Plant Archives Vol. 25, Supplement 1, 2025 pp.2179-2186 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.299

IMPACT OF VARIOUS BIOSTIMULANTS ON GROWTH, YIELD AND QUALITY OF BUTTER BEAN (*PHASEOLUS LUNATUS* L.) CULTIVAR KKL 1 IN POLYHOUSE CONDITIONS

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(Date of Receiving : 10-10-2024; Date of Acceptance : 06-12-2024)

ABSTRACT

Butter beans (*Phaseolus lunatus* L.) are prized for their significant nutraceutical benefits, which are crucial in addressing malnutrition in developing countries. Given their nutritional advantages, global cultivation demand is increasing. This study aims to boost production and improve crop quality through effective agronomic practices. To minimize dependence on synthetic chemicals, the study investigates the use of biostimulants as an alternative, offering a promising method for enhancing crop growth and performance. The experiment took under polyhouse condition (G) condition at Horticultural & Forestry Research Station, Kodaikanal from December 2023 to June 2024. Various biostimulants were applied foliarly in different doses: Control (B_1) Seaweed extract at 3% (B_2) and 5% (B_3), Panchagavya at 3% (B_4) and 5% (B_5), Vermiwash at 5% (B_6) and 10% (B_7), and Fulvic acid at 6g/l (B_8) and 9g/l (B_9), each replicated three times. Among the treatments, B_3 (Seaweed extract 5%) was most effective in all growth, yield and quality parameters under polyhouse conditions, including plant height (104.86 cm, 147.87 cm, 176.50 cm, 254.82cm at 45, 60, 90 DAP, final plant height respectively), days to flower emergence (50.52 days), number of pods per plant (96.33), pod length (12.57 cm), pod girth (4.12 cm), pod weight (15 g), pod yield (1.53 kg/plant), number of seeds per pod (6.02), fresh seed yield (364.12 g/plant), and dry seed yield (245.30 g/plant) followed by Panchagavya 3% as the second best treatment was observed. The control group (B_1) showed the lowest values in all parameters.

Keywords **:** Biostimulant; Butter bean; Panchagavya; Seaweed extract; Yield characters.

Introduction

Butter beans (*Phaseolus lunatus* L) are leguminous crops rich in both protein and nutrients, belonging to the popular plant family Leguminaceae. They are believed to have originated from Guatemala or nearby regions. It has adapted well to tropical environments and thrives in warm temperate climates, as well as humid, sub-humid, and semi-arid tropical climates. *Phaseolus lunatus*, commonly known as butter bean, lima bean or double bean, is cultivated in various regions of South Asia, notably in Maharashtra (Pune), Karnataka (Chikkamangaluru) and Tamil Nadu (Kodaikanal and Nilgiris) in India. Known for their nitrogen-fixing abilities, butter beans also contribute to soil enrichment through substantial leaf shedding, which aids in restoring soil fertility (da Costa Neto *et al*., 2017). Butter beans come in two varieties: bush and pole types. Bush varieties bear more quickly than pole lima bean varieties.

They reach a height of around two feet and typically have smaller seeds. Pole lima beans can reach heights of 10 to 12 feet and have large seeds, otherwise

it is called as lima beans. Butter beans are highly esteemed for their nutritional profile, boasting high protein content, low sugar levels, and a rich array of essential minerals. These attributes make them valuable in combating protein malnutrition, particularly in developing countries (Ishaya & Aletor, 2019). They are also a significant source of vitamins and minerals. For instance, per 100 g of seed weight, butter beans typically contain 20.88-45 g of carbohydrates, 7.8-20.6 g of protein, 43 mg of starch, and 1.99-2.9 mg of sugars. Amino acid content includes 3330 mg of glutamic acid, 1210 mg of alanine, 1280 mg of glycine, and 1470 mg of lysine. In terms of minerals, they provide macro minerals such as 111-366 mg of phosphorus, 508-1750 mg of potassium, and 43-216 mg of magnesium. Micro minerals found in butter beans include 2.39-6.8 mg of iron, 0.84-1.3 mg of copper and 0.95-1.3 mg of zinc (Souci, Fachmann, & Kraut, 2008); (Salau, 2010).

