



RESEARCH ARTICLE

Boosting green gram yield with foliar application of liquid organics

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Abstract

Pulses are integral to Indian agriculture due to their numerous benefits in sustainable farming practices. The continuous cultivation of the same crops has led to soil degradation and pulses can help restore soil health by enriching it with nitrogen. Prolonged use of inorganic fertilizers not only deteriorates soil structure and health but also contributes significantly to environmental pollution. Foliar applications of liquid organic fertilizers like seaweed extract, panchakavya, jeevamrutha, amirthakaraisal and mango leaf extract stimulates plant growth, yield and metabolic activity. To evaluate the effectiveness of these organic formulations, a field study was conducted at the organic farm of Krishna College of Agriculture and Technology, Madurai, during the *Kharif* season of 2024. The field experiment with seven treatments were carried out in randomized block design and replicated thrice. Growth, yield characters, yield and economics were recorded and worked out for each treatment. Among the treatments, foliar application of seaweed extract resulted in higher growth, yield attributes, yield and maximum net return with B:C ratio.

Keywords: foliar; green gram; panchakavya; organics; seaweed extract

Introduction

Pulses are integral to Indian agriculture due to their numerous benefits in sustainable farming practices (1). With the increasing emphasis on crop diversification in modern agriculture, the inclusion of pulses in cropping systems has become essential. Repetitive cultivation of same crops resulted in soil degradation and pulses can help restore soil health by enriching it with nitrogen, benefiting both the soil biota and subsequent crops. Pulses are also valuable in challenging weather conditions, serving as a reliable contingency crop when other crops fail, thus maximizing the use of available natural resources and growing periods (2).

As a rich protein source, green gram serves as an excellent meat alternative for vegans (3). It's a short duration, nitrogen-fixing, low input requirement, crop and resilience under resource-limited conditions have made it popular among small and marginal farmers in India's dryland regions (4). Incorporating green gram into various cropping systems and crop rotation practices helps maintain soil fertility and productivity, thereby enhancing agricultural output and increasing farmers' profits (5). It is cultivated in 31.28 lakh ha with a production and productivity of 3.10 MT and 570 kg/ha in India. Overall area of green gram was 1.48 lakh ha with production of 17.72 lakh tonne in Tamil Nadu during 2024.

In organic farming, pulses are especially important for their role in atmospheric nitrogen fixation, contributing significantly to on-farm nitrogen self-reliance. In India, pulses are predominantly grown

on marginal lands under rainfed conditions by resource poor farmers (6). Pulses are a crucial component of sustainable agriculture and human nutrition, yet their productivity in many regions remains suboptimal. One of the primary constraints is that pulse-growing soils are often deficient in essential nutrients such as nitrogen and phosphorus. Despite this, the use of chemical fertilizers in pulse cultivation is considerably low. This limited nutrient supplementation, coupled with unreliable soil moisture during critical growth stages and the impact of various biotic and abiotic stresses, significantly hampers yield potential. Addressing these challenges is essential for improving pulse productivity and ensuring food and nutritional security (5).

Continuous application of inorganic fertilizers negatively impacts soil health and structure, while overuse results in environmental contamination. During this intensive agricultural scenario, use of inorganic fertilizers is inevitable, however for concerning about the soil health and future soil environment, the best alternate source for plant nutrients is use of organic sources of manures.

Organic farming is a regulated agricultural system that exclusively utilizes organic inputs for nutrient cycling and pest and disease management, while strictly avoiding synthetic agrochemicals and genetically modified organisms. As a specialized form of diversified agriculture, it addresses farming challenges through the use of locally available resources-primarily farm-derived materials, naturally occurring minerals and plant-based preparations.

Many Indian farmers, particularly those who are marginal and small-scale, are unable to apply the recommended doses of fertilizers due to their prohibitive cost and unavailability. To achieve sustainable soil fertility and crop productivity, organic manures offer a sustainable alternative, supplying essential nutrients, increasing soil organic matter, improving water retention and structure and enhancing both soil physicochemical properties and microbial activity (7).

