Original Research Article

Effect of Seaweed (*Gracilaria edulis*) Extract and Phosphorus on Growth and Economic of a Black gram (*Vigna mungo* L.)

ABSTRACT

A field experiment trial on black gram was conducted during *Zaid*, 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3), organic carbon (0.73%), available nitrogen (274.46 kg/ha), available phosphorus (31.10 kg/ha), and available potassium (328 kg/ha). The foliar spray was applied thrice at different concentrations (5.0, 7.5, 10, and 15.0% v/v) of seaweed extract of *Gracilaria edulis* (*G. Sap)* with different levels of phosphorus (30 and 40 kg/ha) and control plot with water spray. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. The results showed that *viz:* plant height (42.84 cm), number of branches per plant (7.07), number of nodules per plant (14.11), root dry weight (0.41 g/plant) were recorded significantly higher with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. Whereas, plant dry weight (17.55 g/plant) was recorded significantly higher with 10% *G. Sap* + Phosphorus 40 kg ha^{-1}. Also, the highest gross returns (62,716.50 INR/ha), net returns (26,259.00 INR/ha), and benefit-cost ratio (1.72) were obtained with the application of 15% *G. Sap* + Phosphorus 40 kg ha^{-1} when compared to other treatments. Thus, foliar application of seaweed extract could be a promising option for yield enhancement in black gram.

Keywords: *Seaweed extract, Phosphorus, Black gram, Growth, and Economic*

INTRODUCTION

Black gram [*Vigna mungo* L.] is very rich in protein containing about 25% in its seed and is the richest in phosphoric acid among pulses. It also acts as a cover crop and its deep root system protects the soil from erosion. Black gram being leguminous can fix atmospheric nitrogen and thus help in restoring soil fertility. Black gram is an annual, herbaceous about 30 to 100cm in height and the germination is epigeal. It is a self-pollinated crop and there would be the chance of cross-pollination due to insects. In the northern region of India, it is grown in both *Kharif* and *Zaid* seasons due to severe cold in winter, it is not grown in *Rabi*, while in eastern states of India it is grown in *Rabi* season, and in south India, it is grown in both seasons except *Rabi* season.

Saline environmental bioactive algae extracted from seaweed are currently used in food, animal supplement, as raw materials in the industry. India is striving to increase its seaweed production to 11.2 lakh tonnes by 2025, up from the current production levels of 0.25 lakh tonnes in 2021. Marine bioactive substances extracted from seaweed play a great role in a new generation of natural organic fertilizer which contains all essential nutrients, amino acids, vitamins, cytokinin, and auxin-like promoting hormone. Seaweed act as a plant nutrient-bearing fertilizer. Especially in foliar spray, as a means to avoid excessive fertilizer application and to improve mineral absorption through leaves. Using macroalgal agricultural bio-stimulants (ABs) on crop plants can generate numerous benefits with reported effects, including enhanced rooting, higher crop and fruit yields, enhanced photosynthetic activity, and resistance to fungi and bacteria viruses [10].

Application of phosphorus to pulse crop has been found very effective and called a master key element for increasing yield, it plays a vital role in the growth and development of roots and nodulation [11]. Judicious, use of phosphate fertilizer is supposed to result in better nodulation and efficient functioning of nodules bacteria for fixation of atmospheric nitrogen to be utilized by the plant during the grain development stage, which in turn leads to an increase in grain yield [4]. It plays an important role in plants' main metabolic processes, including photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis, and respiration.

MATERIALS AND METHODS

The method that was carried out for the germination test was “Top of Paper (TP) Media” at Agronomy laboratory, SHUATS, Prayagraj on 16th March 2021. Germination of black gram *var. Shekhar-2* had recorded as 86.6%. A field trial was conducted during *Zaid,* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is located at 25^{o}39”42” N latitude, 81^{o}67”56” E longitude, and 98m altitude above the mean sea level (MSL). The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorus, and low in potassium. Nutrient sources were Urea, Single Super Phosphate, and Murate of potash to fulfill the requirement of Nitrogen, Phosphorus, and Potassium. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. The treatments which are with T_1- 5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_2 - 5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_3 - 7.5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_4 - 7.5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_5 - 10% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_6 - 10% *G. Sap* + Phosphorus 40 kg ha^{-1},T_7 - 15% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_8 - 15% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_9 - Control water spray (20:40:20 NPK kg/ha). Blanket application of a recommended dose of Nitrogen and Potassium (20:0:20 NPK kg/ha). The date of sowing was 24th march 2021with the seed rate of 20kg/ha. The foliar application seaweed (*Gracilaria edulis*) extract was sprayed at 15, 30 & 45 DAS. The growth parameters of the plants were recorded at frequent intervals from germination up until harvest and finally, the yield parameters were recorded after harvest. The growth parameters such as plant height, number of branches, number of nodules, root dry weight, plant dry weight. These parameters were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design [5]. Economic analysis is also calculated according to valid data.

