PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol 11(4): 407-411
https://doi.org/10.14719/pst.4565

HORIZON
e-Publishing Group

RESEARCH ARTICLE

Influence of plant growth regulators on yield attributes and physical parameters of fruit quality in sapota under the eastern tropical region of India

Deeksha Gautam[1], Gobinda Chandra Acharya[2], Subash Chandra Swain[1], Sunil Samal[1], Deepa Samant[2]*, Adamala Anil Kumar[2], Charu Shekhawat[3] & Kuldeep Kumar Shukla[1]

[1]Department of Fruit Science and Horticultural Technology, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha-751003, India

[2]ICAR-IIHR, Central Horticultural Experiment Station, Bhubaneswar, Odisha-751019, India

[3]Department of Horticulture, Agriculture University, Kota, Rajasthan-325001, India

*Email: horti.deepa@gmail.com

OPEN ACCESS

ARTICLE HISTORY
Received: 06 August 2024
Accepted: 23 September 2024
Available online
Version 1.0 : 08 October 2024
Version 2.0 : 09 October 2024

Check for updates

Additional information
Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE
Gautam D, Acharya GC, Swain SC, Samal S, Samant D, Kumar AA, Shekhawat C, Shukla KK. Influence of plant growth regulators on yield attributes and physical parameters of fruit quality in sapota under the eastern tropical region of India. Plant Science Today. 2024; 11(4): 407-411. https://doi.org/10.14719/pst.4565

Abstract

The present study was conducted at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar, during 2022 and 2023 to evaluate the impact of the application of plant growth regulators on fruit set, yield and physical fruit quality of Sapota (*Manilkara zapota* L.) cv. DHS-1. The experiment was designed in a randomized completely block design with nine treatments consisting of NAA (50 and 100 ppm), CPPU (5 and 7.5 ppm), SA (150 and 300 ppm) and Homobrassinolide (10 and 15 ppm) and water as control. Treatments were imposed on 24-year-old, uniformly grown sapota trees, planted at 10m x 10m spacing, at flowering, fruit set and one month after fruit set. In general, the application of PGRs was effective in augmenting fruit sets, fruit retention, yield attributes and physical fruit quality over control. However, the application of NAA and CPPU performed better at higher doses. The treatment NAA @100 ppm resulted in the highest fruit set (34.76 %), fruit retention (57.46% at 30 DAFS, 28.48 % at 120 DAFS), yield (47.77 kg/tree) and physical fruit viz. pulp content (93.80%), dry matter (26.15%), fruit length (7.47 cm) and fruit width (6.57 cm). Pearson correlation coefficient analysis showed positive links among fruiting, yield, yield attributing traits and physical fruit quality parameters of sapota, as well as a negative correlation for peel content.

Keywords

plant growth regulators; foliar spray; pea stages; yield

Introduction

Sapota (*Manilkara zapota* L.), known as chico, chikoo, sapodilla, lamut and chicle, belongs to the Sapotaceae family. It is native to Mexico and Colombia and grows in tropical biome (1). The fruits are highly flavourful and nutritious. Pulp is mellow, sweetened and crumbly. It features a sandy, granular texture and a distinctive aroma. Sapota fruits are rich in phenolic compounds and ascorbic acid, which leads to their various health benefits for humans. Sapota fruit is also known to contain sugars, protein, amino acids, and carotenoids. It has high levels of minerals, including potassium, copper, iron, zinc, and calcium (2, 3). In Central and South American countries, its bark and fruits produce milky latex, used to produce a commercial product known as Gutta parcha. This latex is a critical ingredient in the preparation of chewing gum (Chickle).

In India, it ranks as the sixth most significant commercial fruit, following mango, banana, citrus, apple, and guava. Cultivation of this fruit in India began in Gholwad village, Maharashtra, in 1898. (4). Being hardy with minimal incidence of weeds, disease and pests, its cultivation has been spread in tropical and subtropical regions of India. The major sapota-producing states are Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Gujarat, West Bengal, Odisha and Haryana. Odisha, located on the eastern coast of India, cultivates sapota in both coastal and interior districts, including Jagatsinghpur, Balasore, Khurda, Kendrapara, Puri, Cuttack and Ganjam. In Odisha, sapota is grown over an area of approximately 3.36 thousand hectares, yielding an annual production of about 15.72 thousand metric tonnes (5).