Biostimulants are potent sources of both macro and micronutrients essential for optimal plant growth, containing significant concentrations of natural plant growth regulators such as GA3, cytokinin, and NAA (Mandaliya, Desai, Patel, Gondaliya, & Solanki, 2021). Integrating these growth-promoting biostimulants with chemical fertilizers has been shown to enhance crop productivity, reduce production costs, and improve soil fertility. Liquid seaweed extract, increasingly popular globally, enriches soil with organic compounds like amino acids, trace minerals, and plant growth regulators like auxin, cytokinin, and gibberellins, promoting robust plant growth (Spinelli, Fiori, Noferini, Sprocatti, & Costa, 2010). In organic farming, panchagavya, a blend of five cow products, boosts plant immunity, mitigates common diseases, and contains growth-regulating substances such as cytokinin, GA, and IAA (Vallimayil & Sekar, 2012). Vermiwash, derived from earthworm secretions and excretions, is valued for its micronutrient content and organic matter, demonstrating effectiveness as a foliar spray (Ansari, 2008), Fulvic acid acts as a plant hormone and aids in buffering soil acidity and salinity, thereby enhancing plant resistance to stresses like drought and heavy metals (AKINCI & ÖNGEL, 2011). Humic acid similarly protects plants, such as maize, from water stress (García *et al*., 2014). These biostimulants collectively plays a vital role in influencing the growth, yield, and quality of butter beans.

Materials and Methods

The present study entiltled Impact of various biostimulants on growth, yield, and quality of butter bean (*Phaseolus lunatus* L.) cultivar KKL 1 in polyhouse conditions. A trial was carried out in polyhouse condition at the Horticultural and Forestry Research Station (H&FRS) in Kodaikanal. The experiment took place in a polyhouse from December to April (2023-2024). Involved four different biostimulants at varying concentrations: Seaweed extract at 3% (B2) and 5% (B3), Panchagavya at 3% (B4) and 5% (B5), Vermiwash at 5% (B6) and 10% (B7), and Fulvic acid at 6g/l (B8) and 9g/l (B9). The soil in the experimental field was characterized as peaty and lateritic. This location is geographically positioned at 10°24' N latitude and 77°48' E longitude, with an elevation of 2225 meters above sea level. During the study period, the average minimum temperature was 2.5°C and the maximum was 30°C, while the relative humidity ranged from 40% to 100%. The soil in the experimental field is loamy silt with a pH of approximately 5.85. Seed material used was KKL 1 butter beans high yielding variety released during 1991, this variety developed by Horticultural and Forestry Research Station (H&FRS) in Kodaikanal. Tender annual grown for their large flat, crescent, oval shaped seeds with pod length 11-12cm. Observation were recorded on days taken to first flowering, days taken to 50% flowering, number of branches, plant height, number of pods per cluster, number of pods per plant, pod length (cm), pod girth (cm), 100 fresh seed weight (g), 100 dry seed weight (g), pod yield per hectare (t/ha), fresh seed yield per hectare (t/ha), dry seed yield per hectare (t/ha), soluble protein content (%), carbohydrate content (%) at the time of vegetative, flowering and yield and collected data were statistically analyzed.(Fig. 1)

Results and Discussion

The data regarding growth, yield and quality parameters are presented

Growth parameters

Plant height in cm at 45, 60 and 90 days after planting (DAP)

The data on the plant height of butter beans with different biostimulants grown under polyhouse conditions. Plant height at 45 DAP was significantly influenced by the protected conditions and biostimulants. In butter beans sprayed with 5% seaweed extract (B_3) under polyhouse conditions had the highest plant height of 104.86 cm, whereas those treated with the control (B_1) had the lowest height of 86.03 cm. (Table 1)

At 60 DAP, plant height was significantly influenced by the different biostimulants. The effect showed that butter beans sprayed with 5% seaweed extract and grown under polyhouse conditions (B_3) had

the highest plant height of 147.87 cm, while the control group in (B_1) had the lowest height of 117.18 cm. (Table 1)

At 90 DAP, plant height was also significantly influenced by the different biostimulants. The effect revealed that butter beans treated with 5% seaweed extract under polyhouse conditions (G_1B_3) had the maximum plant height of 176.50 cm, whereas the control group in (B_1) recorded the least height of 137.32 cm. (Table 1)

The final plant height was significantly influenced by different biostimulants. The effect showed that butter beans treated with 5% seaweed extract under polyhouse conditions (B_3) reached the maximum plant height of 254.82 cm, while the control group in (B_1) had the least height of 191.75 cm (Table 1). The present results are contradictory to the findings (Noli & Aliyyanti) 2021, 0.4% extract of *P. minor* was the best combination to significantly enhanced plant height, number of leaves and fresh weight of Soybean. A similar result reported by (Kocira *et al*., 2018) showed that a 0.4% extract of *Ecklonia maxima* significantly increased the vegetative growth of *Phaseolus vulgaris* (common bean).