Fig.1. Germination test of black gram was done in the laboratory of the Department of Agronomy, SHUATS, Prayagraj.

Fig.2. The layout of the experimental field, Tilling the research plots through rake and leveling the plots through leveler at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj during *Zaid*, 2021.

Fig.3. The line sowing method was carried out manually for the sowing of black gram seeds at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj during *Zaid*, 2021.

Fig.4. Weeding, thinning, and Foliar application of *G. Sap* (15DAS) was done manually at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj during *Zaid*, 2021.

Fig.5. Black gram plant samples were uprooted at 40DAS for observation of dry matter accumulation and several nodules count.

Fig.6. Black gram root dry weight was taken off accordingly and the Threshing of matured pods from the $1m^2$ area had kept separately.

RESULTS AND DISCUSSION

Effect on the growth of black gram. As can be seen in Table 1, growth parameters are summarized statistically.

Plant height (cm). The Significantly taller plant height (42.84 cm) was recorded in T_8 with15% *G. Sap* + Phosphorus 40 kg ha^{-1}. The increase in plant height may be due to the seaweed saps which contain growth hormones like cytokinin and gibberellins that enhanced the growth of the plant. Similar results were reported that seaweed extract contains growth regulators like betaines and oligosaccharides that induced growth responses in the plants [1].

A number of branches. A significantly higher number of branches (7.07) recorded T_8 with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. Seaweed extracts contain major and minor nutrients, amino acids, vitamins, cytokinins, auxin, and abscisic acid-like growth-promoting substances and have been reported to stimulate the height, branches, nodules, and yield of plants, develop tolerance to environmental stress [12].

A number of nodules. A maximum number of nodules (14.11) recorded T_8 with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. This increase in growth parameters and yield might be due to phosphorus which is indispensable, a constituent of nucleic acid, ADP, and ATP. It has beneficial effects on nodulation, root development, growth, hastens maturity, and improves the quality of crop produce [3].

Root dry weight (g/plant). Significantly maximum root dry weight (0.41g) noted on 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. Extract of seaweed is known to contain nutrients and growth regulators such as auxins (IAA and IBA), gibberellins, cytokinins, betaines, and major macro and micronutrients. An increase in root length, root growth, number of lateral roots, and chlorophyll contents have been reported in different crops by seaweed extract application [6]

Plant dry weight (g/plant). The highest plant dry matter accumulated in T_6 with 10% *G. Sap* + Phosphorus 40 kg ha^{-1} (17.55g). The plants attained more vigor with phosphorus, due to adequate supply and availability of nitrogen, phosphorus, potassium, and spacing in balanced combination, resulting in increased dry weight of the plant. The application of Phosphorus to black gram significantly increased dry matter production. [8] noted similar results.

Crop Growth Rate (g/m^2/day). The maximum CGR recorded in T_1 with 5% *G. Sap* + Phosphorus 30 kg ha^{-1} (11.80 g/m^2/day) at 40-60 DAS. As phosphorus plays a critical in various physiological processes, including root development, nodulation, and nitrogen fixation, better utilization of growth hormones, increased parameters may have been results of soil stimulation at 40kg/ha of phosphorus. Similar results were also observed by [7] & [9].

Relative Growth Rate (g/g/day). The maximum RGR recorded in 5% *G. Sap* + Phosphorus 30 kg ha^{-1} and 7.5% *G. Sap* + Phosphorus 30 kg ha^{-1} (0.044 g/g/day) at 40-60 DAS. [2] experimented to study that the application of 40kg ha^{-1} of phosphorus with spacing 30x10cm in black gram had also shown almost similar results.

Table 1. Effect of Seaweed (*Gracilaria edulis)* Extract and Phosphorus on Growth of Black gram.

Treatment	At harvest					40-60 DAS	
	Plant height (cm)	Number of branches/ plant	Number of nodules/ plant	Root dry weight (g/plant)	Plant dry weight (g/plant)	CGR (g/m^2/day)	RGR (g/g/day)
T_1	38.05	5.87	10.77	0.23	17.04	11.80	0.044
T_2	39.27	6.07	12.78	0.29	17.13	11.66	0.042
T_3	36.36	6.27	9.78	0.23	17.18	11.84	0.044
T_4	37.61	6.27	11.44	0.32	17.47	11.73	0.042
T_5	40.60	6.13	10.78	0.26	17.19	11.64	0.042
T_6	41.24	6.60	13.44	0.36	17.55	11.63	0.041
T_7	38.55	6.13	10.77	0.31	17.39	11.75	0.042
T_8	42.84	7.07	14.11	0.41	17.49	11.63	0.041
T_9	38.05	6.00	11.66	0.24	15.92	11.66	0.042
F-test	S	S	S	S	S	NS	NS
SEm(±)	0.98	0.16	0.61	0.02	0.11	0.12	0.00
CD 5%	2.93	0.48	1.84	0.05	0.34	-	-

T_1- 5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_2 - 5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_3 - 7.5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_4 - 7.5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_5 - 10% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_6 - 10% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_7 - 15% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_8 - 15% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_9 - Control water spray (20:40:20 NPK kg/ha).