The flowering is generally erratic, and this trend has facilitated fruit harvest throughout the year. In tropical areas, substantial fruit drop and poor fruit retention are significant challenges to achieving sapota's high yield potential despite abundant flowering (6). Hormonal unevenness and the struggle to photo-assimilate among emerging fruits are the chief factors among various causes (7).

Ample attention has been given to escalating many fruit crops' quantitative and qualitative traits by exogenous application of PGRs. The use of PGRs is considered a crucial element for enhancing the production of superior fruits in the horticulture sector (8). Foliar feeding of PGRs at specific stages of flowering and fruit development can help address issues of irregular flowering and low fruit set (9). PGRs, alternatively referred to as bio-stimulants or bio-inhibitors, operate intracellularly to modulate specific enzymes or enzyme systems, thereby facilitating the regulation of plant metabolism (10). Using PGRs has shown notable growth, yield and quality outcomes in various fruit crops (3).

The challenges of poor fruit set, low fruit retention, and decreased yield in commercially grown sapota in tropical regions must be addressed. There is a need for further research and efforts in this area. The response of the crops to PGRs depends on various factors like dose of application, time of application, edapho-climatic factor, etc. Therefore, the present research was designed to determine the influence of PGRs on fruit set, fruit retention, yield attributes and physical fruit quality of sapota (*Manilkara zapota* L.) cv. DHS-1 (Dharwad Hybrid Sapota-1) under the eastern tropical region of India. A quick pictorial chart representing the research work methodology is encapsulated in Figure 1.

Materials and Methods

The present experiment was plotted during 2021 and 2022 at the research farm site of ICAR-IIHR-Central Horticultural Experiment Station, Bhubaneswar, Odisha. Humid, hot and tropical conditions characterized the climate at the experimental site. The site is situated at 20° 15' N latitude and 85° 15' E longitude, with an elevation of 42 meters above mean sea level.

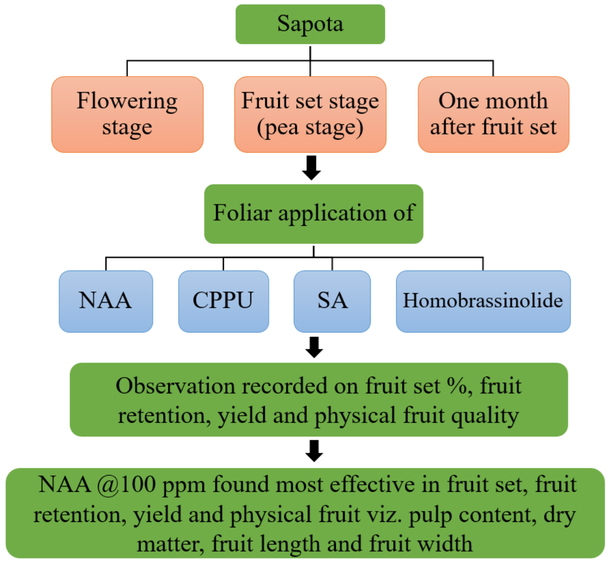

Fig. 1. Pictorial chart form representation of the experiment.

The soil in the experimental site was characterized by sandy loam, consisting of 73.40% sand, 17.25% silt and 9.35% clay. It was highly acidic with a pH of 4.49 with available nitrogen (186.74 kg/ha) comprising low levels of organic carbon (0.24%) and phosphorus (12.15 kg/ha), while potassium levels were moderate (181.51 kg/ha).

Maintenance of the research field was carried out as per standard cultural practices. The experiment was carried out in RCBD design with nine treatments consisting of NAA @50, 100, CPPU @5ppm, 7.5ppm, SA @150ppm, 300ppm and Homobrassinolide @10 ppm,15 ppm keeping one treatment control (water spray). Each treatment was replicated three times and each replication consisted of four plants. The application of PGRs was done each year at flowering, fruit setting (pea stage) and one month after fruit setting.

