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Application of Seaweed-based Biostimulant Reduced the Fungal Damage during Flower Induction in Durian Ri6 Variety Trees

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ABSTRACT: Vietnam has approximately 155,000 hectares of durian plantations, with average yields of 25–30 tons per hectare. Durian growers face significant losses due to fungal infection (phytophthora) diseases, and there is an urgent need for recommendations to control these diseases. To evaluate the effectiveness of the bio-stimulants to control this diseases, a commercial product from OLMIX (Seamel Barricade) was applied on Ri 6 durian variety trees at flowering stage The results showed that the application of 1.5 ml/L of biostimulant performed better after 60 days of plant growth and improved positively the number of flower clusters (48.3 flowers/tree), the percentage of healthy flower clusters per branch (98.2%), the percentage of healthy flowers per cluster (93.4%), flower length (121.9 mm), and fruit set rate of 82%. In addition, we have observed that the fruit development occurred within 97 days after fruit set (DAS), and the highest fruit drop occurred in the 0-14 (DAS) (32.7%). Altogether, our results highlighted the crucial role of biostimulant application for controlling the fungal diseases for durian production in Vietnam.

Keywords: Biostimulant, seaweed-based, diseases, durian.

INTRODUCTION

Durian (*Durio zibethinus* Murr.), a member of the family Bombacaceae and order Malvales, is a tropical fruit native to Southeast Asia, particularly originating from Borneo, Indonesia, and Malaysia. Dubbed the "King of Tropical Fruits," durian is well known for its distinctive aroma, rich flavor, and high nutritional value, which includes fat, protein, carbohydrates, calcium, phosphorus, and ascorbic acid. Its edible pulp is commonly consumed fresh, or processed into candies, jams, fillings for pastries, and flavoring for ice cream. In Vietnam, durian is cultivated primarily in the Southeast and the Mekong Delta, with Tien Giang being the largest producer in the Mekong Delta (Nguyen, 2024; Ketsa, 2018; Alminda *et al.,* 2021). According to the Department of Crop Protection, Vietnam's durian cultivation area reached over 150,000 hectares in 2023, with approximately 76,000 hectares in harvest. The annual yield approached 1.2 million tons, increasing at an average rate of 15% per year. Once all planted areas begin bearing fruit, national production is expected to surge substantially. Durian is mainly grown in the Central Highlands, Mekong Delta, Southeast, and, to a lesser extent, in the South-Central Coast. Fertilization and foliar nutrient application techniques have been shown to significantly enhance plant growth and development across various crops (Walid *et al.*, 2023). However, during the flowering stage, durian flowers are susceptible to fungal infections, which can reduce flower quality and fruit set. Therefore, this study investigates the effectiveness of Seamel BARRICADE, a biostimulant product with preventive fungal disease function, in improving flower health and reproductive success in Ri 6 durian trees.

MATERIALS AND METHOD

The experiment was conducted on 16 durian trees, 6-7 years old, at Loi Trinh Hamlet, My Loi A Commune, Cai Be District, Tien Giang Province, from June 2024 to November 2024. The experiment was arranged in a completely randomized block design with 4 treatments and 5 replications, each replication consisting of 1 tree.

Experimental materials

-Plant material: Ri 6 durian trees aged over 7 years.

-Agricultural inputs: Fertilizers, Seamel BARRICADE, and necessary tools for spraying, fertilization, care, and harvest.

-Location: Loi Trinh Hamlet, My Loi A Commune, Cai Be District, Tien Giang Province, Vietnam.

-Duration: June 20 to August 20, 2024.

Experimental design

The experiment followed a completely randomized block design with four treatments and four replications.

Each replication consisted of a single tree, totaling 20 trees.

Table 1.

Treatment	Product	Concentration (mL/L)
1	Seamel BARRICADE	0.5 ml/L
2	Seamel BARRICADE	1 ml/L
3	Seamel BARRICADE	1.5 ml/L
Control	Farmer's standard practice	

Application schedule

Sprays were applied every 10 days for a total of 7 applications:

- First application: 10 days after flower bud emergence
- Second to seventh application: Every 10 days after the previous spray

Observational parameters

Data were collected at regular intervals (10, 20, 30, 40, 50, and 60 days after the first spraying – **DAS**):

- Number of flower clusters per branch (based on 3 branches per tree)
- Number of flowers per cluster (based on 5 clusters per tree)
- Percentage of healthy flower clusters and flowers per cluster
- Percentage of blackened (diseased) flower clusters and flowers
- Flower length (mm)

RESULT AND DISCUSSION

Effect of Seamel BARRICADE on flower cluster formation

The number of flower clusters per branch varied significantly across treatments and time points. At 10 days after the first spraying (10 DAS), treatment 3 (1.5 mL/L) showed the highest number of flower clusters per branch (32.0 clusters), which was significantly higher than the control (26.3), treatment 2 (26.0), and treatment 1 (20.0). This trend continued at 20 DAS, where treatment 3 reached to 46.0 clusters, outperforming the control (36.7), treatment 2 (35.7), and treatment 1 (26.3). The difference remained statistically significant throughout the observation period, with treatment 3 consistently showing the highest values: 51.0 (30 DAS), 50.3 (40 DAS), 49.3 (50 DAS), and 48.3 clusters (60 DAS). Meanwhile, treatment 1 recorded the lowest flower cluster number at 60 DAS (13.3), indicating a potential decline in flower development at lowest dosage (0.5 mL/L). The consistent superiority of treatment 3 suggests that Seamel BARRICADE at 1.5 mL/L enhances floral induction and differentiation, possibly due to its biostimulant components, which promote nutrient uptake, hormone balance, and overall plant vigor.

