SHORT COMMUNICATION

The effect of PGRs on growth and yield attributes of sapota cv. Cricket Ball in Chhattisgarh Plains Zone

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Receipt: 13.11.2024 *Revised: 10.12.24* *Acceptance: 12.12.24*
DOI: 10.53552/ijmfmap.10.2.2024.148-155

ABSTRACT

The current study was conducted at the Horticulture Farm, Department of Fruit Science, CoA, IGKV, Raipur (C.G.) in the years 2020–21 and 2021–22.Twenty-year-old sapota cv. Cricket Ball trees were sprayed with varying PGRs doses during two stages, such as 50% flowering and the pea stage of fruit development. This investigation was arranged by utilisingRandomised Block Design, replicated thrice along with twenty five treatments. The findings revealed that plant growth parameters such as length (11.64 cm), girth of new shoots (1.13 cm) and number of leaves shoot^{-1} (28.33 cm), were highest in T_{12} (GA_3 @ 150 ppm at 50% flowering + pea stage *) among all treatments, while the maximum yield (qt-ha^{-1}) was recorded in T_6 (*NAA @ 200 ppm at 50% flowering + pea stage) *27.72 qt-ha^{-1}. The gross return and net return (in rupees ha^{-1}) of Sapota were also recorded highest in T_6 (*NAA @ 200 ppm at 50% flowering + pea stage*) Rs 159045.90 and Rs 114977.89 ha^{-1} but the benefit-cost ratio was highest in T_3 (*NAA @ 100 ppm at 50% flowering + pea stage*) 2.81.*

Keywords: Benefit: cost, CCC, GA_3, gross realisation, growth parameters**,** NAA,

One of the delectable fruits of humid tropical and subtropical regions is the sapota [*Manilkaraachras*(Mill.) Forsberg], is commonly known as chiku in Indian parlance. Nowadays, fruit growers are very much attracted towards the cultivation of sapota; the main reason for this is that it can be grown in different soil and climatic conditions. Sapotaplant areflowers and fruits throughout the year. It gives a single crop in April and May after flowering in summer. Both flowers and fruits suffer from high temperatures. Many civilizations have utilized sapodilla fruit as a traditional indigenous medicine (Lim 2013). When boiled, the unripe fruits, which are rich in tannins, can be used to cure diarrhea. Young fruit extracts have also been shown to alleviate pulmonary issues (Kulkarni*et al.*, 2007). Minerals like potassium, calcium, iron, copper, and zinc, as well as phenolic components, are abundant in the fruits (Kulkarni*et al.* 2007; Mund*et al.* 2016; Sumati and Sivasankar 2017). In India, the cultivation of Sapota is 163.90 thousand hectares and production is 1495 thousand metric tons, with a productivity of 9.1 metric tons per hectare (Anonymous, 2019). In Chhattisgarh, the total area under Sapota is 340 hectares, with an annual production of 1578 metric tons (Anonymous, 2019).

The remarkable expansion in area reveals grower's readiness to embrace this fruit in exchange for significant financial rewards. However, in the plains of Chhattisgarh sapota cultivation faces twin problem of poor agro-climate and self-incompatibility leading to low production. The use of plant growth regulators is an effective method to increase fruit set and reduces dropping of fruit in sapota to increase production. PGR$_S$ (Plant Growth Regulators) are used to control all stages of crop development including plant growth, flowering, fruit set, fruit growth and development and are used at particular stages to have maximum effect. Fruit length, fruit diameter, fruit volume, specific gravity, average pulp weight, average peel weight, number of seeds per fruit, weight of seeds per fruit, and fruit weight in sapota have all been found to increase with varying concentrations of plant growth regulators such as synthetic auxins, gibberellins, and CCC (Bhujbal*et al.*, 2013; Kavyashree*et al.*, 2018; Akshay*et al.*, 2020). Amongst different synthetic auxins, NAA seems to be most useful in terms of fruit setting and fruit retention in some fruits crops (Siriwardana*et al.*, 2019; Godi*et al.*, 2020; Kour*et al.*,2019; Singh *et al.* 2018). Likewise, CCC and GA_3were found to enhance the number of flowers and number of fruits per tree (Agarwal and Dikshit, 2008). Considering beneficial role of PGRs, an experiment was conducted to standardize appropriate stage of application and optimum doses of plant growth regulators on growth and fruit yield of sapota cv. Cricket Ball and To estimate the economics and B: C ratio of different plant growth regulators treatments.