The fruits were picked at the full mature stage. Fruit yield and physical fruit quality attributes were recorded and analyzed at a central laboratory in the Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. Recorded data of various parameters were statistically analyzed using the variance technique (11). Duncan's Multiple Range Test was employed to determine significant differences at the p=0.05 level. As regulated by growth regulators, Pearson correlation coefficients among fruiting, yield, yield attributing traits and physical fruit quality parameters of sapota were worked out using KAUGRAPES software.

The data presented in Table 1 revealed that the number of flowers per shoot ranges from 7-9 in sapota crops, and the application of PGRs was found to be significantly effective in fruit sets and the total number of fruits per shoot. Among the different PGRs, the maximum fruit set (34.76 %) and the total number of fruits per shoot (2.77) were recorded with T4 (NAA @100 ppm), which was significantly higher than the rest of the treatments, followed by T2 (CPPU 7.5 ppm), whereas the minimum was recorded under control. The positive influence of NAA on fruits per shoot and fruit set could be attributed to its role in translocating and mobilizing the stored metabolites or photosynthates from source to sink (12). The results are supported by many scientists (13-16).

Table 1: Pooled data on the effect of NAA, CCPU, SA and Homobrassinolide on flowering, fruit set % and yield of sapota *cv*. DHS-1.

Treatments	Flower/shoot	fruits/shoot	Fruit set	Fruits/trees	Average fruit weight	Yield
	(nos.)	(nos.)	(%)	(nos.)	(g)	(kg/tree)
T_1	7.97^{cd}	2.19^{bc}	27.52^{d}	340.77^{d}	127.98^{c}	43.61^{d}
T_2	8.08^{b}	2.64^{a}	32.71^{b}	347.31^{b}	132.73^{b}	46.10^{b}
T_3	7.94^{b}	2.35^{b}	29.65^{c}	344.09^{c}	129.07^{c}	44.41^{c}
T_4	7.98^{a}	2.77^{a}	34.76^{a}	354.20^{a}	134.87^{a}	47.77^{a}
T_5	7.58^{cd}	1.94^{de}	25.54^{f}	323.88^{g}	125.26^{d}	40.57^{f}
T_6	7.32^{d}	1.75^{ef}	23.96^{g}	321.04^{h}	122.73^{e}	39.40^{g}
T_7	7.78^{c}	2.00^{cd}	25.77^{f}	331.91^{f}	125.42^{d}	41.63^{e}
T_8	7.92^{cd}	2.08^{cd}	26.26^{e}	340.00^{e}	127.93^{c}	43.50^{d}
T_9	7.17^{e}	1.67^{f}	23.31^{h}	316.08^{i}	121.78^{e}	38.49^{h}

T_1:CPPU 5ppm; T_2: CPPU 7.5 ppm; T_3: NAA 50 ppm; T_4: NAA 100 ppm; T_5: SA 150 ppm; T_6: SA 300 ppm; T_7: Homobrassinolide10 ppm; T_8: Homobrassinolide15ppm; T_9: Control (Water spray)

The values marked with the same alphabets are non-significant at P>0.05, NS: Non-significant.

Further, figure 2 exhibited a decreasing trend of fruit retention with the progression of fruit maturity, regardless of given treatments. Fruit retention at 30 days after fruit set (DAFS) was found to range from 50.50 to 57.46 %, although, at the fruit maturity stage (120 DAFS), it was recorded from 20.27 to 28.48 %. It is apparent from the glancing at data that foliar spray of NAA @100 ppm (T4) substantially upgraded the fruit retention in sapota. The treatment T4 (NAA @100 ppm) achieved the supreme fruit retention (57.46 %) at 30 DAFS, closely followed by T2, i.e. CPPU 7.5 ppm (55.66 %). The results remained the same throughout the observation period (60, 90 and 120 DAFS). The positive influence of NAA on fruit retention could be due to its role in facilitating appropriate augmentation of nutrients and anticipation of creating an abscission layer by some inhibiting enzymatic activities (17). The results also align closely with the findings of other researchers (13, 15, 18).

