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Exogenous application of biostimulants for enhancing productivity and quality in guava cv. Allahabad Safeda

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ABSTRACT

Biostimulants have rapidly emerged as a new frontier in sustainable agriculture, enhancing crop performance without the harmful effects of chemicals. Though known for some time, their systematic use and scientific validation are recent, making them a widely adopted and still-emerging technology in modern horticulture. The experiment was conducted at a farmer's field in Vellore to evaluate the impact of various biostimulants on the yield and quality parameters of the guava cv. Allahabad Safeda. The experiment was laid out in a Randomised Block Design (RBD) with ten treatments comprising foliar applications of three biostimulants at various concentrations, *viz.,* seaweed extract (1%, 2%, 3%), humic secret (1%, 2%, 3%), and Wilbond (0.1 g/L, 0.3 g/L, 0.5 g/L) along with a control, and replicated thrice. The biostimulants were applied twice: once at the pre-flowering stage and again at 30 days after fruit set. Among the treatments, the foliar application of Wilbond at 0.5 g/L recorded superior quality attributes such as total soluble solids (12.43 ºBrix), ascorbic acid content (197.76 mg/100 g), total sugars (14.37%), reducing sugars (3.05%), and non-reducing sugars (11.32%). The result clearly indicates that foliar application of Wilbond at 0.5 g/L (T_6) was found to significantly enhance and maintain the overall quality characteristics in guava cv. Allahabad Safeda, thus offering a promising approach for improving productivity in commercial guava cultivation.

Key words: Foliar application, seaweed extract, humic secret, wilbond, ascorbic acid.

INTRODUCTION

Guava (*Psidium guajava* L.) is a tropical, subtropical fruit, that originated in Tropical America and belongs to the Myrtaceae family. In India, guava grows in almost every state except those with a temperate climate. India is currently the largest producer of guava, with 3.14 lakh hectares under cultivation and a yield of 4.92 million tons (Goswami *et al.,* 8). Guava is called a "super-fruit" because it is rich in nutrients, especially vitamin A and C. Its seeds are high in omega-3 and omega-6 fatty acids and dietary fibre. Guava also provides thiamine, riboflavin, phosphorus, calcium, iron, and pectin (0.15–1.8%), along with other important nutrients (Shukla *et al*., 15). Because of these health benefits, demand for guava is rising steadily. Allahabad Safeda is a standard cultivar that has been widely cultivated in several Indian states, including Tamil Nadu. The fruits are round, smooth-skinned, and weigh between 90–150 g, featuring white flesh. The fruit has an average total soluble solid content of 9.5°Brix and contains 140 mg of vitamin C per 100 g of pulp.

Chemical fertilisers are important to increase crop yields and improve food security. However, excessive use has created environmental problems, such as soil deterioration, water pollution, destruction of soil ecology, and reduced soil fertility; this harms human health. Therefore, implementing organic substances instead of chemical fertilisers is necessary to maintain soil fertility, health, and food quality (Suhag, 17). Biostimulants can be used as fertiliser additives to support nutrient uptake, promote plant growth, and increase tolerance to abiotic stress. Nutrition plays a crucial role in guava growth and crop production, and bio-stimulants offer an eco-friendly approach to enhancing fruit quality. Bio-stimulants are substances or microbes that promote growth by influencing metabolic processes, improving nutrient storage for biomass production, and protecting plants from biotic and abiotic stresses. Both organic and inorganic bio-stimulants, including growth regulators, antioxidants, and inorganic salts, are gaining popularity in the horticulture sector (Darshan *et al.,* 5).

Seaweed extracts contain organic and mineral compounds (micro and macronutrients) (Aziz *et al.,* 2). They affect flowering because of balanced carbohydrate and nitrogen content (Zahedipour-Sheshglani and Ashgari, 19) and contain plant growth regulators such as auxin and cytokinin plus organic

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compounds and polysaccharides (Sivasankari *et al.,* 16). Biologically active compounds in seaweed extracts improve soil health, plant growth, and resistance to environmental stresses (Barkule *et al.,* 3).

Willowood Wilbond is a plant growth regulator. It stimulates and increases seed germination. It enhances the uptake of water and nutrients in adverse conditions. It improves the resistance to stress due to disease, salt and temperature in adverse conditions. It enhances the immunity of the crop towards bacterial and viral diseases by inhibition of enzymatic activity, leading to irreversible damage to bacterial and viral cell membranes. It enhances the size and quality of the fruits and vegetables. It enhances flowering and reduces fruit drop.

