Biological Forum – An International Journal **14(4): 1376-1380(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Enhanced effect of Plant Growth Regulators in inducing and Retaining Flowering in Sapota *(Manilkara zapota* L.) cv. Kalipatti

Jannila Praveena[1*], S.N. Dash[2], Kabita Sethi[3], R.K. Panda[4] and S.C. Swain[5]

[1]Ph.D. Research Scholar, Department of Fruit Science and Horticulture Technology, College of Agriculture, Odisha University of Agriculture Technology (Odisha), India.
[2]Former Professor and Head, Department of Fruit Science and Horticulture Technology, College of Agriculture, Odisha University of Agriculture Technology (Odisha), India.
[3]Junior Horticulturist, AICRP on Cashew, College of Agriculture, Odisha University of Agriculture Technology (Odisha), India.
[4]Assistant Professor, Department of plant physiology, College of Agriculture, Odisha University of Agriculture Technology (Odisha), India.
[5]Associate Professor, Department of Fruit Science and Horticulture Technology, College of Agriculture, Odisha University of Agriculture Technology (Odisha), India.

(Corresponding author: Jannila Praveena)*
(Received 07 August 2022, Accepted 10 October, 2022)
(Published by Research Trend)

ABSTRACT: A field experiment was conducted at Horticultural Research Station, Odisha University of Agriculture and Technology, Bhubaneswar during 2020-2022. The experiment was carried out with ten treatments involving different concentrations of plant growth regulators *viz.,* Brassinolide (0.5 ppm and 1.5 ppm), Salicylic acid (150 ppm and 300 ppm), NAA (150 ppm), and their combinations were embedded in Randomized Block Design with three replications. The major problem confronting sapota production is flower and fruit drop at different stages of production, which causes a drastic loss to the sapota farmers. The major aim of the research was to control the flower drop by use of new generation plant growth regulators and their combinations. The growth regulators were applied as foliar spray during three phenological stages (vegetative, flowering and pea stage of fruiting). The results obtained from this experiment showed that combined effect of Brassinolide and NAA (1-Naphthalene Acetic Acid) has significant effect on flowering parameters. Application of Brassinolide 1.5 ppm along with NAA 150 ppm showed the maximum value for, duration of flowering (34.57 days), number of flowers per shoot(37.86), flower retention percentage(40.08 %), minimum value for flower drop %(59.92 %), days to initiation of flowering (31.46 days) over control.

Keywords: Sapota, Plant growth regulators, Brassinolide, Salicylic acid, NAA.

INTRODUCTION

Sapota (*Manilkara zapota* L.) is commonly known as 'Chiku' in India. It is an evergreen tree and belongs to the family Sapotaceae and is native of tropical America especially the South Mexico or central America. The chromosome number of sapota is 2n=26. It is the sixth important commercial fruit crop of India after mango, banana, citrus, apple and guava. In India, it was first introduced at Gholwad village of Dhanu Taluka in Thane District of Maharashtra State in 1898 (Chadha, 1992). It is a crop of tropical region, needs warm and humid climate. It can be grown on a wide range of soils. The most ideal soils are deep alluvium, sandy loams, red laterites and medium black. It requires 125-250 cm annual rainfall and a temperature of 11-38°C.

Sapota is mainly grown in India, Philippines, Malaysia, Indonesia, Florida, Guatemala, Mexico and Sri Lanka. India is the largest producer of sapota in the world. It commonly grows in Indian states like Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal and Odisha. In India the area under sapota cultivation is 78 thousand hectares with 783 thousand metric tonnes production (NHB, 2021-22) In Odisha sapota is mostly cultivated in Balasore, Cuttack, Kendrapara, Jagatsinghpur, Puri, Khurda and Ganjam.

Sapota produces large number of flowers thrice a year in different flushes but the major problem confronting the crop is heavy fruit drop Wind plays an important role in pollination. The flowers and fruits drop at different stages of development starting from flowering, fruit set and goes up to maturity of fruits. However, fruit drop at the mature stage adversely affects the yield resulting in major loss to the farmers. About 90% of sapota flower buds develop into flowers of which only 50% of the flowers sets fruit and among those only 10% reach maturity. Most of the fruit drop occurs in the first

five weeks following fruit set. The growth of sapota fruit follows a double sigmoid curve and the time required from fruit set up to maturity is more than ten months (Rao and Chundawat 1988). In recent years considerable attention has been given to increase fruit set and to check fruit drop of many fruit crops with the help of new generation plant growth regulators.

