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Efficacy of Biostimulants on Growth, Flowering and Yield of *Dendrobium* var. Sonia White

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ABSTRACT

The experiment was conducted during March, 2022–February, 2023 at Greenhouse Complex, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India to assess the effects of various biostimulants on the performance of *Dendrobium* var. Sonia White under naturally ventilated polyhouse conditions. Nine treatments were carried out at monthly intervals over a year in a Completely Randomized Design (CRD) with three repetitions, using a foliar spray of different biostimulants viz. Chitosan viz. 75, 100, 125 ppm; Brassinosteroid viz. 0.25, 0.50, 0.75 ppm; Novel Organic Liquid Nutrients at 2%; *Gliricidia* Nutrient Extract at 2%. The result indicated that among all treatments, the application of 0.75 ppm Brassinosteroid (T_6) at monthly intervals resulted in maximum plant height (43.94 cm), leaf area (45.82 cm^2) and chlorophyll content (0.478 mg g^{-1}) after 12 months. In terms of flowering parameters, it also resulted in the highest number of spikes $plant^{-1}$ (4.87), longest spike length (49.42 cm), highest number of florets $spike^{-1}$ (12.01), longest floret length (7.59 cm), longest spike longevity (52.44 days), longest vase life (31.96 days) along with Highest Net realization (₹ 7457160 per ha^{-1}) and BCR (2.03) in *Dendrobium* var. Sonia White.

KEYWORDS: *Dendrobium* orchid, biostimulants, brassinosteroid, growth, flowering, yield

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Commercial floriculture has emerged as a lucrative industry in agribusiness with a significant increase in the area under flower cultivation over the past two decades. The cultivation methods have shifted from traditional to modern, hi-tech export-oriented processes that produce high-quality cut flowers. There is a high demand for exotic and modern cut flowers such as orchids, anthuriums, heliconias and BOP in international as well as domestic markets.

Orchids (*Dendrobium* spp.) are an important commercial cut flower and pot plant. They belong to the Orchidaceae family and are native to Tropical and Subtropical Asia (De et al. 2015; De and Biswas, 2022). The genus *Dendrobium* is one of the largest and most diverse of orchids. They are highly valued for their beauty and long lasting flowers, making them top picks for cut flower production and potted plants (Sugapriya et al. 2012; De and Pathak, 2020). The largest exporters of orchids are Taiwan, Thailand, Netherlands, China, Japan, New Zealand and Germany, while, United States is the largest importer of potted orchids (De, 2020). A blooming orchid industry in India would boost the local economy and add another dimension to India's soft power. Flower growers adopt a variety of cultural practices, environmental manipulation and chemical stimulants to produce high quality flowers. While cultural practices and environmental manipulation are labour-intensive and expensive. Thus, ornamental growers may prefer to use chemical growth stimulants in order to manipulate plant characteristics and high-quality flower production.

Biostimulants are organic materials or microorganisms that enhance nutrient uptake, trigger growth, enhance stress tolerance and improve crop quality (Sankari et al., 2015; Zhang et al. 2024). They supplement mineral fertilizers and promote growth when applied in small quantities. Organic growth stimulants like seaweed extract, vermiwash, chitosan, cow urine, Jivamrut, etc. have gained attention worldwide. Chitosan, a natural biopolymer derived from chitin found in the exoskeleton of arthropods and crustaceans, is widely used in agriculture to promote plant growth, reduce transpiration and improve disease and insect resistance (Palpandi et al., 2009; Nge et al., 2006; Deepmala et al., 2014; Abd-El-Hady, 2020). It has been shown to be effective in reducing the severity of leaf spot disease in orchids and increasing productivity by 15–20% when used with fewer chemical fertilizers (Uthairatanakij et al., 2007).

Brassinosteroids (BRs) are a type of plant hormone that promotes growth and are similar to auxins. One well-known example of a BR is brassinolide. BRs regulate various developmental processes such as root and shoot growth, vascular differentiation and seed germination, as well as respond to environmental stress (Mitchell et al., 1970; Molina et al., 2014; Sridhara et al., 2021). Novel Organic Liquid Nutrients is an organic liquid fertilizer made from banana pseudostem sap. It is a patented product of Navsari Agricultural University and can increase crop yield while reducing the use of chemical fertilizers. It contains gibberellic acid and cytokinin, which are good for plant growth (Champaneri et al., 2021). *Gliricidia sepium* is a leguminous tree and its leaves contain nitrogen, phosphorus, potassium, calcium and magnesium, making them useful as a biostimulant (Aroonluk et al., 2020; Sooksawat et al., 2024). *Gliricidia* extracts can also inhibit the growth of certain fungi, bacteria, and nematodes, and promote growth and immunity in plants (Ganesan, 1994; Lakmini et al., 2007; Juanico et al., 2023). The present research aimed to investigate the efficacy of bio-stimulants viz., on the growth, flowering and yield of *Dendrobium* var. Sonia White under naturally ventilated polyhouse.

