International Journal of Environment, Agriculture and Biotechnology
Vol-11, Issue-5; Sep-Oct, 2026
Peer-Reviewed International Journal
Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Evaluation of Natural Biostimulants for Improving Flowering and Fruiting behaviour in Sweet Orange (Citrus sinensis (L.) Osbeck) var. Nucellar.

S. S. Patil[1], S. G. Patil[2], R. V. Nainwad[3], Dr. S. R. Wankhede[4], Dr. S. V. Pawar[5]

[1]M.Sc. (Hort.) student, Department of Horticulture, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi, Vidyapeeth, Parbhani, Maharashtra, India
[2]O/I Fruit Research Station, Chhatrapati Sambhajinagar, Maharashtra, India
[3]Assistant Horticulturist, Fruit Research Station, Chhatrapati Sambhajinagar, Maharashtra, India
[4]Assistant Professor, Horticulture, College of Agriculture, Badnapur, VNMKV, Parbhani, Maharashtra, India
[5]Assistant Professor, Plant Pathology, College of Agriculture, Badnapur, Maharashtra, India

Received: 18 Sep 2026; Received in revised form: 10 Oct 2026; Accepted: 16 Oct 2026; Available online: 24 Oct 2026
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Abstract— *The present investigation was conducted during the Ambe Bahar season of 2024–25 at the Sweet Orange Research Station, Badnapur, Tq. Badnapur, Dist. Jalna, Maharashtra, to evaluate the influence of natural biostimulants on flowering and fruiting behaviour of nucellar sweet orange (Citrus sinensis (L.) Osbeck). The experiment was laid out in a Randomized Block Design (RBD) comprising seven treatments replicated thrice. The treatments consisted of brassinolide @ 10, 15 and 20 ppm and yeast extract @ 1000, 1500 and 2000 ppm, along with an untreated control. The biostimulants were applied as foliar sprays at full bloom and again 30 days after full bloom. Observations were recorded on days required for flowering, number of flowers, days required from fruit set to fruit maturity, fruit set, fruit drop and fruit retention. Significant variation was observed among the treatments for flowering and fruiting parameters. Brassinolide @ 20 ppm (T3) recorded superior performance with respect to flowering and fruiting attributes, followed by brassinolide @ 15 ppm (T2), while yeast extract @ 2000 ppm (T6) performed comparatively better among the yeast extract treatments. The application of biostimulants favourably influenced fruit set and fruit retention while reducing fruit drop compared with the untreated control. Overall, foliar application of brassinolide @ 20 ppm and yeast extract @ 2000 ppm showed a positive influence on flowering and fruiting behaviour of nucellar sweet orange under the agro-climatic conditions of the Marathwada region.*

Keywords— ***Sweet orange, Citrus sinensis, natural biostimulants, brassinolide, yeast extract, flowering, fruit set, fruit drop, fruit retention, fruit maturity.***

I. INTRODUCTION

Sweet orange (*Citrus sinensis* (L.) Osbeck) is an important citrus fruit crop widely cultivated in tropical and subtropical regions for its nutritional and economic importance. In India, it is mainly grown in Andhra Pradesh, Maharashtra and Telangana, while Jalna, Chh. Sambhajinagar, Nanded and Parbhani are major sweet orange-growing regions of Maharashtra. sweet orange (Nucellar Mosambi) is widely cultivated in the Jalna region due to its good yield potential and desirable fruit quality (Thorat *et al*.,2018).

Flowering and fruiting are important phases in sweet orange production and are closely associated with fruit set, fruit retention and final crop productivity. Plant biostimulants have gained importance for their potential to improve plant growth, flowering, fruit set and crop productivity. Rouphael and Colla (2020) reported that biostimulants can enhance flowering, fruit set and crop productivity through various physiological mechanisms.