(Shehata, Abdel-Azem, Abou El-Yazied, & El-Gizawy, 2011) found that applying amino acids and seaweed extract to celeriac plants significantly increased plant height and leaf weight compared to a control group, this enhanced growth potential may be due to the macro and micronutrients and other growth-promoting substances in the seaweed extract. Similarly, (Zodape, Mukhopadhyay, Eswaran, Reddy, & Chikara, 2010) observed that foliar sprays of liquid seaweed fertilizer improved the growth and nutritional quality of okra. They reported significant improvements in growth parameters, including height, fresh weight, and dry weight, in plants treated with these fertilizers. Additionally, (Zahid, 1999) and (Reitz & Trumble, 1996) noted increased plant size and mass with seaweed application, suggesting cytokinins as an active component.

Days taken to first flowering

The data in Table 1 indicate that the application of different biostimulant at various concentrations significantly affected the number of days to first flowering under the polyhouse condition. Specifically, plants sprayed with 5% seaweed extract under polyhouse condition (B_3) shows shorter duration (48.50 days) for first flower initiation, while the control (B_1) taken longer duration (56.32 days). (Sridhar & Rengasamy, 2010) found that treating plants with SLF (Seaweed Liquid Fertilizer) led to higher chlorophyll levels, which may result from the uptake of magnesium from the SLF, a key component of chlorophyll. This increase in chlorophyll enhances photosynthate production as act as a carbon source for earlier flower initiation. (Table 2)

Days taken to 50% flowering

Data presented in Table 1 the plants sprayed with 5% seaweed extract under polyhouse conditions (B_3) had the shortest time to 50% flowering (64.02 days). The longest time (77.50 days) was observed in the control group (B_1). These findings are consistent with those of (Sasikumar, Govindan, & Anuradha, 2011) who studied the impact of seaweed extract (*Dictyota dichotoma*) application on *Abelmoschus esculantus*. (Sutharsan, Nishanthi, & Srikrishnah, 2014) also reported similar results in tomatoes, demonstrating that higher potassium levels can significantly accelerates flower initiation. Their findings highlighted that Seaweed liquid extract from *Sargassum crassifolium,* rich in potassium relative to other macronutrients and growth regulators that contribute to enhancing flower production through effective pollination which is facilitated by potassium. This was supported by (Fan, Wang, Wang, & Wu, 2001) who found that potassium helps to increase the pollen germination rate and pollen tube growth in *Arabidopsis* by regulating the turgor pressure in pollen tube. Because potassium plays a more important role as a major osmotica in pollen tube growth than in pollen germination. The growth of the pollen tube involves a rapid expansion of cytoplasmic volume, necessitating adequate potassium ions to maintain optimal cytoplasmic solute concentrations.

Number of branches

As per the Table 1, the highest number of branches (4.79) was observed with the 5% seaweed extract under polyhouse conditions (B_3), and the lowest number (3.53) was noticed in the control group (B_1). (Kumari *et al*., 2023) noted that the application of seaweed extract (SWE) enhanced root growth by inducing the expression of an auxin-related gene, which elevated auxin levels and consequently promotes cell division and expansion. As a result, cambial activity is stimulated, leading to earlier interfascicular cambium development and an increase in the number of vascular bundles. These changes in internodal cells are associated with a significant increase in water uptake, osmotic pressure, and the transport of sugars and nitrogenous compounds (SIRCAR, 1965). These factors are effectively linked to the vegetative growth of plants led to encourage the greater number of branches per plant. This finding is supported (Noli & Aliyyanti) and found that 0.4%

extract of *P. minor* was the most effective combination, significantly increasing number of branches and fresh weight of soybean plants.

