawat and Bhuva, 1982) [7].

The spray of growth retardant SADH (Succinic acid 2, 2 dimethyl hydrazide) or Daminozide checked the vegetative growth which increases the upsurge of flowering and makes uniform maturity. It enhances the initial fruit set and fruit retention in sapota (Ray *et al*., 1991) [17]. Thus it minimizes the incompatibility also.

The exogenous application of Gibberellic acid (GA3) increases cell size and intercellular spaces coupled with accumulation of water and nutrients in greater amount thus it would be increased the growth, yield, fruit quality and shelf life of sapota fruits (Agrawal and Dikshit, 2010) [2]. The application of GA3 at flowering also results in parthenocarpic fruit development which reduces the number of seed & weight. Thus, this hormone overcomes the problem of infertility also.

The foliar application of NAA (1-Napthalene Acetic Acid) at flowering stage increases cell elongation by enlargement of vacuoles and loosening of cell wall after increasing its plasticity. So it improves the physical and qualitative characters of sapota fruits (Agrawal and Dikshit, 2010) [2]. It also limits the fruit drop in many fruit crops (Delvadia *et al*., 1994 in chiku, Brahmachari *et al*., 1996 in guava, Nambisan *et al*., 2007 in sapota and Bhowmick and Banik (2011) in mango) [8, 4, 14, 3].

2. Materials and Methods

The present investigation entitled "Effect of plant growth regulators on yield and quality of sapota [*Manilkara achra*s (Mill.) Forsberg] Cv. Kalipatti." was undertaken at Fruit Research Station, Himayatbagh, Aurangabad during the year 2018- 2019.

The details of the material used and methodology followed for recording various observations are given below.

The experiment was conducted on twelve years old sapota trees of uniform growth, spaced at eight meter apart from either side. The experiment was initiated in March 2018. The design of experiment was Randomized Block Design with ten treatments.

Treatments details

Ten treatments involving three plant growth regulators *viz.*, NAA (150, 200 and 250 ppm), GA3 (50, 100 and 150 ppm), SADH (50, 100 and 150 ppm) and control and their combinations were embedded in Randomized Block Design with three replications, as detailed below. The randomization of all the treatments was made as per the standard procedure.

Table 1: Treatments of plant growth regulators and concentration (ppm)

Treatments	Plant growth regulators	Concentration (ppm)
T1	SADH	50
T2	SADH	100
T3	SADH	150
T4	NAA	150
T5	NAA	200
T6	NAA	250
T7	GA3	50
T8	GA3	100
T9	GA3	150
T10	Control	Water spray

3. Results and Discussion

The observations were recorded on various aspects *viz*., fruit drop, Length of fruit, Diameter of fruit, volume of fruit, weight of fruit, weight of pulp, weight of seed per fruit, number of seeds per fruit.

Yield contributing observations

3.1 Fruit drop (%)

The responses to the application of different plant growth regulator treatments regarding the percentage of fruit drop were significant.

The data presented in the Table 2 clearly indicated that the minimum percentage of fruit drop (41.74%) was produced by the treatment T6 *i.e.* NAA 250 ppm, which was significantly superior over control and rest of the treatments under study. Followed by the treatment T5 *i.e.* NAA 200 ppm (42.70%), which was statistically at par with the treatments T4 *i.e.* NAA 150 ppm (43.37%). In remaining treatments also the percentage of fruit drop significantly less over control. Significantly maximum percentage of fruit drop (56.66%) was produced under the treatment T10 *i.e.* control.

The data regarding fruit drop per cent revealed that, increasing levels of NAA and GA3 significantly decreased the fruit drop per cent. The minimum fruit drop (41.74%) was observed in treatment T6 *i.e.* NAA 250 ppm being at par with treatment T5 *i.e.* NAA 200 ppm over control. This might be due to increased auxin synthesis in plant system by exogenous application of NAA and GA3 which turned into decreased ABA synthesis and thus resulted in lower fruit drop. However NAA was most effective to control fruit drop. The above results were in agreement with those of Nagargoje *et al*. (2007) [13] and Delvadia *et al*. (1994) [8] in sapota, Yadav and Chaturvedi (2005) [21] in ber and Gupta and Kaur (2007) [10] in plum.

Table 2: Effect of plant growth regulators on various yield contributing aspects.