Brassinolide, a biologically active brassinosteroid, regulates important processes such as cell division, cell elongation and plant development. Bishop and Yokota (2002) described the role of brassinosteroid signaling in plant developmental processes, while Manghwar *et al*. (2022) reported its role in regulating plant growth and development.

Yeast extract is a natural biostimulant rich in amino acids, vitamins, polypeptides and minerals, and its nutrient-rich composition supports plant growth and physiological activity (Tao *et al*., 2022). El Ghit (2020) reported that foliar application of yeast extract improved plant growth and fruit number. Considering the importance of flowering and fruiting in crop productivity, the present investigation was undertaken to study the effect of foliar application of brassinolide and yeast extract on flowering and fruiting parameters of nucellar sweet orange.

II. MATERIALS AND METHODS

The study was undertaken during the 2024–25 season at the Sweet Orange Research Station, Badnapur, District Jalna, Maharashtra. The experiment was performed on 16-year-old nucellar sweet orange trees, for which 42 healthy and uniform trees were selected. The trial was arranged in a Randomized Block Design (RBD) consisting of seven treatments, each replicated three times, with two plants representing each treatment within a replication. The treatment schedule included brassinolide at 10, 15 and 20 ppm and yeast extract at 1000, 1500 and 2000 ppm, along with an untreated control. All treatments were administered through foliar application at the full bloom stage, followed by a second application one month after the first spray.

Table 1: Treatments Details

Sr. No	Treatment	Treatments Details
1	T1	Brassinolide @ 10 ppm
2	T2	Brassinolide @ 15 ppm
3	T3	Brassinolide @ 20 ppm
4	T4	Yeast extract @ 1000 ppm
5	T5	Yeast extract @ 1500 ppm
6	T6	Yeast extract @ 2000 ppm
7	T7	Control

Flowering Parameters:

Number of flowers per plant: The number of flowers per plant was recorded by manually counting the flowers on each experimental tree.

Days required for flowering: The number of days required for flowering was recorded from the initiation of flowering to full bloom and expressed in days.

Days required from fruit set to maturity: The number of days required for fruit maturity was recorded from fruit set to harvest for each tree and expressed in days.

Fruiting Parameters:

Fruit set (%): Fruit set was recorded by determining the number of fruits successfully established from the tagged flowers after full bloom and expressed as percentage.

Fruit drop (%): The set fruit from above tagged flowers were used for studying the intensity of fruit drop up to the time of harvesting and percentage were worked out.

$$Fruit\ drop\ (\%) = \frac{\text{Total number of fruit set} - \text{No. of fruits at harvest time}}{Total\ no.of\ fruit\ set} X\ 100$$

Fruit retension (%): At the time of harvest, we counted the total number of fruits that remained on the tagged flowers. The percentage of fruit retention was then calculated based on the number of fruits initially present at the fruit set stage.

$$Fruit\ retention\ (\%) = \frac{\text{Number of fruits as harvest}}{Total\ no.of\ fruit\ set} X\ 100$$

Statistical Analysis: The experimental data were statistically analysed as per the methods described by Panse and Sukhatme (1985). The standard error (S.E.) and critical difference (C.D.) at the 5% level of significance were calculated wherever applicable.

III. RESULT AND DISCUSSION

The effect of biostimulants on flowering parameters:

Table 2.: Effect of Brassinolide and Yeast extract treatments on Days required for flowering, days required for fruit set to fruit maturity and Number of flowers.

Treatment	Treatments Detail	Days required for flowering	Days required from fruit set to fruit maturity	Number of flowers (Per tree)
T1	Brassinolide @ 10 ppm	17.69	243.81	8076.97
T2	Brassinolide @ 15 ppm	16.83	239.05	8223.73
T3	Brassinolide @ 20 ppm	15.46	220.60	8806.11
T4	Yeast extract @ 1000 ppm	18.09	244.00	7761.96
T5	Yeast extract @ 1500 ppm	16.93	235.74	7930.35
T6	Yeast extract @ 2000 ppm	15.97	232.23	8616.11
T7	Control	18.98	255.29	7567.01