Seaweed bio fertilizers are addressed as an alternative to chemical fertilizers and it contains all the necessary plant essential minerals. They are biodegradable, non-polluting, non-toxic and non-hazardous (8). Their usage as a liquid fertilizer is quite more attractive for foliar spray which induce higher growth and yield of crops (9).

Use of fermented liquid organic fertilizers like panchakavya and jeevamrutha, are vital. These fermented fertilizers contain not only nutrients but also microbial loads and plant growth promoting substances that stimulate plant growth, yield, metabolic activity and resistance to pests and diseases (10). The foliar application of essential nutrients, plant growth promoters and plant growth regulators during critical stages of crop development, along with soil application of major nutrients, is becoming an increasingly important trend in agriculture (11). This approach enhances the physiological and biochemical functions of plants, thereby maximizing the productivity of pulse crops (12).

Excessive reliance on chemical inputs in agriculture has led to ecological degradation, deterioration of soil and water quality and a decline in food nutritional value. In response to these concerns, there is increasing recognition of organic farming as a sustainable alternative to mitigate the adverse effects of conventional chemical-based practices. Consequently, there is a critical need to formulate a scientifically sound, locally adaptable and economically feasible nutrient management strategy utilizing organic resources. This understanding forms the basis of the study and hence the experiment was designed to evaluate the impact of foliar application of liquid organics in productivity of green gram.

Materials and Methods

A field experiment was conducted in organic farm at Krishna College of Agriculture and Technology, Madurai during *Kharif* season 2024 (9°58' N latitude; 77°48' E longitude and 218 m MSL). The soil was sandy clay loam in texture, low in available nitrogen (182.5 kg ha⁻¹), high in available phosphorus and potassium (25 kg ha⁻¹ and 455 kg ha⁻¹). During the cropping period, a total rainfall of 266.7 mm was received in 11 rainy days. The mean and maximum temperature were 36.9°C and 19.8°C. During the cropping period, average relative humidity was 63.7% and wind velocity was 9.2 km hr⁻¹. Green gram variety VBN 4 released by Tamil Nadu Agricultural University with duration 65-70 days was used as a test crop for this study. The experiment was laid in randomized block design with seven treatments viz. T₁- Seaweed extract, T₂- Panchakavya, T₃- Jeevamurtham, T₄- Beejamurtham, T₅- Tree leaf extract (Mango), T₆- Amirthakaraisal and T₇- Absolute control with three replications. Treatments T₁ to T₆ were imposed as foliar application. Individual plot with a dimension of 4 x 3 m² was formed with its net plot size of 3.6 x 2.6 m². Seed rate adopted was 20 kg ha⁻¹ with 30 x 10 cm spacing. Prior to sowing, seeds were treated with liquid rhizobium fertilizer at 125 mL and then were shade-dried for half an hour. Irrigation was given immediately after sowing and life irrigation on 3

days after sowing (DAS). Subsequent irrigation was given as and when required by considering rainfall quantity received during the cropping period. Hand weeding was done on 15th and 30th DAS.

Foliar application of liquid organics

Foliar application of liquid organics viz. Seaweed extract, Panchakavya, Jeevamurtham, Beejamurtham, Amirthakaraisal, Tree leaf extract (Mango) was given on 30 and 45 days after sowing at 3% concentration to the respective plots. IFFCO organic seaweed extract made up of 28% w/v extract from red and brown seaweed was used for this research trail. It contains humic acid, fulvic acid, proteins, carbohydrates, vitamins, enzymes, amino acids, organic acids and plant hormones like auxins, cytokinins and gibberellins. Various products like cow dung (10 kg), cow urine (10 L), jaggery (2 kg), gram flour (2 kg) and hand full of soil collected from the farm were used for the preparation of jeevamurtham. All these were put in a 200 L plastic barrel and the volume was made up to 200 L. The mixture was stirred thoroughly with a long stick in clockwise direction twice a day for 2-3 days before application.