2. MATERIALS AND METHODS

The present investigation was carried out in a naturally ventilated polyhouse at Greenhouse Complex, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India during March, 2022–February, 2023. It aimed to evaluate bio-friendly compounds in the quality improvement of orchids and thus to reduce the use of harmful chemicals in orchid production under protected cultivation. The experiment was laid out in Completely Randomized Design (CRD) consisting of 9 treatments; T_1: Chitosan 75 ppm, T_2: Chitosan 100 ppm, T_3: Chitosan 125 ppm, T_4: Brassinosteroid 0.25 ppm, T_5: Brassinosteroid 0.50 ppm, T_6: Brassinosteroid 0.75 ppm, T_7: Novel Organic Liquid Nutrients 2%, T_8: *Gliricidia* Based Nutrient Extract 2%, T_9: Control (Water spray) with 3 repetitions.

Dendrobium var. Sonia White was grown in a polyhouse oriented in an East-West direction and had dimensions of 32 meters in length, 24 meters in width and a central height of 6 meters. The experimental material used was two year old uniform, healthy tissue cultured plants of *Dendrobium* var. Sonia White. The benches made from galvanized square pipes, were 3.3 feet high, 3 feet wide and 50 feet long with a distance of 1.5 feet between each bench. Since *Dendrobium* orchids are epiphytic, soilless media, specifically coconut husk was used as the planting medium. To create a rectangular block measuring 30×20 cm^2, one layer of coconut husk pieces was arranged properly and tied together. Two coconut husk blocks row^{-1} were arranged on a bench, with a spacing of 20 cm between them and a spacing of 10 cm between two rows of coconut husk blocks. A planting density of 4 plants $coconut^{-1}$ husk block was adopted for

the experiment.

The growth promoter chitosan (CHT) was dissolved in acetic acid and final volume was made up to 1000 ml of distilled water by using a measuring cylinder. Stock solution of 10 ppm Brassinosteroid was made up by dissolving 0.01 g Brassinosteroid into alcohol followed by final volume made up of 1000 ml with distilled water using a measuring cylinder. The required quantity was used from stock solution of Brassinosteroid. For making 2% solution of Novel Organic Liquid Nutrients, 20 ml of Novel Organic Liquid Nutrients was measured with the help of a measuring cylinder and dissolved in water and 1000 ml of volume was prepared. *Gliricidia* based Nutrient Extract of 2% solution was prepared by 20 ml *Gliricidia* based Nutrient Extract measured with the help of a measuring cylinder then dissolved in water and 1000 ml of volume was prepared. Individual biostimulants were applied as a foliar spray to the plant every month up to one year. Plastic sheets were used to separate the treatments within a bed during foliar spray.

3. RESULTS AND DISCUSSION

Various effects of different biostimulants on growth, flowering and yield of *Dendrobium* var. Sonia White are depicted in Table 1 and 2.

3.1. Growth parameters

The data concerning vegetative characters clearly showed prominent effect of different biostimulants (Table 1).

The study found that the foliar application of biostimulants significantly affected all parameters. Among all the treatments, the foliar spray of 0.75 ppm (T_6) brassinosteroid resulted in the maximum plant height (43.94 cm) after 12 months which was statistically at par with the treatment T_5, T_4, T_3 and T_7 (Table 1). Maximum number of leaves plant^{-1} (9.20) was recorded in plants with foliar application of 0.50 ppm of brassinosteroid (T_5) which was statistically at par with T_2, T_3, T_4, T_6 and T_7 (Table 1). Similarly, treatment (T_5) recorded a maximum number of shoots plant^{-1} (3.95) which was statistically at par with T_6-0.75 ppm Brassinosteroid (3.84). However, the application of 0.75 ppm of brassinosteroid (T_6) showed the maximum leaf area (45.82 cm^2), which was statistically at par with T_5 (Table 1). Whereas, the shortest plants (31.39 cm), minimum number of leaves (7.12) and shoots plant^{-1} (2.18), smallest leaf area (28.43 cm^2) were observed in control (T_9-water spray) after 12 months.