Humic secret is a plant growth bio-stimulant and soil enhancer formulated with humic acids that promote health and growth. It contains humic acid, fulvic acid and bio-potash to maintain fertile soil and plant and root growth. Humic secret increases the availability of phosphorus, iron, zinc and manganese, chelates soil nutrients, and increases uptake. It improves root mass, soil carbon content and microbial activity, enhances water retention, germination and plant quality, reduces fertiliser requirements and increases yield in most crops. Keeping this in view, the present investigation has been put forward to find out an effective biostimulants that influence the yield and quality of guava cv. Allahabad Safeda.

MATERIALS AND METHODS

The experiment was conducted during 2023-2024 at farmer's field in Asanampattu, Vellore district, Tamil Nadu, at 12º 70' North latitude and 78º 81' East longitude, 182.42 meters above mean sea level. It followed randomized block design (RBD) with three replications and ten treatments. Six-year-old guava cv. Allahabad Safeda trees, spaced at 6m × 6m in square system and foliar sprays of selected biostimulants were applied at two critical phenological stages, namely pre-flowering and 30 days after fruit set (DAFS), to ensure effective absorption and physiological response.

The treatments consisted of three concentrations each of seaweed extract (1, 2, and 3%), humic secret (1, 2, and 3%), and Wilbond (0.1, 0.3, and 0.5 g L^{-1}) along with an untreated control receiving water spray only. Thus, the experiment included a total of ten treatment combinations. The experimental layout and treatment application schedule are illustrated in Fig. 1.

Observations were recorded on growth, yield, and fruit quality parameters following standard experimental procedures, and the collected data were

Fig. 1. Foliar application of biostimulants at different growth stages in guava cv. Allahabad Safeda.

subjected to statistical analysis appropriate for RBD to determine treatment significance.

RESULTS AND DISCUSSION

Among the different biostimulant treatments, Wilbond at 0.5 g L^{-1} (T6) recorded the highest flowering performance, producing the maximum number of flowers per shoot (34.12) and fruit set percentage (85.78), followed by seaweed extract at 3% (T3), which recorded 32.09 flowers per shoot and 81.26% fruit set, and humic acid at 3% (T9), which produced 30.33 flowers per shoot and 79.23% fruit set (Table 1). Flowering initiation and fruit set with Wilbond may be due to beta-sitosterol and stigmasterol interacting with phytohormone pathways involving gibberellins and auxins, as reported by (Al-Saif *et al.* 20) and (Khatoon *et al.,* 10). Maximum fruit length (7.59 cm) and diameter (9.38 cm) were obtained with Wilbond 0.5g l^{-1}, followed by seaweed extract @ 3% and humic acid @ 3%. Wilbond-related increases in fruit size may reflect auxin-stimulated cell division, enlargement, and greater sink strength, with sterols promoting cell elongation and division, as reported by (Yokota 27) and (Engin *et al.,* 7). Maximum fruit weight (172.24 g) was also with Wilbond 0.5g l^{-1}, followed by seaweed extract @ 3% (164.32 g) and humic acid @ 3% (161.26 g).

Maximum pulp weight (151.04 g) was noted with the Wilbond 0.5 g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (141.98 g), and it was at par with humic acid @ 3 % T_9 (134.33 g). Minimum seed weight (6.63 g) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (6.97 g), and it was at par with humic acid @ 3 % T_9 (7.01 g). Maximum pulp : seed ratio (22.78) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (20.37), and it was at par with humic acid @ 3 % T_9 (19.16). It might be due to the reason that nutrients, plant growth hormones, trace elements and vitamins present in wilbond may

Table 1: Effect of biostimulants on yield parameters of guava cv. Allahabad Safeda.

Treatment	Number of fruits per tree	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Pulp weight (g)	Seed weight (g)	Estimated yield (t ha^{1})
T_1	145.69	6.54	6.12	137.12	117.38	132.21	4.91	6.05
T_2	165.38	7.12	7.72	155.26	135.85	149.40	5.86	7.45
T_3	175.17	7.42	8.87	164.32	144.07	158.07	6.25	8.22
T_4	150.81	6.71	6.54	142.90	122.57	137.70	5.19	6.42
T_5	160.59	7.02	7.33	152.01	132.86	146.36	5.65	7.12
T_6	180.12	7.59	9.38	172.24	152.19	165.73	6.51	8.59
T_7	140.79	6.32	5.72	131.92	111.36	126.33	4.59	5.66
T_8	155.82	6.88	6.95	148.11	128.72	142.65	5.46	6.81
T_9	170.37	7.36	8.48	161.26	141.87	155.13	6.13	7.89
T_{10}	131.56	6.08	5.31	120.26	100.68	116.25	4.01	5.16
S. Ed (±)	2.41	0.07	0.19	2.58	2.56	2.46	0.12	0.17
CD (p=0.05)	4.85	0.15	0.40	5.19	5.15	4.94	0.25	0.34