These results are in agreement with findings by Nguyen (2015) and Le (2020), who observed an increased in flowering intensity with timely foliar applications of bioregulators and micronutrients. Similarly, Dang (2022) reported that optimal timing and concentration of foliar sprays could enhance floral meristem activity in tropical fruit trees. Furthermore, Tran *et al*. (2018) emphasized the importance of the 30–50-day window after flower bud initiation, noting the fact that this period is critical for the application of external inputs, as also observed in this study. The role of biostimulants and foliar applications in enhancing flowering has been widely recognized. For example, Khan *et al*. (2019) demonstrated that foliar application of seaweed extracts improved flower quantity and quality in fruit crops by modulating endogenous hormone levels and enhancing stress tolerance. Similarly, Jannin *et al*. (2013) highlighted that bio-stimulants can accelerate flowering by influencing the expression of genes related to floral induction pathways. Moreover, studies by Calvo *et al*. (2014) reported that plant bio-stimulants enhance nutrient uptake efficiency and metabolic activities, leading to improved flowering performance and fruit yield. These studies support the hypothesis that the bioactive compounds in Seamel BARRICADE may act through similar physiological and molecular mechanisms to promote flower cluster development in durian production particularly under fungal disease infection.

Table 2: Average number of flower clusters per branch at different time points 10, 20, 30, 40, 50 & 60 DATFA.

Treatment	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
1	20.0 b	26.3 c	31.3 c	28.3 c	20.3 c	13.3 b
2	26.0 b	36.5 b	40.7 b	38.7 b	37.0 b	36.7 b
3	32.0 a	46.0 a	51.0 a	50.3 a	49.3 a	48.3a
Control	25.3 b	36.7 b	41.7 b	38.7 b	36.0 b	34.7 b
Mean	*	**	*	**	**	**
CV(%)	20.7	31.3	24.9	31.9	30.0	22.5

In the same column followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level. *: Significant difference at 5% level, **: Significant difference at 1% level

Effect on disease incidence in flower clusters and individual flowers

The percentage of healthy flower clusters also differed significantly among treatments. At 40 days after treatment (40 DAS), A3 achieved the highest cluster health rate (98.7%), with only 1.3% of clusters exhibiting symptoms of fungal infection, compared to treatment 1, which showed 9.6% infected clusters. Similar trends were observed at 50 and 60 DAS, where treatment 3 maintained a low infection rate (2.0% and 1.8%, respectively), while treatment 1 exhibited a marked increase in infected clusters (28.2% and 34.4%). At the individual flower level, treatment 3 consistently maintained high flower health throughout the study. At 60 DAS, treatment 3 showed the lowest percentage of blackened flowers per cluster (6.6%), followed by the control (18.2%), treatment 2 (16.6%), and treatment 1 (23.3%). These results indicate that Seamel BARRICADE applied at higher concentrations not only promotes flowering but also enhances resistance or tolerance to floral diseases, potentially through strengthening cellular defense mechanisms or by modulating the phyllosphere microbial community. This is consistent with previous reports highlighting the protective roles of biostimulants in tropical fruit crops. For instance, Alminda *et al* (2021) emphasized the dual role of foliar biostimulants in promoting vegetative growth while suppressing disease incidence in fruit crops under humid tropical conditions. Similarly, Saichol (2018) noted the high susceptibility of durian flowers to fungal pathogens during the flowering period and recommended timely foliar protection to maximize flower retention and fruit set. Furthermore, international studies support these findings; for example, Reddy *et al* (2020) demonstrated that biostimulants enhance plant immunity by inducing systemic acquired resistance, thereby reducing pathogen colonization on reproductive organs. In addition, research by Singh and Singh (2017) revealed that foliar applications of certain bioactive compounds can alter the microbial community on leaf and flower surfaces, increasing beneficial microbes that outcompete pathogens. These mechanisms may explain the sustained flower health observed in treatment treatment 3, reinforcing the potential of Seamel BARRICADE as a multifunctional agent in integrated flower management.

The percentage of healthy and blackened flower clusters per branch.

Table 3: Effect on disease incidence in flower clusters and individual flowers.