The increased growth observed in plants treated with brassinosteroid is likely due to the acceleration of hormonal activity caused by the application of this compound. Brassinosteroids work synergistically with auxin to promote growth, resulting in both cell elongation and cell division and higher meristematic activity, which leads to better plant height. Additionally, Brassinosteroid is known to promote photosynthesis and growth by positively regulating the synthesis and activation of various photosynthetic enzymes, including RuBisco, which resultsin rapid vegetative growth (Xia et al., 2009). The increased number of shoots and leaves could be because of BR responsible for cell division and cell enlargement and is known to influence the production of more shoots and plant spread which in turn facilitated more points for production of leaves. Padmalatha et al. (2013) also found that a brassinosteroid (BR) concentration of 10 ppm resulted in maximum plant height, number of leaves, and leaf area in gladiolus. The increase in vegetative growth, indicated by plant height, number of shoots, and leaves, is

Table 1: Effect of foliar application of biostimulants on vegetative and biochemical parameters of *Dendrobium* var. Sonia White after 12 months

Treatments	Plant height (cm)	No. of leaves plant^{-1}	No. of shoots plant^{-1}	Leaf area (cm^2)	Chlorophyll (mg g^{-1})
T_1: Chitosan @ 75 ppm	36.96	7.61	3.03	35.25	0.413
T_2: Chitosan @ 100 ppm	39.61	8.67	3.04	36.61	0.411
T_3: Chitosan @ 125 ppm	40.53	8.53	3.25	36.93	0.416
T_4: Brassinosteroid @ 0.25 ppm	41.37	8.59	3.42	38.35	0.424
T_5: Brassinosteroid @ 0.50 ppm	42.54	9.20	3.95	42.05	0.465
T_6: Brassinosteroid @ 0.75 ppm	43.94	8.57	3.84	45.82	0.478
T_7: Novel organic liquid nutrients @ 2%	39.86	8.77	3.08	32.27	0.393
T_8: Gliricidia based nutrient extract @ 2%	38.80	7.86	2.95	35.07	0.375
T_9: Control (water spray)	31.39	7.12	2.18	28.43	0.332
SEm±	1.46	0.30	0.10	1.35	0.005
CD (p=0.05)	4.32	0.89	0.28	4.00	0.015

Table 2: Effect of foliar application of biostimulants on flowering and quality parameters of *Dendrobium* var. Sonia White

Treatments	No. of spikes plant^{-1}	No. of florets spike^{-1}	Spike length (cm)	Floret length (cm)	Floret width (cm)	Longevity of spike (days)	Vase life (days)
T_1: Chitosan @ 75 ppm	3.68	11.10	42.23	6.39	6.99	40.50	26.33
T_2: Chitosan @ 100 ppm	3.94	10.93	39.25	6.34	7.04	46.59	27.19
T_3: Chitosan @ 125 ppm	4.15	11.30	40.64	7.25	7.45	52.17	29.22
T_4: Brassinosteroid @ 0.25 ppm	4.35	10.67	40.03	6.47	7.14	45.12	24.69
T_5: Brassinosteroid @ 0.50 ppm	4.55	11.39	46.64	7.12	7.50	47.07	27.41
T_6: Brassinosteroid @ 0.75 ppm	4.87	12.01	49.42	7.59	7.37	52.44	31.96
T_7: Novel organic liquid nutrients @ 2%	3.83	11.41	45.92	6.67	7.22	45.49	25.39
T_8: Gliricidia based nutrient extract @ 2%	3.61	10.38	40.58	6.29	6.96	44.19	23.91
T_9: Control (water spray)	3.20	10.28	37.32	5.89	6.62	34.42	22.77
SEm±	0.17	0.29	1.68	0.16	0.13	2.20	1.65
CD (p=0.05)	0.52	0.86	4.98	0.47	0.39	6.54	4.91

supported by the findings of Swamy and Rao (2008) in Geranium; Chaudhari (2012) and Raveendra et al. (2013) in Daisy; Mollaei et al. (2018) in Gladiolus; Badawy et al. (2017) in Zinnia. Chlorophyll content in leaves of orchid plants was also affected by foliar application of different biostimulants. Foliar spray of 0.75 ppm Brassinosteroid (T_6) resulted in the highest chlorophyll content in leaves (0.478 mg g^{-1}) at the end of the experiment which was statistically at par with T_5. While, the control treatment (T_9) exhibited the lowest chlorophyll content (0.332 mg g^{-1}) as per the Table 1. Higher chlorophyll content may be due to the increased chlorophyll synthesis enzymes due to brassinosteroid promotion, combined with decreased levels of catabolizing enzymes. In support of this statement, an increase in chlorophyll content due to homo-brassinolide spray was also revealed by Swamy and Rao (2008) in Geranium; Chaudhari (2012) in Daisy; Badawy et al. (2017) in Zinnia; Gao et al. (2021) in maize.