Yield parameters

Number of pods per cluster

Specifically, the Seaweed Extract 5% under polyhouse conditions (B_3) resulted in the maximum number of pods per cluster at 6.78, with the panchagavya 3% (B_4) being the next most effective. The minimum number of pods per plant 4.25, was recorded in the control group (B_1) (Table 2). The findings are consistent with those of (Kumar & Sahoo, 2011) and (Temple & Bomke, 1989), who reported increased bean pod yield, number of pod per plant and number of pod per cluster after applying foliar sprays of crude extracts from *Macrocystis integrifolia* and *E. maxima.*

Number of pods per plant

Significant differences were noted in the number of pods per plant in butter beans treated with various biostimulants under protected growing conditions. The maximum number of pods per plant (96.33) was observed with Seaweed Extract 5% under protected conditions (B_3), followed by the biostimulant panchagavya 3% (B_4) with 90.40 pods. The minimum number of pods (72.56) was recorded in the control group (B_1) (Table 2). The present results are contradictory to the findings of (Ramya, Nagaraj, & Vijayanand, 2010) applied liquid extracts of marine algae as a soil drench to cluster bean plants and observed significant improvements in yield-related parameters, including the number of pods per plant, pod weight, and pod length. The enhancements in seaweed-treated plants are believed to be linked to the hormonal substances present in the extracts, particularly cytokinins. In vegetative plant organs, cytokinins are associated with nutrient partitioning, while in reproductive organs, high levels of cytokinins may be related to nutrient allocation.

Pod length (cm)

The investigation on pod length in butter beans sprayed with different biostimulants grown under protected conditions is summarized. The seaweed Extract 5% (B_3) produced the maximum pod length of 12.70 cm under polyhouse conditions (B_3), while the minimum pod length of 11.17cm was recorded in the control group (B_1) (Table 2).This finding is supported by (Ramya *et al*., 2010) used liquid extracts of marine algae as a soil drench for cluster bean plants and observed significant improvements in yield parameters, including the pod length and pod weight.

Pod girth (cm)

Significant differences in pod girth of butter beans were observed when sprayed with different biostimulants under protected environmental conditions. Among the Seaweed Extract 5% under protected conditions (B_3) recorded the maximum pod girth of 4.12 cm, followed by the biostimulant panchagavya 3% (B_4) at 4.10cm and the minimum pod girth of 3.68 cm recorded in the control group (B_1) (Table 2). These findings are consistent with those of (Biswajit Pramanick, Koushik Brahmachari, & Arup Ghosh, 2013) and Youssef *et al.* (2019). The application of panchgavya at 3% was found to be the second most effective treatment for improving pod characteristics. This could be attributed to the relatively higher carbohydrate content, which may have promoted growth rates, thereby increasing the number of pods, the weight of individual pods, and other pod-related traits.

Pod yield per hectare (t/ha)

Significant butter beans pod yield per hectare were observed under polyhouse conditions.

Regarding the butter beans treated with Seaweed Extract 5% under polyhouse conditions (B_3) produced the maximum pod yield per hectare (4.98 t/ha). This was followed by Panchagavya 3% under protected conditions (B_4) with a yield of 4.73 t/ha. The lowest yield (3.27t/ha) was noted in the control group (B_1). The similar results were reported by (Kumar & Sahoo, 2011) and (Temple & Bomke, 1989), which showed an increase in pod yield for beans following foliar spray with crude extracts of *Macrocystis integrifolia* and *E. maxima*. This finding is supported by (Nelson & Van Staden, 1984) found that applying Kelpak 66 seaweed liquid extract foliarly increased bean yields by 24%. (Z Sarhan, 2011) found that seaweed extracts significantly improved potato plant growth and yields. (Thirumaran, Arumugam, Arumugam, & Anantharaman, 2009) reported that Seaweed Liquid Fertilizer (SLF) from Rosenvingea intricata enhanced okra yields. (Rathore *et al*., 2009) observed that foliar applications of seaweed extract increased soybean yields, with the highest yields from seaweed-treated plants. Similarly, (Khan *et al*., 2009) noted that seaweed extracts boosted crop yields by increasing chlorophyll content, attributed to betaines and hormonal substances like cytokinins that aid nutrient distribution (Table 2).