The experiment was carried out at Horticulture Instructional Farm, Department of Fruit Science, College of Agriculture, Indira Gandhi KrishiVishwavidyalaya, Raipur, Chhattisgarh, India, during years 2020–21 and 2021–22. The experimental site is located in the plains zone of Chhattisgarh at 21.25^0 N latitude and 81.63^0 E longitude with an altitude of 289.15 meters above the mean sea level. The South-West monsoon is the source of rainfall. It receives an annual average rainfall of 1200–1400 mm. The maximum temperature goes as high as 42.50°C during summer and the minimum as below 7.0°C during winter months. The soil of the experimental field was clay-loam, which is locally known as Dorsa in the region.Twenty years old sapota plants cv. Cricket Ball was taken for the study. There were twenty-five treatments along with a control and each treatment was replicated thrice in a complete Randomized Block Design. Different concentrations of plant growth regulators were used in the treatments at 50% flowering and pea stage which are shown in Table 1.

Table 1: Different treatment of Plant Growth Regulators

Treatment	Notation	Treat ment	Notation
T_0	Control (water spray)	T_{13}	Ethrel @ 500 ppm at 50% flowering + pea stage
T_1	NAA @ 100 ppm at 50% flowering stage	T_{14}	Ethrel @ 500 ppm at pea stage
T_2	NAA @ 100 ppm at pea stage	T_{15}	Ethrel @ 500 ppm at 50% flowering + pea stage
T_3	NAA @ 100 ppm at 50% flowering + pea stage	T_{16}	Ethrel @ 1000 ppm at 50% flowering stage
T_4	NAA @ 200 ppm at 50% flowering stage	T_{17}	Ethrel @ 1000 ppm at pea stage
T_5	NAA @ 200 ppm at pea stage	T_{18}	Ethrel @ 1000 ppm at 50% flowering + pea stage
T_6	NAA @ 200 ppm at 50% flowering + pea stage	T_{19}	Cycocel @ 200 ppm at 50% flowering stage
T_7	GA_3 @ 100 ppm at 50% flowering stage	T_{20}	Cycocel @ 200 ppm at pea stage
T_8	GA_3 @ 100 ppm at pea stage	T_{21}	Cycocel @ 200 ppm at 50% flowering+ pea stage
T_9	GA_3 @ 100 ppm at 50% flowering + pea stage	T_{22}	Cycocel @ 400 ppm at 50% flowering stage
T_{10}	GA_3 @ 150 ppm at 50% flowering stage	T_{23}	Cycocel @ 400 ppm at pea stage
T_{11}	GA_3 @ 150 ppm at pea stage	T_{24}	Cycocel @ 400 ppm at 50% flowering + pea stage
T_{12}	GA_3 @ 150 ppm at 50% flowering + pea stage		

During both the years (2020-21 and 22), the spraying took place during the third week of August when the flowers were 50% fully bloomed and during the last week of September when the pea stage was just started. Statistical analysis of different data was carried out using MS-Excel and OPSTAT (online statistical analysis software) for each observed character under study. Data investigation was analysed using randomised block design (RBD), with each treatment replicated three times with the help of the book by Gomez and Gomez (1984).

Length of new shoots (cm): The length of new shoots in sapota obtained from different treatments was significantly different among the treatments (Table 2). New shoots in T_{12} (11.64 cm) had the highest length, which was prominent among all treatments, while T_0 (8.13 cm) recorded the lowest new shoot length. Increased shoot length in GA_3 treatment may be due to faster elongation, increased cell division, and growth. Similar findings have been obtained in Sapota in this regard (Sahu*et al.*, 2022; Patil*et al.*, 2011; Mishra *et al*. 2023; Datta*et al.*2024).