The yield data presented in Table 1 shows that all the treatments of PGRs significantly boosted the sapota produce in terms of fruit number, average fruit weight and yield over the control. However, the effect was more prominent for NAA @100 ppm. Among the different chemical sprays, a maximum number of fruits per tree (354.20), average fruit weight (134.87 g), and yield tree (47.77 kg/tree) was recorded with T4 (NAA @100 ppm), which was significantly higher than rest of the treatments, followed by T2 (CPPU 7.5 ppm) whereas the minimum was recorded under control. Regarding average fruit weight (g), T6 (SA 300 ppm) was at par with the power. The highest number of fruits per tree using NAA might be

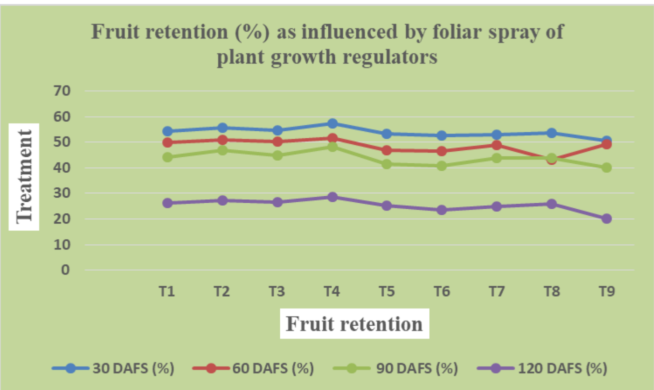

Fig. 2. Fruit retention (%) as influenced by foliar spray of plant growth regulators in sapota cv. DHS-1.

attributed to the substantial fruit set and fruit retention attained by applying NAA. The significant influence of NAA on the increase in fruit weight could be due to its effect on cell elongation and cell wall loosening, which increased its plasticity (9). The enhancement in fruit yield may be attributed to more results in yield-related components, namely, fruit weight and number. The findings are consistent with the previous study outcomes (16, 18-20).

The data presented in Table 2 about physical fruit quality indicated a significant influence on fruit pulp, dry matter and lowest peel. In contrast, no significant impact was observed in fruit length, width, seed content and seed weight.

It is observed that application of T4 (NAA @100 ppm) resulted in maximum fruit pulp (93.80 %) and dry matter (26.15 %) with the lowest peel (4.68 %), whereas the minimum was recorded under control. The effect of NAA on increasing pulp weight and reducing peel weight may be attributed to the enlargement of cell size and intracellular spaces, along with a more significant accumulation of water, sugars and other soluble solids in it, which resulted in the enhanced translocation of metabolites towards fruit development (12, 21). Previously, similar findings were also noted in banana fruit (22).

The effect of treatments on fruit length (cm), fruit width (cm), seed content (%), and seed weight was reported to have a non-significant effect. The results are aligned with previously conducted work as well (23). However, maximum fruit length (7.47 cm), fruit width (6.57 cm), seed content (1.52 %) and seed weight (2.05 g) were found with T4 (NAA @100 ppm), followed by T2 (CPPU 7.5 ppm) whereas the minimum (6.21 cm, 5.23 cm, 0.79 %, 0.97 g) was recorded under control.

Correlation study among fruiting traits, yield attributing traits and physical fruit quality parameters of sapota:

Pearson correlation coefficient analysis was conducted on pooled data to examine the relationships among fruiting traits, yield attributing traits and physical fruit quality parameters of sapota as affected by growth regulators. The data illustrated in Fig. 3 shows that flowering and fruiting characters like flower per shoot, fruit per shoot, fruit set and fruit retention exhibited substantial positive correlations with fruits per tree, average fruit weight, fruit

Table 2: Pooled data on the effect of NAA, CCPU, SA and Homobrassinolide on physical fruit quality parameter sapota *cv.* DHS-1.