Fresh seed yield per hectare (t/ha)

Significant differences in butter beans fresh seed yield per hectare were observed among the different biostimulants. The seaweed Extract 5% under

polyhouse conditions (B_3) achieved the highest yield per hectare (1.92 t/ha), followed by Panchagavya 3% in protected conditions (B_4) with 1.77 t/ha. The lowest yield (1.45 t/ha) was recorded in the control group (B_1) (Table 3). These results were similar to those reported by (Youssef, El-Segai, Abou-Taleb, & Massoud, 2019), (Zodape *et al*., 2010) , (Ramya *et al*., 2010), and (Beghdady, 2016). Regarding the foliar application of SWE, the obtained data demonstrated that the foliar application of SWE (fourg) increased the number of pods per plant, seed yield (kg/fed), and seed yield per plant (g) compared to other seaweed treatments studied.

Dry seed yield per hectare (t/ha)

Significant differences in butter bean dry seed yield per hectare were observed among different biostimulants. (Table 28). Among the butter beans treated with Seaweed Extract 5% under protected conditions (B_3) achieved the highest yield per hectare (1.28 t/ha), followed by Panchagavya 3% under protected conditions (B_4) with 1.19 t/ha. The lowest yield (0.64 t/ha) was recorded in the control group (B_1) (Table 3). This finding is supported by (Rathore *et al*., 2009) studied the effects of foliar applications of various concentrations of seaweed extract on soybean yield. They found that these applications significantly enhanced yield parameters, with the highest grain yield recorded at a 15% seaweed extract concentration. This was followed by a 12.5% concentration, resulting in 57% and 46% increases in yield, respectively, compared to the control.

Biochemical parameters

Soluble protein content (%)

The combined impact of different biostimulants under polyhouse conditions significantly affected the soluble protein content in the cultivar KKL 1. The effects, butter beans with 5% Seaweed Extract under polyhouse conditions (B_3) showed the highest protein content at 28.68%. Conversely, the control (B_1) had the lowest protein content at 24.96% (Table 3 and Fig. 3). Similar results align with (Ramya *et al*., 2010) and (Atzmon & Van Staden, 1994), who found that using marine liquid extracts as soil drench on cluster bean plants significantly increased biochemical parameters like photosynthetic pigments, protein content, and amino acids. The rise in photosynthetic pigments may be due to magnesium, a key component for chlorophyll synthesis, or the increase in the number and size of chloroplasts and better grana development.

Carbohydrate content (%)

There was a slight but notable difference in carbohydrate content among butter beans treated with different biostimulants, under polyhouse conditions. (Table 3 and Fig. 4). Seaweed Extract at 5% under polyhouse conditions (B_3) had the highest carbohydrate content at 42.05%, The lowest carbohydrate content was recorded in the control group (B_1) at 40.10%. Similar results were reported by (Ramya *et al*., 2010), who found that liquid marine extracts as soil drenches for cluster bean plants significantly reduced sugar levels. Similarly, (Shehata *et al*., 2011) observed that amino acids and seaweed extracts increased total sugar content in celeriac plants compared to controls, with the effect being more pronounced at higher application rates and no significant difference between the two treatments. These findings are in line with (Rathore *et al*., 2009), who reported that foliar application of liquid seaweed fertilizers (LSF) improved okra's nutritional quality, including higher carbohydrate, protein, and dietary fiber levels. Similarly, (Zodape *et al*., 2010) found that seaweed extract increased both seed yield and nutritional quality in green gram plants, enhancing carbohydrate and protein content compared to the control group.

Conclusion

In the polyhouse conditions achieved the highest vegetative growth, yield, and quality. The butter beans were treated with various biostimulants, including seaweed extract, Panchagavya, Vermiwash, and fulvic acid at different concentrations. Seaweed extract at 5% concentration showed superior performance in terms of yield and growth attributes in polyhouse conditions. The study clearly demonstrates that using seaweed extract biostimulants is highly beneficial, as they promoted early maturation and improved quality parameters such as higher crude fiber, carbohydrate levels. A bio stimulant significantly boosts the growth and yield of butter beans by enhancing their resilience to environmental stresses and improving seed quality. It also decreases reliance on chemical treatments. Looking ahead, the application of bio stimulants is expected to play a crucial role in sustainable agriculture by promoting more resilient crops and reducing the environmental impact of farming practices. As research advances, bio stimulants may become increasingly sophisticated, offering even greater benefits for crop productivity and ecological health (Fig. 5).