Girth of new shoots (cm): The girth of new shoots measured was varied among the treatments (Table 2). Maximum (1.13 cm) was recorded from T_{12} GA_3 @ 150 ppm treatment at 50% flowering + pea stage, followed by T_9, T10, T11, T_6& T_7 (1.08, 1.05, 1.04, 1.01 & 0.97 cm), respectively. However, minimum girth (0.26 cm) was observed under T_0 (control). This may be due to the effect of GA_3, which induces cell division, cell elongation, and cell growth and also helps in the synthesis of proteins, including various enzymes, thereby increasing the rate of cell growth and photosynthetic capacity. Sahu*et al. (2023)*; Bhujbal*et al.* (2013); and Akshay*et al.* (2020) have also obtained similar findings in Sapota.

Number of leaves shoot^{-1}: The effect of PGR$_S$ in the experiments also showed a positive and significant difference in the number of leaves shoot^{-1} of sapota trees treated with different treatments, as shown in Table 2. At 50% flowering + pea stage, the significantly highest number of leaves shoot^{-1} was observed under GA_3 at 150 ppm (28.33 cm), which was found to be a non-significant difference when compared between treatments T_9, T_{10}, and T_{11} and T_8 and T_7, and the number of leaves shoot^{-1} was (27.83, 27.50, and 27.16), respectively. The lowest number of leaves shoot^{-1} was observed to be 21.66 under control. This is possibly due to the association of the apical meristem with leaf initiation, which is affected by growth inhibitors. The results are consistent with earlier work obtained in Sapota by Sahu *et al.* (2023); Kour *et al.* (2019); Singh *et al.* (2018); and Chavan *et al.* (2009).

Yield (qt-ha^{-1}): The variation in fruit yield qt-ha^{-1} of twenty-five different treatments in Sapota trees cv. Cricket Ball was shown in the Table 3. Significantly, the highest fruit yield of 22.72 kg was observed under NAA treatment at 200 ppm at 50% flowering + pea stage (T6), followed by T_{12}, T9, and T_3 (21.55, 21.40, and 21.01 qt ha^{-1}). While the lowest yield (13.91 qt-ha^{-1}) was recorded under untreated control. This may be due to the fact that NAA have reduced the flower drop and promoted fruit set and fruit retention, which ultimately resulted in higher yield. These findings are aligned in the line of Rehman*et al. (2018);* Bagul*et al. (2021);*Siriwardana*et al.* (2019); Kour*et al.* (2019) and Patil*et al.* (2011) in fruits crops.

Gross realization (Rs.-ha^{-1}): Significantly higher gross realization of Rs. 159045.90 ha^{-1} was noted under the NAA treatment at 200 ppm at 50% flowering + pea stage (T_6) while the lowest gross realisation of Rs 97424.61 ha^{-1} was recorded under untreated control (Table 3). The above findings are largely in agreement with the results obtained in Sapota (Singh *et al.* (2020) and Joshi *et al.* 2016).

Net realization (Rs. /ha): The net realization of different treatments that are applied in sapota treatments in the present study has shown significant variation (Table 3). The NAA treatment at 200 ppm at 50% flowering + pea stage (T_6) had higher net realization of 114977.89 Rs-ha^{-1} during both the years. The minimum net realization of 64396.60 Rs-ha^{-1} was found under control. Similar findings obtained by Desai *et al.(2017),* Jain *et al. (*2020), and Kavyashree *et al. (*2018) in Sapota.

Benefit: cost ratio: Maximum benefit cost ratio 2.81 was noticed under the treatment NAA @ 100 ppm at pea stage, which was found at par with the treatments T_1, T_7, T_5 &T_2 and T_7, T_3, T_5& T_{23} and T_7, T_8& T_5 having benefit cost ratio 2.87, 2.87, 2.86 & 2.81 and 2.71, 2.68, 2.68 & 2.67 and 2.79, 2.78 & 2.77, respectively. However, the minimum benefit: cost ratio of 1.95 was noticed under the control. The above findings are in close conformity with the results obtained by Sahu*et al*. (2018); Singh *et al.* (2018); Mishra *et al.* (2023); Kumar *et al.* (2024); Kaur and Singh (2024) in different fruit crops.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 2: Effect of foliar spray of different concentrations of plant growth regulators on length of new shoots (cm), girth of new shoots (cm) and numbers of leaves shoot^{-1} of sapota cv. Cricket Ball (pooled data of 2020–21 and 2021–22)