Treatments	Fruit length (cm)	Fruit width (cm)	Fruit Pulp (%)	peel (%)	seed content (%)	Seed weight (g)	Dry matter (%)
T_1	6.59^{cd}	6.30^{cd}	90.07^{d}	8.66^{d}	1.27^{c}	1.63^{c}	24.63^{b}
T_2	7.18^{b}	6.42^{b}	92.54^{b}	6.07^{f}	1.40^{b}	1.86^{b}	26.22^{a}
T_3	7.06^{b}	6.41^{bc}	90.95^{c}	7.72^{e}	1.33^{bc}	1.72^{c}	24.80^{b}
T_4	7.47^{a}	6.57^{a}	93.80^{a}	4.68^{g}	1.52^{a}	2.05^{a}	26.15^{a}
T_5	6.59^{cd}	5.88^{f}	88.74^{f}	10.22^{b}	1.04^{ef}	1.31^{ef}	20.58^{e}
T_6	6.49^{d}	5.81^{f}	88.32^{f}	10.70^{b}	0.99^{f}	1.21^{f}	18.84^{f}
T_7	6.67^{c}	6.14^{e}	88.66^{f}	10.20^{b}	1.14^{d}	1.43^{d}	22.39^{d}
T_8	6.60^{cd}	6.21^{de}	89.43^{e}	9.47^{c}	1.11^{de}	1.42^{de}	23.60^{c}
T_9	6.21^{e}	5.23^{g}	86.57^{g}	12.64^{a}	0.79^{g}	0.97^{g}	15.75^{g}

T_1:CPPU 5ppm; T_2: CPPU 7.5 ppm; T_3: NAA 50 ppm; T_4: NAA 100 ppm; T_5: SA 150 ppm; T_6: SA 300 ppm; T_7: Homobrassinolide 10 ppm; T_8: Homobrassinolide 15ppm; T_9: Control (Water spray)

The values marked with the same alphabets are non-significant at P>0.05, NS: Non-significant.

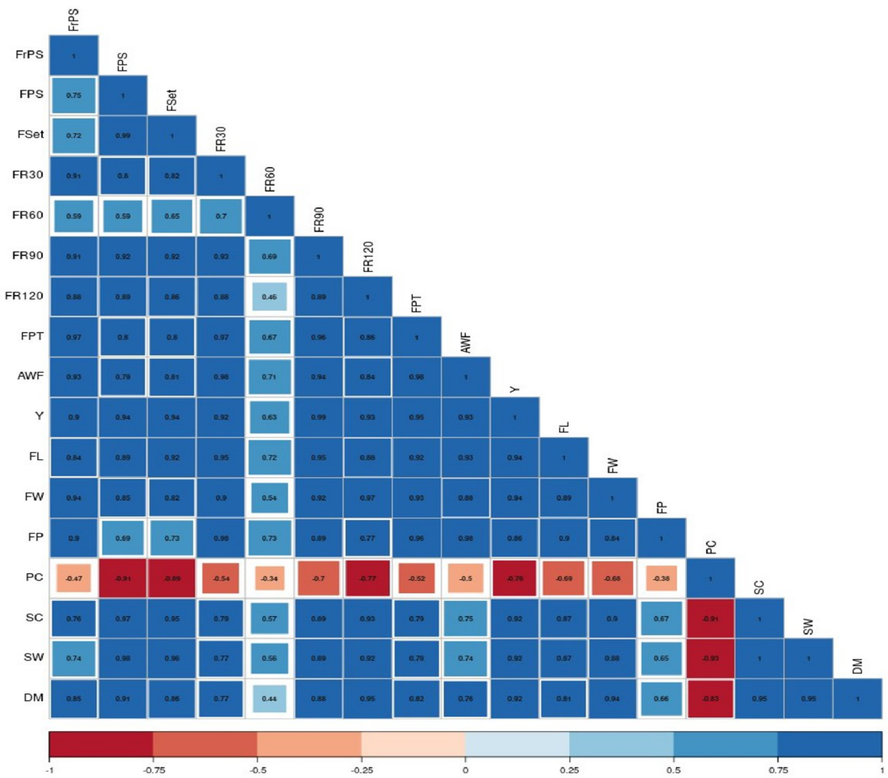

Fig. 3. Correlation study among fruiting traits, yield attributing traits and physical fruit quality parameters of sapota.