For Beejamurtham, cow dung, cow urine, water and lime were used. In a bucket containing 20 L of water, 5 kg of cow dung was placed in a cloth, tied securely and immersed. The setup was left undisturbed overnight. Separately, 50 g of lime was dissolved in 1 L of water and also kept overnight. The following morning, the tied cow dung was repeatedly dipped and squeezed to extract its contents thoroughly. Subsequently, 5 L of cow urine, the prepared lime solution and a handful of soil were added to the extract. The mixture was stirred thoroughly and made ready for application.

Panchakavya was prepared by using five cow products namely cow dung, cow urine, cow milk, ghee and curd. Initially, 5 kg of fresh cow dung and 500 g of cow ghee were thoroughly mixed in a plastic drum and kept under shade for two days. On the third day, the remaining ingredients-3 L of cow urine, 2 L of curd and 2 L of milk -were added to the mixture and mixed thoroughly. The preparation was kept under shade and stirred twice daily to promote aerobic microbial activity. After a fermentation period of 30 days, the mixture was filtered and used for foliar application.

Amirthakaraisal was prepared by thoroughly mixing 10 kg of cow dung, 10 L of cow urine, 1 kg of jaggery and 100 L of water in a cement tank. For the preparation of tree leaf extract, 5 kg of fresh mango leaves were collected and soaked in 6 L of water. The soaked leaves were then chopped, ground into a paste and filtered. Khadi soap was added as a sticking agent and the extract was diluted with 60 L of water before spraying. Foliar application of all the treatments at the respective plots were given at 30 and 45 DAS at 3% concentration.

Results

Growth parameters

Growth attributes such as plant height, number of branches per plant and DMP were recorded at 30 and 45 DAS; and at harvest stage (Table 1-3). Plant height is the index to measure the growth performance of crops. At 30 DAS, there was no significant difference among the foliar application treatments. At 45 DAS and at harvest stage, foliar application of seaweed extract (T₁) recorded maximum plant height of 55.9 and 84.1 cm respectively. It was followed by foliar application of panchakavya spray (T₂). At all stages absolute control (T₇) recorded minimum plant height. Different liquid organics application had considerable impact on number of branches per

Table 1. Effect of liquid organics on plant height (cm) of green gram

Treatments	30 DAS	45 DAS	At harvest
T ₁	17.2	55.9	84.1
T ₂	17.0	52.0	78.4
T ₃	17.2	46.0	74.0
T ₄	17.4	45.0	76.0
T ₅	16.3	49.0	78.0
T ₆	16.1	42.0	71.0
T ₇	14.2	37.0	65.0
S.Ed	0.4	1.25	2.07
CD (p = 0.05)	0.9	2.73	4.44

Table 2. Effect of liquid organics on number of branches plant⁻¹ of green gram

Treatments	30 DAS	45 DAS	At harvest
T ₁	6	7	7
T ₂	5	6	6
T ₃	5	5	5
T ₄	4	5	5
T ₅	5	5	5
T ₆	4	4	4
T ₇	3	4	4
S.Ed	0.12	0.15	0.15
CD (p = 0.05)	0.27	0.33	0.33

Table 3. Effect of liquid organics on dry matter production (kg ha⁻¹) of green gram

Treatments	30 DAS	45 DAS	At harvest
T ₁	156	1501	2678
T ₂	157	1418	2516
T ₃	154	1386	2031
T ₄	150	1394	2071
T ₅	152	1402	2482
T ₆	154	1106	1684
T ₇	130	689	946
S.Ed	4.02	38.74	69.05
CD (p = 0.05)	8.61	82.92	147.78

plant. At all stages, foliar application of seaweed extract (T₁) recorded maximum number of branches- 6, 7 and 7 in numbers at 30, 45 DAS and at harvest stage respectively. However, it was followed by foliar application of panchakavya (T₂). Absolute control (T₇) registered minimum number of branches of about 3, 4 and 4 at 30, 45 DAS and at harvest stage respectively.