Treatments	**Length of new shoots (cm)**	**Girth of new shoots (cm)**	**Number of leaves shoot^{-1}**
T_0 - Control (water spray)	8.13^{k}	0.267^{g}	21.66^{l}
T_1 - NAA @ 100 ppm at 50% flowering stage	9.75^{ghij}	$0.67^{abcdefg}$	25.33^{defgh}
T_2 - NAA @ 100 ppm at pea stage	9.65^{hij}	0.59^{bcdefg}	24.16^{hij}
T_3 -NAA @ 100 ppm at 50% flowering + pea stage	10.31^{defgh}	0.89^{abcd}	25.66^{defg}
T_4 -NAA @ 200 ppm at 50% flowering stage	10.03^{efghij}	$0.75^{abcdefg}$	24.16^{hij}
T_5 -NAA @ 200 ppm at pea stage	10.44^{cdefg}	0.86^{abcdef}	24.83^{efghij}
T_6 -NAA @ 200 ppm at 50% flowering + pea stage	11.05^{abc}	1.01^{ab}	26.16^{cde}
T_7 - GA_3 @ 100 ppm at 50% flowering stage	10.65^{bcde}	0.97^{ab}	27.16^{abc}
T_8 -GA_3 @ 100 ppm at pea stage	10.39^{cdefg}	0.95^{abc}	27.16^{abc}
T_9 -GA_3 @ 100 ppm at 50% flowering + pea stage	11.15^{ab}	1.08^{ab}	27.83^{a}
T_{10} -GA_3 @ 150 ppm at 50% flowering stage	10.89^{bcd}	1.05^{ab}	27.50^{ab}
T_{11} -GA_3 @ 150 ppm at pea stage	10.89^{bcd}	1.04^{ab}	27.50^{ab}
T_{12} -GA_3 @ 150 ppm at 50% flowering + pea stage	11.64^{a}	1.13^{a}	28.33^{a}
T_{13} -Ethrel @ 500 ppm at 50% flowering + pea stage	8.64^{k}	0.44^{defg}	23.66^{ijk}
T_{14} -Ethrel @ 500 ppm at pea stage	8.71^{k}	0.46^{cdefg}	22.50^{kl}
T_{15} -Ethrel @ 500 ppm at 50% flowering + pea stage	9.49^{j}	0.60^{bcdefg}	24.50^{ghij}
T_{16} -Ethrel @ 1000 ppm at 50% flowering stage	9.69^{hij}	$0.64^{abcdefg}$	23.83^{ij}
T_{17} -Ethrel @ 1000 ppm at pea stage	9.53^{j}	$0.78^{abcdefg}$	23.50^{jk}
T_{18} -Ethrel @ 1000 ppm at 50% flowering + pea stage	10.04^{efghij}	0.88^{abcde}	24.66^{fghij}
T_{19} -Cycocel @ 200 ppm at 50% flowering stage	9.58^{ij}	0.38^{efg}	25.00^{defghi}
T_{20} -Cycocel @ 200 ppm at pea stage	9.68^{hij}	0.31^{g}	25.33^{defgh}
T_{21} -Cycocel @ 200 ppm at 50% flowering+ pea stage	10.26^{defghi}	0.35^{g}	26.00^{cdef}
T_{22} -Cycocel @ 400 ppm at 50% flowering stage	10.23^{defghi}	0.31^{g}	25.83^{defg}
T_{23} -Cycocel @ 400 ppm at pea stage	9.89^{fghij}	0.36^{fg}	25.33^{defgh}
T_{24} -Cycocel @ 400 ppm at 50% flowering + pea stage	10.44^{cdef}	0.34^{g}	26.33^{bcd}
SE(m)±	**0.126**	**0.06**	**0.48**
CD at 5%	**0.360**	**0.18**	**1.37**

Table 3: Effect of foliar feeding of different concentrations of plant growth regulators on yield (kg-tree^{-1}), gross realization (Rs./ha), net realization (Rs./ha) and benefit: cost ratio of sapota cv. Cricket Ball (pooled data of 2020–21 and 2021–22)