Plant growth and metabolism are solely responsible for the power and building blocks of a plant cell. Plant hormones regulated the growth of the tissues and metabolic action. Among this Brassinosteroids (BS) constitute a new group plant hormones that has been given different designations such as "New Class of plant hormones" (Clouse and Sasse 1998; Khripach *et al*., 2000), hormones of the twenty-first century, poly hydroxylated steroidal plant hormone (Fariduddin *et al*., 2014). It regulates many processes in plant growth and development, including cell elongation, cell division, vascular differentiation, reproduction, photomorphogenesis, germination of seeds, rhizogenesis, flowering, fruit ripening, tolerance response to various biotic and abiotic stresses, and senescence (Manoli *et al.,* 2018). Salicylic acid (SA) 'natural plant defender' is a phenolic phytohormone found in plants and plays an important role in plant growth and development. It stimulates flowering, increases flower life, improving flowering number or density and fruit set percentages (Kazemi, 2013; Mohammadi *et al.,* 2015) antioxidant activity (Ananieva *et al.,* 2004). NAA(1-Naphthalene Acetic Acid) is synthetic plant hormone in the Auxin family. It seems to be most effective, among the various tested synthetic auxins, in terms of fruit setting and fruit retention (Kaur *et al.,* 2018). Hence the objective of the study to exploit the use of these growth regulators and their combinations.

MATERIALS AND METHODS

The present investigation was carried out Horticultural Research Station, Odisha University of Agriculture and Technology, Bhubaneswar during 2020-2022. The experiment was carried out with ten treatments involving different concentrations of Plant Growth Regulators viz.; Brassinolide (0.5 ppm and 1.5 ppm), Salicylic acid (150 ppm and 300 ppm), NAA (150 ppm), and their combinations were embedded in Randomized Block Design with three replications.

The treatments involved Brassinolide 0.5 ppm, brassinolide 1.5 ppm, Brassinolide 0.5 ppm along with NAA 150 ppm, Brassinolide 1.5 ppm along with NAA 150 ppm, Salicylic acid 150 ppm, Salicylic acid 300 ppm, Salicylic acid 150 ppm along with NAA 150 ppm, Salicylic acid 300 ppm along with NAA 150 ppm, NAA 150 ppm, control (water spray) without any growth regulators. There were mainly 3 basic stages of application of growth regulators first during vegetative stage, then during flowering stage and lastly during fruiting stage (pea stage of fruiting).

For taking this observation we have choose four healthy shoots in different direction of plants. Observations were taken on different flowering parameters in the tagged shoots like days to initiation of flowering, Duration of flowering, number of flowers per shoot, percentage of flower drop, flower retention percentage etc. for both years.

RESULTS AND DISCUSSION

Table 1: Effect of plant growth regulators on days to initiation of flowering.

TREATMENT	Mean (2020-21)	Mean (2021-22)	Mean (Pooled)
T_1- BR (0.5 ppm)	33.06	33.96	33.51
T_2- BR (1.5 ppm)	32.58	32.77	32.67
T_3- BR+NAA (0.5 ppm+150 ppm)	31.44	32.76	32.10
T_4- BR+NAA (1.5 ppm+150 ppm)	30.12	32.79	31.46
T_5-SA (150 ppm)	36.82	35.44	36.13
T_6- SA (300 ppm)	36.88	36.32	36.60
T_7- SA+NAA (150 ppm+150 ppm)	33.56	35.87	34.72
T_8- SA+NAA (300 ppm+150 ppm)	33.42	36.50	34.96
T_9- NAA (150 ppm)	34.02	37.42	35.72
T_{10}- (Control)	36.35	39.64	37.99
SEM	1.432	1.385	0.969
CD (0.05)	4.255	4.116	2.699

Data presented in Table 1 indicated that application of growth regulators significantly affected the days required for initiation of flowering. In first year, the minimum days required for initiation was recorded in T_4 (30.12 days), whereas maximum data recorded in control T_{10} (36.35 days). Similar trend was observed for second year. Mean of two years data revealed that minimum days to initiation of flowering was observed in T_4 (31.46 days) whereas maximum days found in control (i.e., water spray) which was 37.99 days. So, the data revealed that application NAA along with brassinolide had more pronounced effect. Similar result reported by Papadopoulou and Grumet (2005) that exogenous application brassinosteroid increased precocity of bearing cucumber.