Note: T_1: Seaweed extract @ 1%, T_2: Seaweed extract @ 2%, T_3: Seaweed extract @ 3%, T_4: Wilbond @ 0.1 g l-1, T_5: Wilbond @ 0.3 g l-1, T_6: Wilbond @ 0.5 g l-1, T_7: Humic secret @ 1%, T_8: Humic secret @ 2%, T_9: Humic secret @ 3%, T_{10}: Control.

have resulted in higher photo assimilate supply to the growing fruit as a consequence of intensification of the sink demand, thereby increasing the weight of fruit, which ultimately increases in pulp weight.

Maximum fruit yield per tree (18.85 kg) was obtained with Wilbond 0.5g l^{-1} (T6), followed by seaweed extract @ 3 % T3 (17.92 kg), at par with humic acid @ 3 % T9 (17.36 kg). Maximum fruit yield per hectare (15.70 t ha^{-1}) occurred with Wilbond 0.5g l^{-1} (T6), followed by seaweed extract @ 3 % T3 (15.15 t ha^{-1}), at par with humic acid @ 3 % T9 (14.56 t ha^{-1}) (Fig. 2). Wilbond increased root proliferation, nutrient uptake from deeper soil horizons, growth regulators, photosynthetic activity, and hormones affecting cell division, elongation, yield, and better fruit development. Fruit weight, length, and diameter increased mainly through early cell division followed by rapid cell expansion driven by water and metabolite influx, resulting in overall weight gain. Plant hormones may influence fruit development by enhancing assimilate translocation, accompanied by increased water uptake, solute accumulation, and the synthesis of organic compounds. Similar observations have been reported in mango by Aguirre-Medina *et al.* (1) and Kulkarni *et al.* (11), and in apricot by Tarantino *et al.* (18).

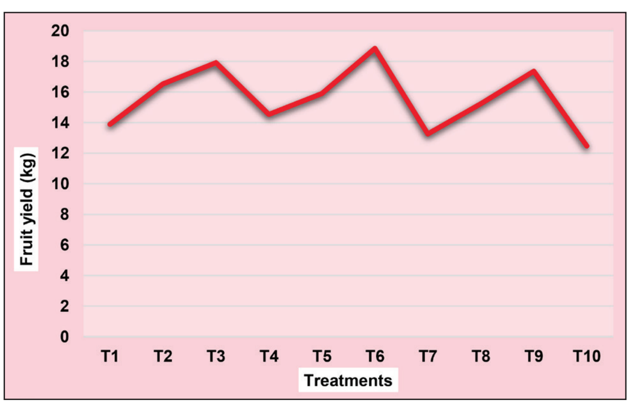

Fig. 2. Effect of biostimulants on fruit yield per tree of guava cv. Allahabad Safeda.

The result for the quality attributes is presented in Table 2. Minimum acidity (0.31 %) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (0.33 %), and it was at par with humic acid @ 3 % T_9 (0.35 %). Maximum TSS: acid ratio (40.09) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (37.06), and it was at par with humic acid @ 3 % T_9 (34.34). Maximum ascorbic acid (197.76 mg 100 g^{-1}) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (196.12 mg 100 g^{-1}), and it was at par with humic acid @ 3 % T_9 (194.45 mg 100 g^{-1}). Ascorbic acid accumulation may be regulated by plant hormones such as auxins, gibberellins, and brassinosteroids. Owing to its structural similarity to brassinosteroids, beta-sitosterol may modulate the activity of these hormones and thereby indirectly influence ascorbic acid biosynthesis. Similar findings have been reported by El-Boray *et al.* (6) in orange and Lobo *et al.* (12).

Maximum total sugar content (14.37 %) was noted with the Wilbond 0.5g l^{-1} (T_6), followed by the application of seaweed extract @ 3 % T_3 (14 %), and it was at par with humic acid @ 3 % T_9 (13.62 %). Maximum TSS (12.43 °Brix) was noted with the

Table 2: Effect of biostimulants on quality parameters of guava cv. Allahabad Safeda.