Treatments	**Gross realization (Rs./ha)**	**Net realization (Rs./ha)**	**Benefit:cost ratio**	**Yield (qt-ha^{-1})**
T_0 - Control (water spray)	97424.61^{x}	64396.60^{x}	1.95^{d}	13.91^{m}
T_1 - NAA @ 100 ppm at 50% flowering stage	133353.79^{l}	97565.74^{l}	2.72^{ab}	19.05^{efgh}
T_2 - NAA @ 100 ppm at pea stage	133602.70^{k}	97814.72^{k}	2.73^{ab}	19.08^{efg}
T_3 -NAA @ 100 ppm at 50% flowering + pea stage	147113.79^{d}	108565.79^{b}	2.81^{a}	21.01^{bcd}
T_4 -NAA @ 200 ppm at 50% flowering stage	138808.29^{j}	100260.29^{j}	2.60^{abc}	19.83^{def}
T_5 -NAA @ 200 ppm at pea stage	145564.90^{e}	107016.89^{d}	2.77^{a}	20.79^{bcd}
T_6 -NAA @ 200 ppm at 50% flowering + pea stage	159045.90^{a}	114977.89^{a}	2.60^{abc}	22.72^{a}
T_7 - GA_3 @ 100 ppm at 50% flowering stage	141569.09^{f}	104281.10^{f}	2.79^{a}	20.22^{cde}
T_8 -GA_3 @ 100 ppm at pea stage	141062.40^{g}	103774.39^{g}	2.78^{a}	20.15^{cde}
T_9 -GA_3 @ 100 ppm at 50% flowering + pea stage	149840.70^{c}	108292.70^{c}	2.60^{abc}	21.4^{bc}
T_{10} -GA_3 @ 150 ppm at 50% flowering stage	140895.29^{h}	101477.29^{i}	2.57^{abc}	20.12^{cde}
T_{11} -GA_3 @ 150 ppm at pea stage	141085.90^{g}	101667.89^{h}	2.57^{abc}	20.15^{cde}
T_{12} -GA_3 @ 150 ppm at 50% flowering + pea stage	150861.40^{b}	105053.39^{e}	2.29^{abcd}	21.55^{b}
T_{13} -Ethrel @ 500 ppm at 50% flowering + pea stage	106106.39^{w}	72103.38^{w}	2.12^{cd}	15.15^{lm}
T_{14} -Ethrel @ 500 ppm at pea stage	108053.89^{v}	74050.90^{v}	2.17^{bcd}	15.43^{l}
T_{15} -Ethrel @ 500 ppm at 50% flowering + pea stage	114606.20^{t}	79628.18^{t}	2.27^{abcd}	16.37^{kl}
T_{16} -Ethrel @ 1000 ppm at 50% flowering stage	114026.70^{u}	79048.71^{u}	2.26^{abcd}	16.29^{kl}
T_{17} -Ethrel @ 1000 ppm at pea stage	117183.10^{r}	82205.11^{s}	2.35^{abcd}	16.74^{jk}
T_{18} -Ethrel @ 1000 ppm at 50% flowering + pea stage	130812.39^{m}	93884.38^{n}	2.54^{abc}	18.68^{fgh}
T_{19} -Cycocel @ 200 ppm at 50% flowering stage	119724.79^{q}	85316.81^{q}	2.48^{abcd}	17.1^{ijk}
T_{20} -Cycocel @ 200 ppm at pea stage	116870.89^{s}	82462.88^{r}	2.39^{abcd}	16.69^{jk}
T_{21} -Cycocel @ 200 ppm at 50% flowering+ pea stage	127412.89^{o}	91624.86^{o}	2.56^{abc}	18.2^{ghi}
T_{22} -Cycocel @ 400 ppm at 50% flowering stage	124563.50^{p}	88775.50^{p}	2.48^{abcd}	17.79^{hij}
T_{23} -Cycocel @ 400 ppm at pea stage	130497.60^{n}	94709.59^{m}	2.64^{abc}	18.64^{fgh}
T_{24} -Cycocel @ 400 ppm at 50% flowering + pea stage	139941.59^{i}	101393.60^{i}	2.63^{abc}	19.99^{de}
SE(m)±	**3,274.298**	**3274.612**	**0.087**	**0.46**
CD at 5%	**9,339.180**	**9340.076**	**0.250**	**1.33**