Foliar application of liquid organics considerably influenced the dry matter production of green gram. At 30 DAS, foliar application of panchakavya (T₂) (157 kg ha⁻¹) recorded maximum dry matter production. However, it was on par with T₁ (foliar application of seaweed extract) (156 kg ha⁻¹). Among the different treatments, maximum dry matter production was attributed with foliar spray of seaweed extract (T₁) which recorded dry matter production of 1501 and 2678 kg ha⁻¹ at 45 DAS and at harvest stage. It was followed by foliar application of panchakavya spray (T₂) which recorded 1418 and 2516 kg ha⁻¹ at 45 DAS and at harvest stage. At all stages, dry matter production was recorded minimum with absolute control (T₇).

Physiological attributes

Leaf area index is the measure of crop growth and a major factor influencing the assimilating capacity of the crop and ultimate productivity. Data recorded on leaf area index at 30, 45 days after sowing and at harvest stage were presented as Fig 1. At 30 DAS, T₂ (0.67) recorded maximum Leaf Area Index (LAI). However, it was followed by T₁ (0.65). Among the different treatments, maximum dry matter production was attributed with foliar spray of seaweed extract (T₁) recorded maximum leaf area index of 1.98 and 1.45 at 45 DAS and at harvest stage. It was further followed by foliar application of panchakavya spray (T₂) which recorded 1.93 and 1.41 at 45 DAS and at harvest stage. At all stages, LAI was minimum (0.51, 1.61 and 1.29) with absolute control (T₇).

Yield attributes and yield

Foliar spray of different liquid organics taken for this study had significant impact on yield attributes of green gram except 100 seed weight (Table 4). On comparison, foliar spray of seaweed extract (T₁) recorded maximum yield attributes such as number of pods (31); number of seeds per plant (13) and pod length (7.7 cm). Absolute control (T₇) recorded minimum number of pods (15), number of seeds per plant (9) and pod length (6.2 cm). There found no differences among any treatments on 100 seed weight.

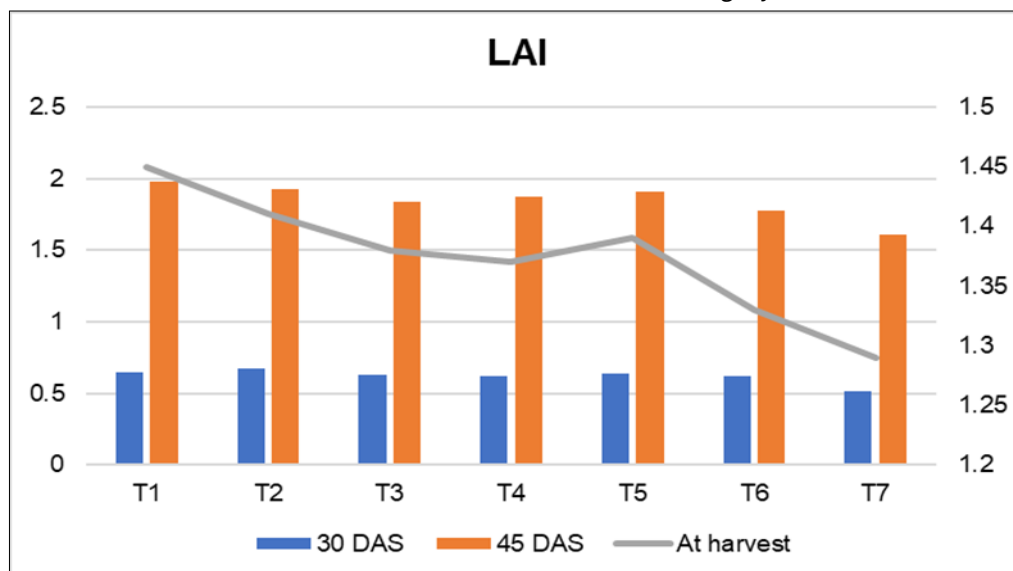
**Fig. 1.** Effect of foliar application of liquid organics on leaf area index of green gram.