Table 1 : Effect of different biostimulant on growth parameter of butter beans (*Phaseolus lunatus* L.) cultivar KKL 1 under polyhouse condition

Treatment	Plant height				Days taken to first flowering	Days taken to 50% flowering	Number of branches
	45 days	60 days	90 days	Final			
B_1	86.03	117.18	137.32	191.75	57.85	77.50	3.53
B_2	94.25	134.40	149.87	207.21	55.20	73.53	4.13
B_3	104.86	147.87	176.50	254.82	50.52	64.02	4.79
B_4	99.84	141.63	168.54	238.81	51.32	68	4.53
B_5	95.36	129.87	159.87	206.43	54.56	71.32	3.93
B_6	96.15	129.68	151.38	210.29	52.73	71.69	3.86
B_7	98.23	138.55	162.21	221.28	52.01	69.18	4.26
B_8	95.86	129.68	150.54	207.56	54.20	73.76	4.02
B_9	95.11	128.24	152.98	208.05	56.35	74.51	3.60
Mean	96.19	133.01	156.58	216.24	53.86	71.50	4.07
SE.d	1.874	2.527	3.136	4.217	1.339	1.487	0.071
CD at 5%	3.973**	5.358**	6.649**	8.940**	2.839**	3.154**	0.152**

NS – Non significant, **-significant Factor 1 – Growing conditions: G1-Poly house condition, G2-Open condition. Factor 2 – Biostimulants, B1-Control, B2-Sea weed Extract 3%, B3-Sea weed Extract 5%, B4-Panchagavya 3%, B5-Panchagavya 5%, B6-Vermiwash 5%, B7-Vermiwash 10%, B8-Fulvic acid 6g/litre of water, B9-Fulvic acid 9g/litre of water.

Table 2 : Effect of different biostimulant on yield parameter of butter beans (*Phaseolus lunatus* L.) cultivar KKL 1 under polyhouse condition

Treatment	Number of pods per cluster	Number of pods per plant	Pod length (cm)	Pod girth (cm)	Pod yield per hectare (t/ha)
B_1	4.25	72.56	11.17	3.68	3.27
B_2	5.56	85.65	11.95	3.97	3.99
B_3	6.78	96.33	12.70	4.12	4.98
B_4	6.59	90.40	12.57	4.10	4.73
B_5	5.24	87.53	11.64	3.84	4.20
B_6	5.91	85.20	11.58	3.79	4.33
B_7	6.03	89.01	12.16	4.02	4.68
B_8	5.65	82.67	11.39	3.93	4.47
B_9	4.98	79.38	11.22	3.76	3.81
Mean	5.67	85.41	11.82	3.91	4.27
SE.d	0.139	2.062	0.299	0.093	0.094
CD at 5%	0.294**	4.373**	0.635**	0.198**	0.199**

NS – Non significant, **-significant Factor 1 – Growing conditions: G1-Poly house condition, G2-Open condition. Factor 2 – Biostimulants, B1-Control, B2-Sea weed Extract 3%, B3-Sea weed Extract 5%, B4-Panchagavya 3%, B5-Panchagavya 5%, B6-Vermiwash 5%, B7-Vermiwash 10%, B8-Fulvic acid 6g/litre of water, B9-Fulvic acid 9g/litre of water.

Table 3 : Effect of different biostimulant on yield parameter of butter beans (*Phaseolus lunatus* L.) cultivar KKL 1 under polyhouse condition

Treatment	Fresh seed yield per hectare (t/ha)	Dry seed yield per hectare (t/ha)	Soluble protein content (%)	Carbohydrate content (%)
B_1	1.45	0.64	24.96	40.10
B_2	1.55	0.76	28.68	40.41
B_3	1.92	1.28	36.32	42.05
B_4	1.77	1.19	35.15	41.90
B_5	1.50	0.84	26.81	40.69
B_6	1.61	0.98	27.25	41.48
B_7	1.72	1.06	33.18	41.69
B_8	1.52	0.92	26.31	40.22
B_9	1.48	0.69	25.06	40.15
Mean	1.61	0.93	29.30	40.97
SE.d	4.217	0.019	0.671	1.132
CD at 5%	8.940**	0.041**	1.423**	2.400**

NS – Non significant, **-significant Factor 1 – Growing conditions: G1-Poly house condition, G2-Open condition. Factor 2 – Biostimulants, B1-Control, B2-Sea weed Extract 3%, B3-Sea weed Extract 5%, B4-Panchagavya 3%, B5-Panchagavya 5%, B6-Vermiwash 5%, B7-Vermiwash 10%, B8-Fulvic acid 6g/litre of water, B9-Fulvic acid 9g/litre of water.