Data presented in Table 2 revealed that application of growth regulators significantly affected the duration of flowering. In first year, the maximum flowering period was recorded in T_4 (34.01 days), whereas minimum data recorded in control T_{10} (28.46 days). Similar trend was observed for second year. Mean of two years data revealed that maximum flowering period was observed in T_4 (34.57 days) whereas minimum period was found in control (i.e., water spray) which was 28.53 days. So, the data revealed that application brassinolide along with NAA increases the flowering period in sapota.

Data presented in Table 3 revealed that application of growth regulators significantly increased the number of flowers per shoot. In first year, the maximum number of flowers per shoot was recorded in T_4 (38.37), whereas minimum data recorded in control T_{10} (32.43). Similar trend was observed for second year. Mean of two years data revealed that maximum number of flowers were observed in T_4 (37.86) whereas minimum flowers per shoot was observed in control (i.e., water spray) which was 32.13. So, the data revealed that application brassinolide along with NAA increases the number of flowers per shoot. This is due to application of brassinolide modulate the metabolic pathway by modifying signaling pathway analysis and involvement of auxin helps in better translocation of food materials. The findings of (Pipattanawong *et al.,* 1996; Li *et al.,* 2010) are in agreement with present investigation.

Table 2: Effect of plant growth regulators on duration of flowering.

TREATMENT	Mean (2020-21)	Mean (2021-22)	Mean (Pooled)
T_1- BR (0.5 ppm)	31.12	32.07	31.60
T_2- BR (1.5 ppm)	32.03	32.10	32.06
T_3- BR+NAA (0.5 ppm+150 ppm)	33.05	34.14	33.60
T_4- BR+NAA (1.5 ppm+150 ppm)	34.01	35.13	34.57
T_5-SA (150 ppm)	29.75	30.67	30.21
T_6- SA (300 ppm)	29.98	30.87	30.43
T_7- SA+NAA (150 ppm+150 ppm)	30.10	31.06	30.58
T_8- SA+NAA (300 ppm+150 ppm)	30.22	31.57	30.90
T_9- NAA (150 ppm)	30.18	30.89	30.54
T_{10}- (Control)	28.46	28.59	28.53
SEM	0.738	1.170	0.626
CD (0.05)	2.192	3.477	1.743

Table 3: Effect of plant growth regulators on number of flowers per shoot.

TREATMENT	Mean (2020-21)	Mean (2021-22)	Mean(Pooled)
T_1- BR (0.5 ppm)	36.58	35.80	36.19
T_2- BR (1.5 ppm)	36.97	36.48	36.73
T_3- BR+NAA (0.5 ppm+150 ppm)	37.65	36.72	37.18
T_4- BR+NAA (1.5 ppm+150 ppm)	38.37	37.35	37.86
T_5-SA (150 ppm)	33.60	32.92	33.26
T_6- SA (300 ppm)	34.05	33.12	33.58
T_7- SA+NAA (150 ppm+150 ppm)	34.10	33.30	33.70
T_8- SA+NAA (300 ppm+150 ppm)	34.18	33.56	33.87
T_9- NAA (150 ppm)	34.63	33.73	34.18
T_{10}- (Control)	32.43	31.83	32.13
SEM	1.107	1.180	0.725
CD (0.05)	3.288	3.507	2.019

Table 4: Effect of plant growth regulators on flower drop %.

TREATMENT	Mean (2020-21)	Mean (2021-22)	Mean (Pooled)
T_1- BR (0.5 ppm)	60.39	62.93	61.66
T_2- BR (1.5 ppm)	60.13	61.63	60.88
T_3- BR+NAA (0.5 ppm+150 ppm)	60.08	62.27	61.18
T_4- BR+NAA (1.5 ppm+150 ppm)	59.86	59.98	59.92
T_5-SA (150 ppm)	64.01	65.42	64.71
T_6- SA (300 ppm)	63.77	64.50	64.13
T_7- SA+NAA (150 ppm+150 ppm)	64.03	63.14	63.58
T_8- SA+NAA (300 ppm+150 ppm)	63.99	62.49	63.24
T_9- NAA (150 ppm)	67.01	66.42	66.72
T_{10}- (Control)	69.38	68.49	68.93
SEM	2.036	1.573	1.193
CD (0.05)	6.048	4.673	3.324