Table 4. Effect of liquid organics on yield attributes of green gram

Treatments	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	Pod length (cm)	100 seed weight (g)
T ₁	31	13	7.7	3.45
T ₂	27	13	7.5	3.46
T ₃	24	11	7.4	3.39
T ₄	22	11	7.3	3.41
T ₅	26	12	7.4	3.39
T ₆	20	10	6.5	3.38
T ₇	15	9	6.2	3.39
S.Ed	0.68	0.15	0.19	-
CD (p = 0.05)	1.47	0.33	0.41	NS

Both seed yield and haulm yield (Table 5, Fig. 2 & 3) were observed maximum with foliar spray of seaweed extract (T₁) (1421 and 1659 kg ha⁻¹ respectively). It was followed by foliar application of panchakavya (T₂) which recorded 1337 and 1543 kg ha⁻¹. Seed yield and haulm yield were found minimum with absolute control (T₇) of about 618 and 742 kg ha⁻¹ respectively.

Economics

Economic efficiency and crop cultivation are the main outcome of the crop yield. Higher crop productivity with lesser cost of cultivation would result in better net return and B:C ratio. Parameters like cost of cultivation, gross return, net return and B:C ratio were worked for all the seven treatments (Table 6, Fig. 4). Cost of cultivation of green gram varied for all the treatments. It was obtained maximum with foliar spray of seaweed extract (T₁) which accounted ₹28020 ha⁻¹ and minimum with absolute control (T₇) of ₹24220 ha⁻¹. Gross return and net return of ₹78985 ha⁻¹ and ₹50965 ha⁻¹ was recorded with foliar spray of seaweed extract (T₁) and minimum with absolute control (T₇) of ₹34361 ha⁻¹ and ₹10141 ha⁻¹. B:C ratio of 2.82 was attained with application of seaweed extract (T₁) as foliar spray and minimum with absolute control (T₇) of 1.42.

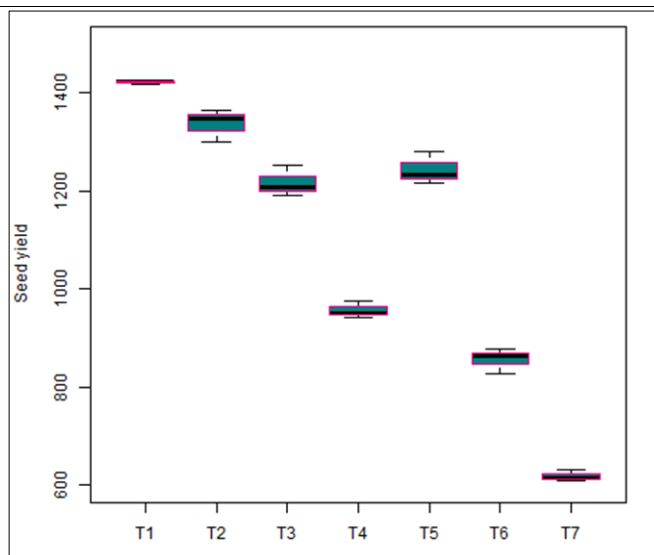
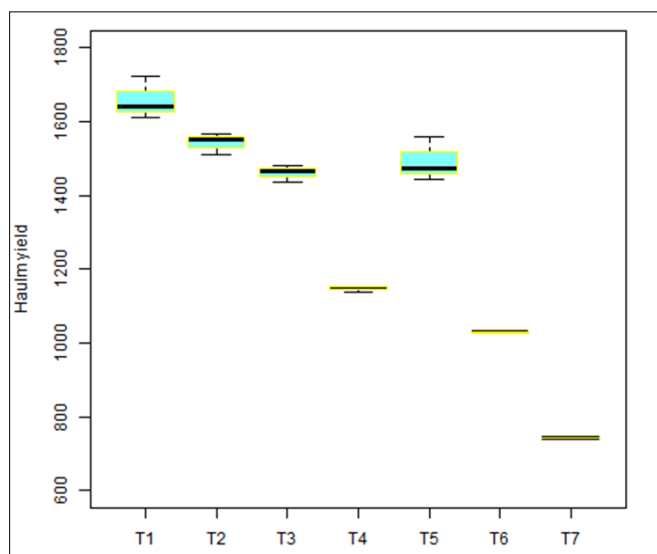
Table 5. Effect of liquid organics on seed and haulm yield (kg ha⁻¹) of green gram