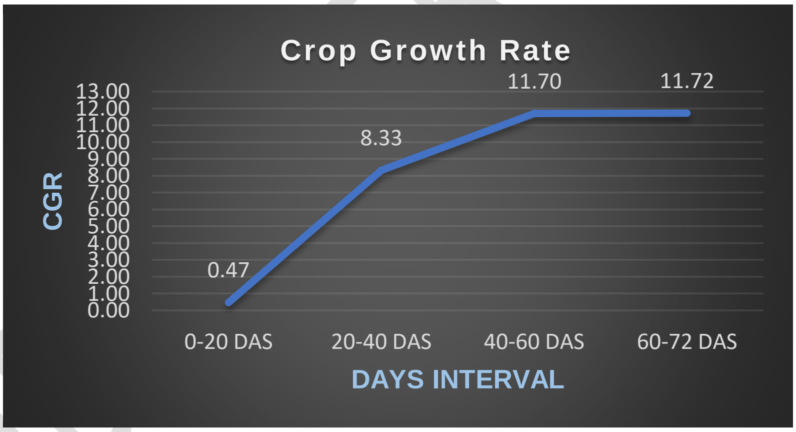

Fig.7. Crop Growth Rate

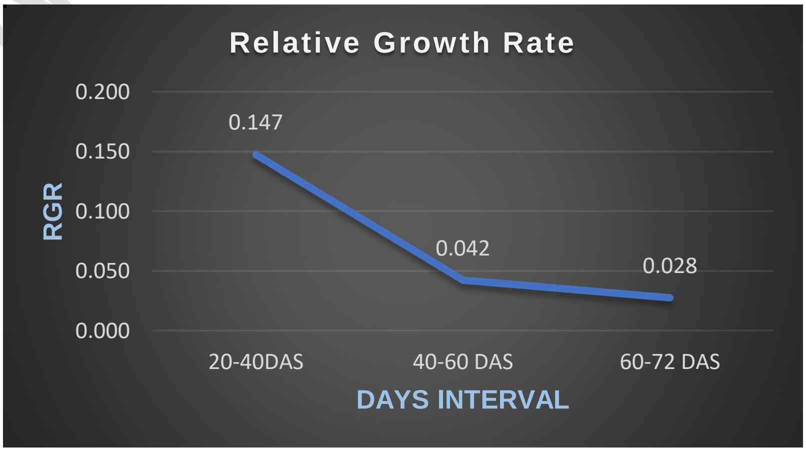

Fig.8. Relative Growth Rate

Economic analysis. As can be seen in Table 2, all the economic parameters *viz.* cost of cultivation, gross return, the net return, and B: C ratio are summarized and also maximum recorded in T_8 with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. The higher economic parameter was recorded with higher concentration and doses of treatment.

Table 2. Effect of Seaweed (*Gracilaria edulis)* Extract and Phosphorus on Economics of Black gram.

Treatment	The total cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B: C ratio
T_1	32,832.00	46,193.49	13,361.49	1.41
T_2	33,457.00	50,847.93	17,390.93	1.52
T_3	33,582.00	49,108.50	15,526.50	1.46
T_4	34,207.00	54,700.38	20,493.38	1.60
T_5	34,332.00	47,338.83	13,006.83	1.38
T_6	34,957.00	56,972.79	22,015.79	1.63
T_7	35832.00	50,234.94	14,402.94	1.40
T_8	36,457.00	62,716.50	26,259.50	1.72
T_9	31,957.00	45,568.53	13,611.53	1.43

T_1- 5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_2 - 5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_3 - 7.5% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_4 - 7.5% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_5 - 10% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_6 - 10% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_7 - 15% *G. Sap* + Phosphorus 30 kg ha^{-1}, T_8 - 15% *G. Sap* + Phosphorus 40 kg ha^{-1}, T_9 - Control water spray (20:40:20 NPK kg/ha).

*Economics not subjected to data analysis

CONCLUSION

Based on my research trail, the treatment combination of 15% *G. Sap* with phosphorus 40kg/ha was found to be more productive and also economically feasible. Although the findings are based on one season, further research is needed to confirm the findings and their recommendation.

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