FrPS- flower per shoot, FPS- fruit per shoot, FSet- fruit set, FR30- Fruit Retention @30DAFS, FR60- Fruit Retention @60DAFS, FR90- Fruit Retention @90DAFS, FR120-Fruit Retention @120DAFS, AWF- average fruit weight, Y- Yield, FL- fruit length, FW- fruit width, FP- fruit pulp, PC-peel content, SC- seed content, SW- Seed weight, DM- Dry matter.

yield, fruit length, fruit width, fruit pulp, seed content, seed weight and dry matter. However, the correlation was significantly negative with peel content. Similarly, yield-attributing traits like fruits per tree and average fruit weight were found to be positively correlated with fruit per shoot, fruit set, fruit retention, fruit yield, fruit length, fruit width, fruit pulp, seed content, seed weight and dry matter, but exhibited negative correlation with peel content. Further, a significant correlation existed among physical fruit quality parameters like fruit length, fruit width, fruit pulp, seed content, seed weight, dry matter and other parameters like fruit per shoot, fruit set, fruit retention, fruits per tree, average fruit weight and fruit yield. Peel content of sapota fruit established a negative correlation with all the characters.

Conclusion

From the two-year study, it may be concluded that foliar application of NAA @100 ppm during flowering, fruit set and one month after fruit set improved fruit set, fruit retention, number of fruits per tree, yield and physical fruit quality, viz. pulp content, dry matter, fruit length and fruit width. Therefore, this research can be helpful for farmers as it demonstrates that the use of PGRs can be an effective tool for improving production and quality and ensuring profitable sapota farming.

Acknowledgements

The authors sincerely thank the Director of ICAR-IIHR, Bengaluru and Vice-Chancellor, OUAT, Bhubaneswar, for their invaluable support and for providing the essential

facilities during the research period. Their assistance has contributed significantly to the success of this study.

Authors' contributions

All the authors contributed to the above work, starting from designing the experiment, collecting data, assisting with statistical analysis, interpretation of results, and manuscript preparation. Conceptualization of research (DG, GCA); Designing of the experiments (DG, GCA, DS); Contribution of experimental materials (GCA, DS); Execution of field/lab experiments and data collection (DG, GCA, DS, AAK); Analysis of data and technical guidance (DG, SCS, SS, CS); Preparation of the manuscript (DG. GCA, DS); modifications and coordination (CS, KKS, AAK). All the authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