Treatments	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)
T ₁	1421	1659
T ₂	1337	1543
T ₃	1217	1460
T ₄	956	1147
T ₅	1243	1492
T ₆	856	1027
T ₇	618	742
S.Ed	28.5	32.5
CD (p = 0.05)	61.17	72.1

Table 6. Effect of liquid organics on economics of green gram

Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross income (₹ ha ⁻¹)	Net income (₹ ha ⁻¹)	B:C ratio
T ₁	28020	78985	50965	2.82
T ₂	27120	74307	47187	2.74
T ₃	27720	67665	39945	2.44
T ₄	27120	53154	26034	1.96
T ₅	26220	69111	42891	2.64
T ₆	27420	47594	20174	1.74
T ₇	24220	34361	10141	1.42

*Data not statistically analyzed.

**Fig. 2.** Effect of foliar application of liquid organics on seed yield (kg ha⁻¹) of green gram.**Fig. 3.** Effect of foliar application of liquid organics on haulm yield (kg ha⁻¹) of green gram.

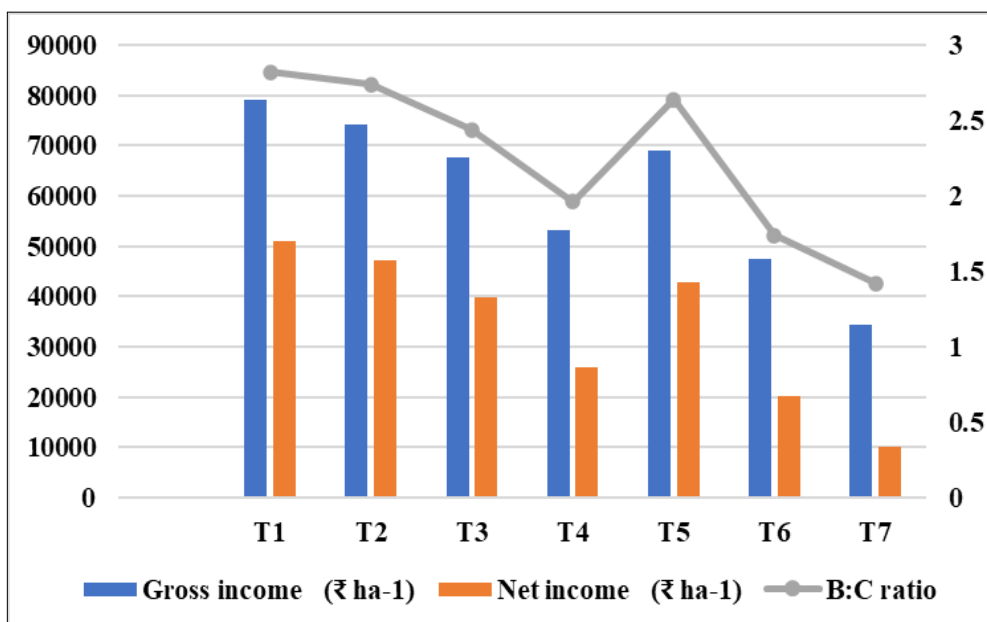


Fig. 4. Effect of foliar application of liquid organics on economics of green gram.