3.2. Flowering and yield parameters

The data showed that different biostimulants had a significant effect on flowering and quality parameters. (Table 2). The data on flowering characteristics clearly showed that higher concentrations of brassinosteroid significantly altered various attributes. The maximum number of spikes plant^{-1} (4.87) was obtained in plants treated with 0.75 ppm brassinosteroid treatment (T_6) after 12 months, which was statistically at par with T_4 and T_5 (Table 2). Moreover, the same treatment recorded the highest number of florets spike^{-1} (12.01) which was at par with T_3, T_5, T_7, the maximum length of spike (49.42 cm) which was at par with T_5, T_7, the length of florets (7.59 cm) which was statistically at par with T_3 and T_5 as per the data shown in Table 2. Whereas the maximum width of floret (7.50 cm) was recorded by the application of 0.50 ppm Brassinosteroid (T_5) which was statistically at par with T_3, T_4, T_6 and T_7. While, minimum number of spikes plant^{-1} (3.20), florets spike^{-1} (10.28), shortest spike length (37.32 cm) and floret length-width (5.89–6.62 cm) were noted in *Dendrobium* orchid sprayed with water i.e., T_9-control treatment.

The foliar spray of 0.75 ppm Brassinosteroid (T_6) increased the longevity of spike (52.44 days), which was statistically at par with T_2, T_3, T_5 and vase life (31.96 days) which was statistically at par with T_2, T_3 and T_5 (Table 2). Whereas minimum spike longevity (34.42 days) and shortest vase life (22.77 days) were noted in spray with water i.e., T_9 - control.

Brassinosteroids (BR) promote plant growth by increasing plant height, leaf area, number of leaves and shoots, leading to more photosynthates and increased flowering attributes in orchids like number of spikes plant^{-1} and floret spike^{-1} potentially due to improved nutrient translocation and enhanced photosynthesis, enhances sucrose translocation to the apical sink (Petzold et al., 1992), contributing to an increased number of florets spike^{-1} in *Dendrobium* var. Sonia White.

According to Mollaei et al. (2018), increased number of spikes plant^{-1} and florets spike^{-1}, vase life was recorded with the application of 1 µM EBR (epibrassinolide). Similar results were obtained by Kumar et al. (2008) and Padmalatha et al. (2013) in gladiolus with the application of BR.

Additionally, the application of brassinosteroids helps to produce longer spikes and increased the number of large sized flowers by promoting the efficiency of auxin in cell growth and aiding in the better translocation and utilization of photosynthates. Which ultimately improves

flower longevity as well as vase life by delaying senescence in flowers. These results were supported by Padmalatha et al. (2013) in gladiolus and Lashaki et al. (2018) in petunia, marigold and calendula. Brassinosteroid application also decreases ethylene production, leading to enhanced physiological parameters and a longer vase life for the flowers. The results are in close conformity with the findings of Raveendra et al. (2013) in daisy.

3.3. Economics

Data presented in table 3 revealed that the application of 0.75 ppm Brassinosteroid (T_6) gained the highest net return of Rs. 74,57,160 per ha with a benefit cost ratio of 2.03 in *Dendrobium* var. Sonia White. This was attributable to the application of brassinosteroid which is an economically feasible chemical for optimal spike production and higher flower yield, resulting in greater returns (Aparna et al., 2021).

Table 3: Economics of flower production per ha in *Dendrobium* var. Sonia White *Price of orchid flowers: ₹ 15 spike^{-1}

Treatments	Yield ha^{-1} (No. of spikes)	Total cost ha^{-1} (₹)	Net return ha^{-1} (₹)	BCR
T_1: Chitosan @ 75 ppm	559920	3673920	4725000	1.29
T_2: Chitosan @ 100 ppm	600140	3693940	5308180	1.44
T_3: Chitosan @ 125 ppm	631520	3713940	5758840	1.55
T_4: Brassinosteroid @ 0.25 ppm	661980	3632620	6297120	1.73
T_5: Brassinosteroid @ 0.50 ppm	693060	3651220	6744620	1.85
T_6: Brassinosteroid @ 0.75 ppm	741800	3669820	7457160	2.03
T_7: Novel organic liquid nutrients @ 2%	582780	3686500	5055140	1.37
T_8: Gliricidia based nutrient extract @ 2%	549880	3628520	4619620	1.27
T_9: Control (water spray)	487420	3614020	3697340	1.02

1US$=INR 82.59 (avg. monthly value of Feb'2023)

4. CONCLUSION

The foliar application of 0.75 ppm Brassinosteroid (T_6) at monthly intervals gave better vegetative growth, flower quality and higher yield in *Dendrobium* var. Sonia White.

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