References

1. POWO. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; https://powo.science.kew.org/ Retrieved 30 August 2024.
2. Mund MD, Alam S, Khan UH, Tahir U, et al. Phytochemicals as complementary and alternative therapeutic formulations with potential pro-apoptotic effects on various cancerous cell lines: a literature survey. Focus Sci. 2016;2(2):1-5.
3. Sumathi M, Shivashankar S. Metabolic profiling of sapota fruit *cv*. Cricket ball grown under foliar nutrition, irrigation and water deficit stress, Sci Hortic. 2017;215:1-8. https://doi.org/10.1016/j.scienta.2016.11.036
4. Cheema GS, Bhat SS, Naik KC. Commercial Fruits of India with Special Reference to Western India. Macmillan and Company, Calcutta. 1954;359-78.
5. Fruit Production Database, National Horticulture Board, New Delhi, India, 2017-18; http//: www.nhb.in.
6. Jannila P, Dash SN, Sethi K, Panda RK, Swain SC. Enhanced effect of Plant Growth Regulators in inducing and Retaining Flowering in Sapota (*Manilkara zapota* L.) cv. Kalipatti. Biological Forum. 2022;14(4):1376-380.
7. Bhamare SP, Patel HC, Singh B. Effect of PGRs on reduction of fruit drop in mango cv. Mallika. Asian J. Hort. 2014; 9:510-511. Effect of PGRs on reduction of fruit drop in mango cv. Mallika. https://doi.org/10.15740/has/tajh/9.2/510-511
8. Gill K, Kumar P, Negi, Sharma R, Joshi AK, Suprun II, Al-Nakib EA. Physiological perspective of plant growth regulators in flowering, fruit setting and ripening process in citrus. Sci Hortic. 2023; 309. https://doi.org/10.1016/j.scienta.2022.111628
9. Singh G, Bons HK. Influence of naphthalene acetic acid on fruit setting, fruit quality and yield of *Manilkara achras* L. cv. Kalipatti under subtropical conditions. Indian J. Exp. Biol. 2020;*58*(09): 661-66.
10. Bisht TS, Rawat L, Chakraborty B, Yadav V. A Recent Advances in Use of Plant Growth Regulators (PGRs) in Fruit Crops-A Review. 2018. Int J Curr Microbiol App Sci 2018; 7(5): 1307-336 https://doi.org/10.20546/ijcmas.2018.705.159
11. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Statistical methods for agricultural workers (Ed. 3) 1954.
12. Kaur N, Bons HK. Influence of different plant growth regulators on yield and quality of sapota (*Manilkara achras* L.) cv. Kalipatti. Indian J Agric Sci. 2019;89(5):842-5. https://doi.org/10.56093/ijas.v89i5.89667
13. Das RC, Mahapatra SK. Effects of growth substances on retention and growth of sapota fruits (*Achras sapota* L.). Plant Sci J. 1975; 7:93-94.
14. Kadam DD, Garad BV, Jadhav YR, Mangave KK, Patgaonkar DR. Influence of growth regulators on flowering behaviour of sapota under semi-arid zone of Maharashtra. J Soil Crop. 2005;15 (1):111-14.
15. Nagargoje BS, Kachave DB, Shinde SB, Jadhav KM. Effect of NAA on flower drop, fruit drop, fruit retention in sapota cv. Kalipatti. J Soils Crops, 2007;17:173-75.
16. Aggarwal S, Dikshit SN. Studies on the effect of plant growth regulators on qualitative characters of sapota cv. Cricket Ball. Indian Journal of Horticulture. 2010; 67:117-80.
17. Sahu RL, Singh P, Panigrahi HK, Rana G. Studies on the effect of plant growth regulators on flowering, fruit retention, fruit drop and yield of sapota [*Manilkara achras* (Mill.) Forsberg] cv. Cricket Ball under Agro-climatic condition of Chhattisgarh Plains. Pharm Innov. 2022;11(10):465-70
18. Bhujbal DS, Naik DM, Kale SA. Studies on effect of growth regulators on flowering, fruiting and quality of sapota. Int. J. Agric. Sci. 2013;9(1):289-92.
19. Chavan SR, Patil MB, Phad GN, Suryawanshi AB. Effect of growth regulators on yield attributes and quality of sapota [*Manilkara achras* (Mill.) Forsberg] *cv*. Kalipati, Asian J. Hort. 2009;4(1):176-77.
20. Patil MB, Munde GR, Nainwad RV, Mane SS. Studies on effect of plant growth regulator on physical characters of sapota. Asian J Hort 2011;6(1):98-100.
21. Stern RA, Flaishman M, Ben-Arie R. Effect of synthetic auxins on fruit size of five cultivars of Japanese plum (*Prunus saliciana* Lindl.). Sci Hortic. 2007;112:304-09. https://doi.org/10.1016/j.scienta.2006.12.032
22. Mulagund J, Kumar S, Soorianathasundaram K, Parika H. Influence of post-shooting sprays of sulphate of potash and certain growth regulators on bunch characters and fruit yield of banana *cv*. Nendran (French Plantain Musa AAB). The Bioscan. 2015;10(1):153-159.
23. Naik KM, Bhosale AM, Bansod VU and Dapurkar ND. Influence of different chemicals and bio-mix on plant growth and physiological parameters of sapota fruits cv. Kalipatti. Pharm Innov 2022;11(12):3031-033