Discussion

Growth attributes

Plant height, number of branches per plant and dry matter production was found maximum with seaweed extract applied as foliar spray. This may result from the presence of higher amount of macro, micronutrients and phytohormones such as auxin and cytokinin. This is in conformity with earlier findings (13, 14). It was followed by foliar spray of panchakavya. Enhanced protein synthesis and growth regulators like IAA and GA_3 present in Panchagavya, which promote cell division, multiplication and enlargement, ultimately leading to longer internodes increased the growth attributes. The result is closely related to previous reports (12, 15). Absolute control recorded minimum growth attributes due to unavailability of required nutrients for plants.

Physiological attributes

Application of seaweed extract as a foliar spray have resulted in maximum LAI followed by application of panchakavya. Foliar application of seaweed extract increases the LAI of plants due to its rich content of bioactive compounds such as plant growth regulators (cytokinins, auxins and gibberellins), trace elements and polysaccharides. These compounds stimulate cell division and expansion in the leaves, promoting larger leaf size and increased surface area for photosynthesis. Additionally, the nutrients in seaweed extract enhance overall plant health and vigor, supporting better leaf development and contributing to a higher LAI. This outcome supports the previous findings (16). Similarly, presence of growth regulatory substances such as IAA, gibberellic acid and cytokinin would have resulted in maximum LAI. Similar kind of result was reported (17). Inadequate nutrient supply at absolute control resulted in minimum LAI.

Yield attributes and yield

Foliar spray of seaweed extract increases the yield attributes and overall yield of green gram due to its rich composition of essential nutrients, growth-promoting hormones and bioactive compounds. These components enhance key physiological processes such as nutrient uptake, photosynthesis and enzyme activity, resulting in improved plant growth, flowering and pod development. Additionally, seaweed extract boosts stress tolerance and root

health, leading to better nutrient assimilation. This overall improvement in plant health and growth directly contributes to increased yield attributes like number of pod, number of seeds per pod and pod length, thereby enhancing the overall yield of green gram. Comparable results were documented (14). It was followed by application of panchakavya. The easy transfer of nutrients and growth stimulants to plants through foliar spray of optimum dose of panchagavya might be the reason for enhancement in yield attributes which resulted in higher yield. This is in accordance with earlier findings (17, 18). Yield attributes and yield was minimum with absolute control.

Economics

The cost of cultivation was relatively higher with foliar spray of seaweed extract, primarily due to its higher input cost compared to other liquid organic formulations. However, the application of seaweed extract and panchagavya as a foliar spray resulted with maximum seed and haulm yield. This, in turn, led to increased gross return, net return and benefit-cost (B:C) ratio. These results are consistent with previous research findings (17, 19).

Conclusion

The present study revealed that foliar spray of seaweed extract at 3% concentration significantly improved the growth attributes, yield parameters and overall yield of green gram. Furthermore, this treatment recorded higher net returns and benefit-cost (B:C) ratio compared to other practices. These findings suggest that foliar application of seaweed extract is an effective and feasible strategy for the organic cultivation of green gram, offering both agronomic and economic benefits to farmers.

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Authors' contributions

VA had done conceptualization, supervision, funding acquisition, writing - methodology and editing. KJ had done conceptualization, data correction and writing - original draft. SK had done writing - supervision and editing. SE had done writing - methodology and supervision. SR had done writing - original draft, methodology and validation. PSR had done writing - original draft and editing. SM had done writing - methodology and editing.

Compliance with ethical standards

Conflict of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

In the preparation of this work, the author(s) utilized ChatGPT to enhance language quality and readability. Following the use of this tool, the author(s) thoroughly reviewed and edited the content as necessary and accept full responsibility for the final published material.

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