Treatment	Titratable acidity (%)	TSS (ºBrix)	TSS:Acid ratio	Ascorbic acid (mg 100 g^{-1})	Total sugars (%)	Reducing sugars (%)	Non reducing sugars (%)
T_1	0.29	11.18	38.55	92.03	8.05	4.64	3.31
T_2	0.21	11.81	56.23	117.43	9.39	5.21	4.17
T_3	0.18	12.23	67.94	129.62	10.01	5.40	4.60
T_4	0.26	11.38	43.76	99.21	8.44	4.80	3.54
T_5	0.22	11.68	53.09	111.32	9.07	5.11	3.97
T_6	0.16	12.43	77.68	135.80	10.37	5.54	4.83
T_7	0.33	10.98	33.77	87.80	7.64	4.48	3.06
T_8	0.23	11.59	50.23	105.22	8.75	4.99	3.78
T_9	0.19	12.02	63.26	123.61	9.76	5.35	4.41
T_{10}	0.35	10.48	29.94	74.27	6.78	4.21	2.57
S.Ed(±)	0.004	0.09	2.37	3.06	0.17	0.06	0.11
CD(p=0.05)	0.01	0.19	4.77	6.15	0.35	0.13	0.22

Note: T_1: Seaweed extract @ 1%, T_2: Seaweed extract @ 2%, T_3: Seaweed extract @ 3%, T_4: Wilbond @ 0.1 g l-1, T_5: Wilbond @ 0.3 g l-1, T_6: Wilbond @ 0.5 g l-1, T_7: Humic secret @ 1%, T_8: Humic secret @ 2%, T_9: Humic secret @ 3%, T_{10}: Control.

Wilbond 0.5g l^{-1} (T_6), followed by the seaweed extract @ 3 % T_3 (12.23 °Brix), and it was at par with humic acid @ 3 % T_9 (12.02 °Brix). The increase in TSS (10.48 °Brix), and sugars (6.78 %) by application of wilbond @ 0.5g l^{-1} (T6) along with the RDF could be due to the breakdown of complex organic metabolites into simple molecules or hydrolysis of starch into sugars; however, after complete hydrolysis of starch, no further increase in sugars occurred, and these parameters subsequently declined, as they, along with other organic acids, are primary substrate for respiration. The increase in total soluble solids (TSS) following sterol application may be attributed to enhanced mobilization of metabolites from source to sink tissues, along with increased conversion of starch and organic acids into soluble sugars. These results are in agreement with the findings of Hong Bo *et al.* (9), who reported higher TSS content in 'Baiyulong' pitaya fruits, Champa *et al.* (4), who observed increased TSS in grapes, and Aguirre-Medina *et al.* (1) in mango.

Maximum reducing sugar (3.05 %) was noted with Wilbond 0.5g l-1 (T6), followed by seaweed extract @ 3 % T3 (2.92 %), at par with humic acid @ 3 % T9 (2.78 %). Maximum non-reducing sugar (11.32 %) was noted with Wilbond 0.5g l-1 (T6), followed by seaweed extract @ 3 % T3 (11.08 %), at par with humic acid @ 3 % T9 (10.84 %); minimum (9.01 %) was recorded in control (T10) (Fig. 3). This increase may be attributed to the ability of Wilbond to enhance amylase activity, leading to the hydrolysis of complex polysaccharides into simple sugars. Similar observations were reported by Meena *et al.* (13), Mutum *et al.* (14) in papaya, El-Boray *et al.* (6) in orange, and Lobo *et al.* (12).

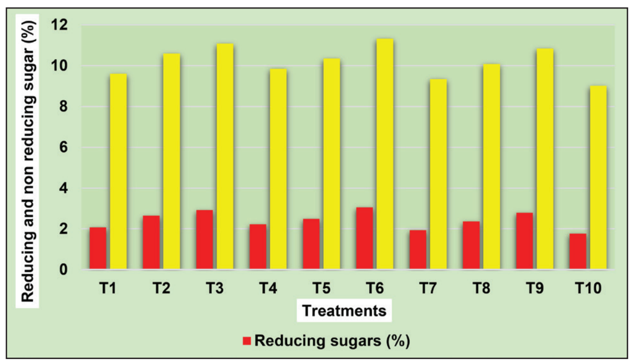

Fig. 3. Effect of biostimulants on reducing and non reducing sugars of guava cv. Allahabad Safeda.

Wilbond significantly influenced guava flowering, yield, and fruit quality. It enhanced flowering and fruit set, improving fruit weight, length, diameter, pulp weight, and yield. It also improved total soluble solids, ascorbic acid, total sugars, reducing and non-reducing sugars, while reducing acidity. The findings indicate that Wilbond @ 0.5 g l^{-1} can be recommended as an effective biostimulant and a sustainable strategy to improve productivity and fruit quality in guava cultivation while reducing dependence on conventional chemical inputs.

AUTHOR'S CONTRIBUTION

Conceptualization of research (SC); Designing of the experiments (RM); Contribution of experimental materials (JMK); Execution of experiments and data collection (JV); Analysis of data and interpretation (SC, RM); Preparation of manuscript and literature review (SC, JMK).

DECLARATION

The authors declare no competing interests.

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