Fig. 1 : Experimental field view of polyhouse condition

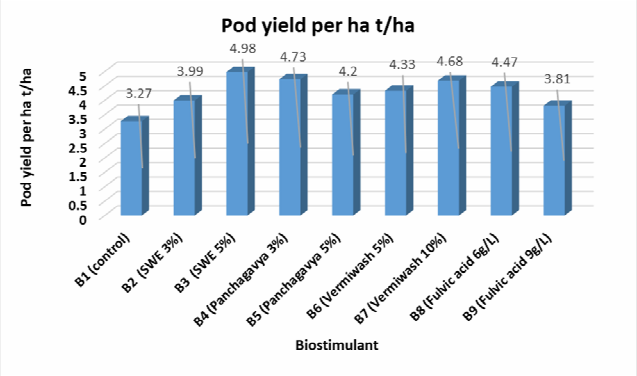

Fig. 2 : Effect of biostimulant and growing condition on pod yield per ha (t/ha)

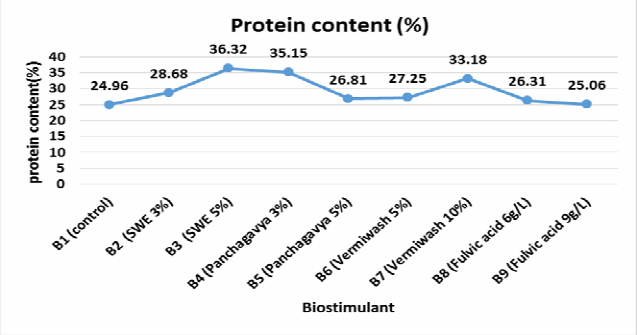

Fig. 3 : Effect of biostimulant and growing condition on protein content (%)

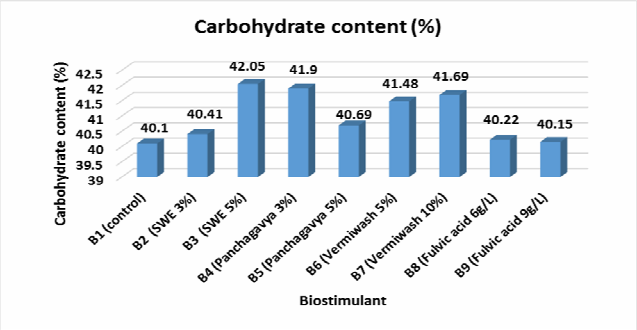

Fig. 4 : Effect of biostimulant and growing condition on carbohydrate content (%)

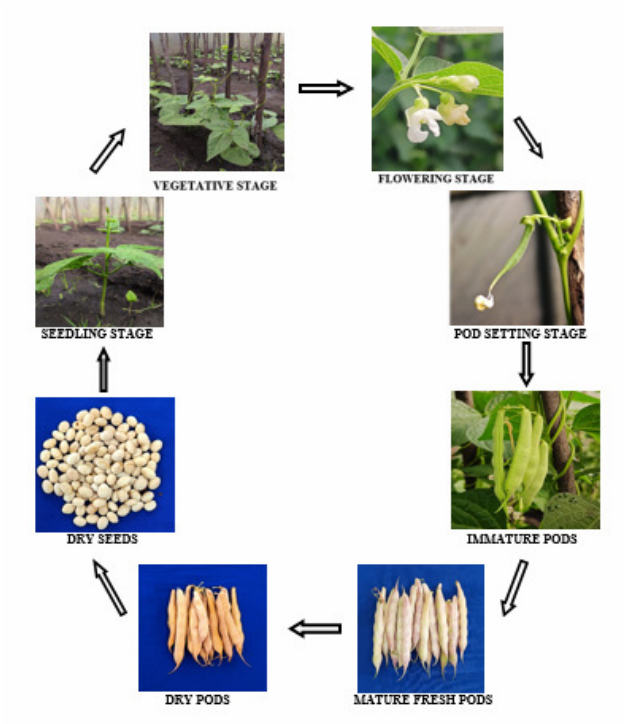

Fig. 5 : Different stages of butter bean

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