Biostimulant application significantly influenced flowering behaviour of sweet orange (Table 1). The number of flowers per tree was highest with T_3 (brassinolide @ 20 ppm; 8806.11), which was at par with T_6 (8616.11) and T_2 (8223.73), whereas the lowest number was recorded in T_7 (7567.01). The time required for flowering was shortest under T_3 (15.46 days), at par with T_6 (15.97), T_2 (16.83) and T_5 (16.93), while T_7 required the maximum period (18.98 days). Similarly, the minimum duration from fruit set to fruit maturity was recorded with T_3 (220.60 days), statistically at par with T_6 (232.23 days), whereas the maximum duration was observed in T_7 (255.29 days).

The earlier flowering and reduced time to fruit maturity under T_3 indicate a favourable response of brassinolide, while T_6 showed a comparatively better response among yeast extract treatments. The response may be associated with the reported role of brassinolide in promoting flowering, whereas yeast extract may improve nutrient uptake and thereby support flowering and subsequent development.

These findings are consistent with Tepkaew *et a*l. (2022) and Al-Ealayawi and Al-Dulaimy (2023) for brassinolide-induced flowering, and with Faten and Bakry (2004) and El-Desouky *et al*. (2011) for the beneficial effect of yeast extract on flowering.

The effect of biostimulants on Fruiting parameters:

Table 3.: Effect of Brassinolide and Yeast extract treatments on Fruit set (%), Fruit drop (%) and Fruit retension(%).

Treatment	Treatments Detail	Fruit set (%)	Fruit drop (%)	Fruit retention (%)
T1	Brassinolide @ 10 ppm	21.83	82.25	17.75
T2	Brassinolide @ 15 ppm	25.70	80.16	19.84
T3	Brassinolide @ 20 ppm	27.32	79.30	20.70
T4	Yeast extract @ 1000 ppm	17.42	84.92	15.08
T5	Yeast extract @ 1500 ppm	19.93	83.38	16.62
T6	Yeast extract @ 2000 ppm	23.35	82.53	17.46
T7	Control	16.43	86.82	13.17

Biostimulant application significantly affected fruit set, fruit drop and fruit retention (Table 2). Fruit set was highest with T_3 (27.32%), followed by T_2 (25.70%) and T_6 (23.35%), compared with 16.43% in the control. Fruit drop was lowest under T_3 (79.30%), at par with T_2 (80.16%) and T_1 (82.25%), whereas the control recorded the highest drop (86.82%). Conversely, fruit retention was highest with T_3 (20.70%), statistically at par with T_2 (19.84%) and T_6 (17.46%), while the lowest retention (13.17%) was recorded in T_7.

The higher fruit set and retention and lower fruit drop under T_3 indicate a favourable effect of brassinolide on fruit establishment and retention. Among yeast extract treatments, T_6 (2000 ppm) showed a comparatively better

response. The improved fruit set with yeast extract was attributed in the source to enhanced nutrient uptake, while the reduction in fruit drop and increase in fruit retention were associated with biostimulant application.

The present findings are in agreement with Mostafa and Kotb (2018), Ali *et al*. (2019) and Sharma (2021) for improved fruit set, and with Ali *et al*. (2019), Kumari et al. (2019) and El-Boray *et al*. (2015) for reduced fruit drop. The improvement in fruit retention is also supported by Mostafa and Kotb (2018) and Kumari *et al*. (2019).

IV. CONCLUSION

Biostimulant application significantly influenced the flowering and fruiting performance of sweet orange. Brassinolide @ 20 ppm (T_3) emerged as the most effective treatment, promoting early flowering and fruit maturity and increasing the number of flowers per plant. It also enhanced fruit set and fruit retention while reducing fruit drop compared with the control. Overall, brassinolide @ 20 ppm demonstrated the most favourable effect on flowering and fruiting performance of sweet orange.

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