Treatments	40 DAS		50 DAS		60 DAS	
	The percentage of healthy (%)	**The percentage of blackened (%)**	**The percentage of healthy (%)**	**The percentage of blackened (%)**	**The percentage of healthy (%)**	**The percentage of blackened (%)**
1	90.4c	9.6a	71.8d	28.2a	65.6c	34.4a
2	95.1b	4.9c	95.7b	4.3c	97,3b	2.7c
3	98.7a	1.3d	98.0a	2.0d	98,2a	1.8d
Control	92.8c	7.2b	93.1c	6.9b	96.3b	3.7b
Mean	*	**	*	**	*	**
CV(%)	18.8	22.5	21.7	29.5	27.3	21.4

In the same column followed by the same letter are not significantly different according to Duncan's multiple range test at the 5% significance level. *: Significant difference at 5% level, **: Significant difference at 1% level

Flower length, used as an indicator of flower development, showed a progressive increase across all treatments; however, treatment 3 consistently showed a better performance. At 60 DAS, flowers under treatment 3 treatment reached an average length of 121.9 mm, significantly longer than those under A2 (107.0 mm), the control (106.8 mm), as well as treatment 1 (103.5 mm). This consistent elongation suggests that the highest concentration of Seamel BARRICADE (1.5 mL/L) effectively stimulates floral development. Flower elongation is closely associated with cell expansion, carbohydrate mobilization, and hormonal signaling. In addition, auxins and gibberellins, also play critical role for pedicel and perianth development. The significant improvements observed in treatment 2 and treatment 3 may reflect in enhancing in assimilate allocation and hormonal regulation during the flower development stages. This is in line with findings by Khan *et al*. (2021), who demonstrated that the application of seaweed-based bio-stimulants improve reproductive organ growth through the stimulation of endogenous hormone synthesis, notably gibberellic acid (GA_3), which promotes floral elongation and vascular differentiation. Moreover, Craigie (2011) highlighted the presence of bioactive compounds such as betaines, cytokinin, and oligosaccharides in seaweed extracts, which contribute to cell wall loosening and expansion - processes essential to flower enlargement. Our results also are in agreement with the work of Sharma *et al*. (2020), who observed improved floral traits and yield components in fruit crops following foliar applications of bio-stimulants derived from marine algae. It is worthy to highlight that in our study we did not observe any floral abnormalities or deformations indicating that Seamel BARRICADE is inducing the reproductive development. This finding is aligns with the observations by Rathore *et al.* (2009) and Ali *et al.* (2022), who reported no phytotoxic effects from bio-stimulant use in reproductive tissues, even under tropical field conditions.

Flower morphology (Flower length)

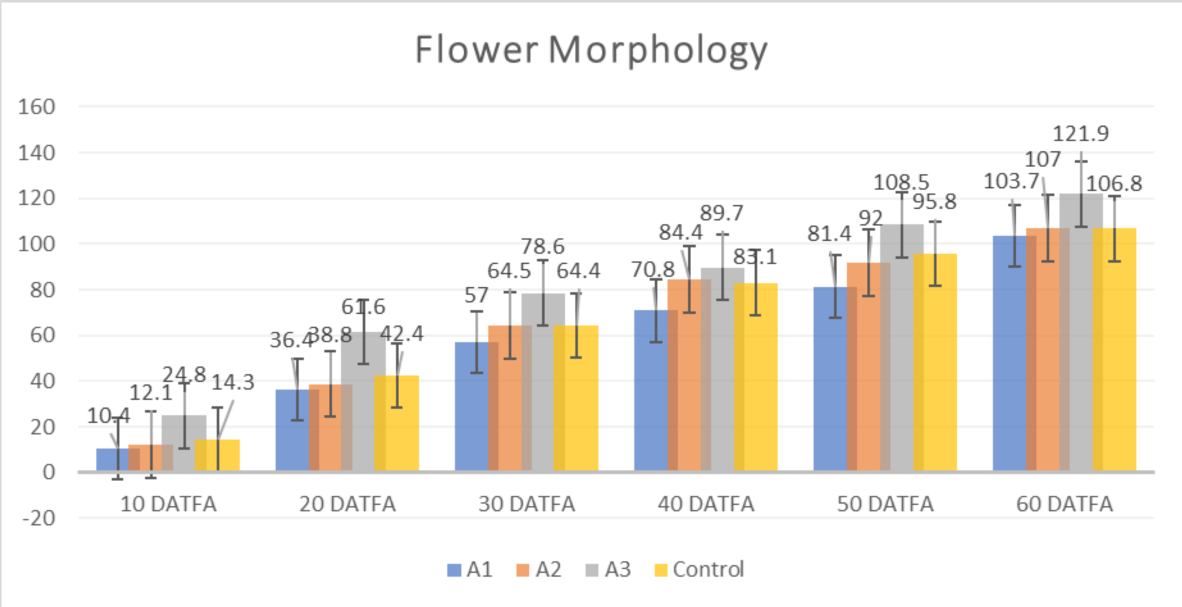

Chart 1: Flower morphology (Flower length)

CONCLUSION

The experimental findings demonstrate that Seamel BARRICADE, particularly at 1.5 mL/L (treatment 3), significantly improves flower cluster formation, reduced disease incidence, and enhances flower development in Ri 6 variety of durian. These outcomes highlight the importance of applying foliar bio-stimulants at critical phenological stages of durian production and support the integration of Seamel BARRICADE into durian flower management programs in the Mekong Delta region.

FUTURE SCOPE

Future studies may explore its synergistic effects with other organic or microbial treatments for sustainable durian production.

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