Sr. No.	Treatments	Fruit Drop (%)	Length of Fruit (cm)	Diameter of Fruit (cm)	Volume of Fruit (cm^3)	Weight of Fruit (g)	Weight of Pulp (g)	Weight of seeds per fruit (g)	Number of seeds per fruit
T1	SADH 50 ppm	46.66	4.96	4.71	65.23	72.07	70.58	1.49	1.78
T2	SADH 100 ppm	47.71	5.27	4.95	63.90	72.74	71.28	1.45	1.81
T3	SADH 150 ppm	49.66	4.82	4.38	71.68	71.04	69.84	1.46	1.76
T4	NAA 150 ppm	43.37	4.50	4.34	64.41	70.44	69.35	1.43	1.81
T5	NAA 200 ppm	42.70	5.92	5.76	72.89	74.66	73.56	1.42	1.97
T6	NAA 250 ppm	41.74	4.50	4.25	76.93	81.03	79.52	1.41	1.96
T7	GA3 50 ppm	48.07	4.53	4.25	67.15	69.66	68.43	1.44	1.77
T8	GA3 100 ppm	47.08	6.22	5.99	74.92	79.14	77.74	1.39	1.74
T9	GA3 150 ppm	48.81	6.28	6.03	81.48	85.63	84.26	1.35	1.66
T10	Control (water spray)	56.66	3.31	3.08	54.86	60.76	59.06	1.72	2.07
SE±		2.08	0.20	0.32	2.79	2.26	2.20	0.13	0.33
CD at 5%		6.20	0.60	0.96	8.30	6.72	6.56	NS	NS

3.2 Length of fruit (cm)

Data presented in Table 2 revealed that the treatment of growth regulators showed significant effects in respect of length of fruits. The treatment T9 *i.e.*GA3 150 ppm showed significantly more length of fruit (6.28 cm) over rest of all treatments. However the treatments T2 and T5 which were found to be statistically at par with the treatment T8 *i.e.* GA3 100 ppm. The lowest length of fruit (3.31 cm) was observed in control treatment T10.

Maximum value for length of fruit (6.28 cm) was recorded under treatment T9 *i.e.* GA3 150 ppm being at par with T8 *i.e.* GA3 100 ppm. Increase in length of fruit by GA3 application was probably due to an increase in the volume of mesocarp cells. Further the size of fruit was also increased by foliar application of NAA caused excessive cell division in mesocarp thus increased the size of fruit. The similar results were found by Kumar *et al*. (1998) [11] in guava, Bhowmick and Banik (2011) [3] in mango, Agrawal and Dikshit (2010) [2] and Patil *et al*. (2011) [16] in sapota.

3.3 Diameter of fruit (cm)

Data presented in Table 2 stated that the treatment T9 *i.e.* GA3 150 ppm recorded significantly highest diameter of fruit (6.03 cm) over rest of all the treatments followed by the treatment T8 *i.e.* GA3 100 ppm (5.99 cm). However, minimum diameter of fruit was observed in the treatment T10 (control) (3.08 cm).

The results in respect to diameter of fruit indicated that, it was significantly increased by foliar application of various plant growth regulators over the control. The maximum diameter of fruit (6.03 cm) was observed in treatment T9 *i.e.* GA3 150 ppm being at par with T8 *i.e.* GA3 100 ppm. Possible reason for increase in fruit diameter might be due to their involvement in cell division, cell elongation and increased volume of intercellular spaces in the mesocarpic cells. (Sharma *et al*. 2005) [19]. The findings are in agreement with the results obtained by Kumar *et al*. (1998) [11] in guava, Agrawal and Dikshit (2010) [2] in sapota, Bhowmick and Banik (2011) [3] in mango and Patil *et al*. (2011) [16] in sapota.

3.4 Volume of fruit (cm^3)

As regards to average volume of fruit, maximum fruit volume (81.48 cm^3) was obtained under the treatment T9 *i.e.* GA3 150 ppm, which was significantly superior over control and rest of the treatments under study, which was statistically at par with the treatment T6 (76.93 cm^3) and T8 (74.92 cm^3). Minimum fruit volume (54.86 cm^3) was recorded under the treatment T10 *i.e.* control.

It is evident from the present investigation that, the treatment T9 *i.e.* GA3 150 ppm recorded significantly maximum fruit volume (81.48 cm^3) being at par with T6 *i.e.* NAA 250 ppm and T8 *i.e.* GA3 100 ppm over no application (control). The increase in volume of the fruit due to increased size of fruit by exogenous application of GA3 and NAA. The application of GA3 increased size of fruit by cell elongation and NAA by cell division. The above findings are in agreement with the results of Syamal *et al*. (2010) [20] in papaya, Bhowmick and Banik (2011) [3] in mango, Agrawal and Dikshit (2010) [2] in sapota and Patil *et al*. (2011) [16] in sapota.