Data presented in Table 4 indicated that application of growth regulators significantly affected the percentage of flower drop. In first year (2019-2020), the minimum flower drop % was observed in T_4 (59.86%), whereas, maximum drop was found in control T_{10} (69.38%). Similar trend was observed for second year. Mean of two years data revealed that minimum flower drop percentage was observed in T_4 (59.92 %) which was found to be at par with other concentrations of brassinolide, whereas maximum drop found in control (i.e., water spray) which was 68.93%. So, the data revealed that application of brassinolide alone and in combination with NAA had more pronounced effect in controlling the flower drop percentage. Moreover, reduced flower drop due to BRs is in line with the application of GA3 +brass inosteroids + BA in Thompson Seedless grapes (Warusavitharana *et al.,* 2008).

Table 5: Effect of plant growth regulators on flower retention %.

TREATMENT	Mean (2020-21)	Mean (2021-22)	Mean (Pooled)
T_1- BR (0.5 ppm)	39.61	37.07	38.34
T_2- BR (1.5 ppm)	39.87	38.37	39.12
T_3- BR+NAA (0.5 ppm+150 ppm)	39.92	37.73	38.82
T_4- BR+NAA (1.5 ppm+150 ppm)	40.14	40.02	40.08
T_5-SA (150 ppm)	35.99	34.58	35.29
T_6- SA (300 ppm)	36.23	35.50	35.87
T_7- SA+NAA (150 ppm+150 ppm)	35.97	36.86	36.42
T_8- SA+NAA (300 ppm+150 ppm)	36.01	37.51	36.76
T_9- NAA (150 ppm)	32.99	33.58	33.28
T_{10}- (Control)	30.62	31.51	31.07
SEM	2.036	1.573	1.193
CD (0.05)	6.048	4.673	3.324

Data presented in Table 5 revealed that application of growth regulators significantly affects the flowers retention percentage. In first year, the maximum retention percentage was found in T_4 (40.14 %), whereas minimum data recorded in control T_{10} (30.62 %). Similar trend was observed for second year. Mean of two years data revealed that maximum flower retention percentage was observed in T_4 (40.08 %) whereas minimum flower retention percentage was observed in control (i.e., water spray) which was 31.07 %. So, the data revealed that application brassinolide along with NAA increases flower retention percentage over other treatment tested. BRs are known to facilitate pollen tube growth (Mussig, 2005), retard abscission, enhance resistance to water, nutrient stress, enhanced photosynthesis and mobilization of metabolites to the flowers (Bhatia and Kaur 1997) which resulted in less flower drop and more retention of flowers.

CONCLUSIONS

The result of present study conclusively showed that effect of plant growth regulators had significant effect on different flowering parameters of sapota cv. Kalipatti. Foliar application Brassinolide 1.5 ppm along with NAA 150 ppm had pronounced effect to induce a greater number of flowers, more flower retention and in controlling the flower drop percentage over other treatment tested in sapota cv. kalipatti. This might be due to application of brassinolide modulate the metabolic pathway by modifying signaling pathway analysis and involvement of auxin helps in better translocation of food materials.

FUTURE SCOPE

There is need to be conduct in depth studies on the role of BR on the induction and retaining of flowering. Moreover, a better understanding of BR biosynthetic pathways and molecular level characterization will facilitate metabolic engineering of BRs for targeted applications.

Acknowledgement. This is to acknowledged by the corresponding author to the Department of Fruit Science and Horticulture Technology, Department of Molecular Biology and Biotechnology, Odisha University of Agriculture and Technology. Furthermore, University grant Commission Government of India for providing research fellowship.
Conflict of Interest. None.

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How to cite this article: Jannila Praveena, S.N. Dash, Kabita Sethi, R.K. Panda and S.C. Swain (2022). Enhanced effect of Plant Growth Regulators in inducing and Retaining Flowering in Sapota *(Manilkara zapota* L.) cv. Kalipatti. *Biological Forum – An International Journal, 14*(4): 1376-1380.