3.5 Weight of fruit (g)

It is evident from data presented in Table 2 that there were significant differences in respect of average weight of fruit as affected by different plant growth regulator treatments under study.

Maximum average weight of fruit (85.63 g) was recorded under the treatment T9 *i.e.* GA3 150 ppm, which was significantly superior over control and rest of the treatments under study.

The treatment T6 (81.03 g) *i.e.* NAA 250 ppm being statistically at par with the treatments T8 (79.14 g) *i.e.* GA3 100 ppm, which were significantly superior over control and the treatments T4, T5, and T7. Minimum average weight of fruit (60.76 g) was recorded under the treatment T10 (control).

The significantly highest weight of fruit (85.63 g) was recorded in treatment T9 *i.e.* GA3 150 ppm which was found at same bar with T6 *i.e.* NAA 250 ppm and T8 *i.e.* GA3 100 ppm. The exogenous application of Gibberellic acid (GA3) increases in cell size and intercellular spaces coupled with accumulation of water and nutrients in greater amount thus it increases the weight of fruit. The foliar application of NAA at flowering increases cell elongation by enlargement of vacuoles and loosening of cell wall after increasing its plasticity which ultimately increased the weight of fruit. The above findings are in close conformity with the results obtained by Syamal *et al*. (2010) [20] in papaya, Agrawal and Dikshit (2010) [2] in sapota, Bhowmick and Banik (2011) [3] in mango and Patil *et al*. (2011) [16] in sapota.

3.6 Weight of pulp of fruit (g)

The data presented in the Table 2 clearly indicated that, the maximum weight of pulp (84.26 g) was recorded in the treatment T9 *i.e.* GA3 150 ppm, which was significantly superior over control and rest of the treatments under study. Followed by treatment T6 (79.52 g) *i.e.* NAA 250 ppm, which was statistically at par with the treatments T8 (77.74 g) *i.e.* GA3 100 ppm.

The minimum average weight of pulp (59.06 g) was recorded under the treatment T10 (control), which was statistically at par with the treatments T4, T3 and T7.

It clarify from the data in respect to weight of pulp that, the maximum pulp weight (84.26 g) was recorded with higher concentration of GA3 application in T9 *i.e.*150 ppm GA3 being at par with T6 *i.e.* NAA 250 ppm and T8 *i.e.* GA3 100 ppm. The increased weight of pulp with exogenous application of plant growth regulators due to higher accumulation and translocation of extra metabolites from other parts of the plant towards developing fruits. Similar result was obtained by Sharma *et al*. (2005) [19] in litchi. The increase in weight of pulp could be attributed to increase size and weight of fruits. Moreover, probably there was a greater diversion of photosynthates to sink (fruit) which ultimately added to the pulp of fruit. The results are in conformity with the findings of Syamal *et al*. (2010) [20] in papaya, Bhowmick and Banik (2011) [3] in mango and Agrawal and Dikshit (2010) [2] in sapota, Patil *et al*. (2011) [16] in sapota and Meena *et al*. (2012) [12] in grape.

3.7 Weight of seeds per fruit (g)

The data on weight of seeds per fruit given in Table 2 which revealed that the effects of various plant growth regulators at various concentrations were found to be non- significant over control.

The data shows that the minimum (1.35 g) weight of seed was recorded in T9 *i.e.* GA3 150 ppm and it was found statistically at par with the treatment T8 *i.e.* GA3 100 ppm, the maximum (1.72 g) weight of seed was recorded in T10 (control).

The results are in accordance with Patil *et al.* (2010) [15]. They reported an increase in seed weight with the application of NAA as compared to GA.

3.8 Number of seeds per fruit

The data on number of seeds per fruit given in Table 2 which revealed that effect of various plant growth regulators at various concentrations were found to be non- significant over control.

The data shows that, the minimum (1.66) seed number was recorded in T9 *i.e.* GA3 150 ppm and followed by the treatment T8 *i.e.* GA3 100 ppm and T3 *i.e.* SADH 150 ppm and the maximum number of seeds per fruit (2.07) in T10 (control). The results are in accordance with Patil *et al.* (2011) [16] who reported the minimum number of seed with the application of GA as compared to NAA.

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