Original Research Article

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

ABSTRACT

A field experiment trial on blackgram was conducted during *Zaid*, 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India. 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 ₹/ha), net returns (26,259.00 ₹/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 blackgram.

Keywords: *Seaweed extract, Phosphorus,* Blackgram*, Growth, and Economic*

INTRODUCTION

Blackgram is scientifically known as *Vigna mungo* (L.) and commonly known as Urd in India. It is a tropical leguminous plant [14]. A family leguminoceae are includes about 18,000 species, which are characterized by their pods and alternate pinnate or trifoliate leaves Grain legumes, commonly known as pulse belong to sub-family papilioniace as their flowers resemble the shape of butterfly [1]. It is popular because of its nutritional quality having rich protein (22-24%), carbohydrates (56.6-59.6%), fat (1.2-1.4%), Minerals (3.2%), phosphorous (385 mg/100g) and it is rich source of calcium and iron. It defers from other pulses in its peculiarity of attaining a somewhat mucilaginous pasty character, giving additional body to the mass due to long polymer chain of polysaccharide chain of carbohydrates. Tamil Nadu leads first in productivity with an average yield of 775 kg/ha. It contained, 24.7 % protein, 0.6 % fat, 0.9 % fibre and 3.7 % ash as well as sufficient quantity of calcium, phosphorus and important vitamins. Due to cheaper protein source of it is designated as "poor man's meat" [2].

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 [7]. 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 [15]. 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 [17].

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 [20]. 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 [6]. 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 [Fig.1]. Germination of blackgram *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), India 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 [Fig.2]. 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 2021 with the seed rate of 20kg/ha. “Line Sowing” method carried for sowing [Fig.3]. The foliar application seaweed (*Gracilaria edulis*) extract was sprayed at 15, 30 & 45 DAS [Fig.4]. 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 reading such as plant height, number of branches, number of nodules, root dry weight, plant dry weight [Fig.5&6]. These parameters were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design [8]. Economic analysis is also calculated according to valid data.

Fig.1. Germination test of blackgram 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 blackgram 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. Blackgram plant samples were uprooted at 40DAS for observation of dry matter accumulation and several nodules count.

Fig.6. Blackgram 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 and Growth attributes of blackgram. As can be seen in Table 1, growth parameters are summarized statistically.The Significantly taller plant height (42.84 cm) was recorded in T_8 with15% *G. Sap* + Phosphorus 40 kg ha^{-1}. However, 10% *G.Sap* + Phosphorus 30 kg ha^{-1} (40.60cm) and 10% *G.Sap* + Phosphorus 40 kg ha^{-1} (41.24cm) statistically at par with 15% *G.Sap* + Phosphorus 40 kg ha^{-1}. The minimum plant height (35.85cm) was recorded in the treatment combination 7.5% *G.Sap* + Phosphorus 30 kg ha^{-1}. A significantly higher number of branches (7.07) recorded T_8 with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. However, 10% *G.Sap* + Phosphorus 40 kg ha^{-1} (6.60) statistically at par with 15% *G.Sap* + Phosphorus 40 kg ha^{-1}. The minimum number of branches (5.87) were recorded in the treatment combination 5% *G.Sap* + Phosphorus 30 kg ha^{-1}. A maximum number of nodules (14.11) recorded T_8 with 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. However, 5% *G.Sap* + Phosphorus 40 kg ha^{-1} (12.78), 10% *G.Sap* + Phosphorus 40 kg ha^{-1}(13.44) statistically at par with 15% *G.Sap* + Phosphorus 40 kg ha^{-1}. Significantly maximum root dry weight (0.41g) noted on 15% *G. Sap* + Phosphorus 40 kg ha^{-1}. However, 10% *G.Sap* + Phosphorus 40 kg ha^{-1} (0.36) statistically at par with 15% *G.Sap* + Phosphorus 40 kg ha^{-1}. The minimum root dry weight (0.23 g/plant) was recorded with application of 5% *G.Sap* + Phosphorus 30 kg ha^{-1} and 7.5% *G.Sap* + Phosphorus 30 kg ha^{-1}. The highest plant dry matter accumulated in T_6 with 10% *G. Sap* + Phosphorus 40 kg ha^{-1} (17.55g). However, 7.5% *G.Sap* + Phosphorus 40 kg ha^{-1} (17.47), 15% *G.Sap* + Phosphorus 30 kg ha^{-1} (17.39) and 15% *G.Sap* + Phosphorus 40 kg ha^{-1} (17.49) statistically at par with 15% *G.Sap* + Phosphorus 40 kg ha^{-1}. The minimum plant dry weight (17.16) was recorded with application of 5% *G.Sap* + Phosphorus 30 kg ha^{-1}. There was no significant difference in crop growth rate among the treatments at 40-60 DAS. maximum Crop growth rate (11.84 g/m^2/day) were recorded in the treatment combination 7.5% *G.Sap* + Phosphorus 30 kg ha^{-1} [Fig.7]. However, lowest (11.63 g/m^2/day) was observed in 15 % *G.Sap* + Phosphorus 40 kg ha^{-1}. There was no significant difference in relative growth rate among the treatments at 40-60 DAS interval. The maximum relative growth rate were recorded in the treatment combination of 5% *G.Sap* + Phosphorus 30 kg ha^{-1} and 10% *G.Sap* + Phosphorus 30 kg ha^{-1} which is 0.044 [Fig.8]. The minimum Relative growth rate were recorded in the treatment combination of 10% *G.Sap* + Phosphorus 30 kg ha^{-1} and 10% *G.Sap* + Phosphorus 40 kg ha^{-1} which is 0.041. The results demonstate that 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 [3].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 [19].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 [5]. 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 [9]. Maize dry matter accumulation significantly increased by increasing concentration of

Kappaphycus alvarezii (*K.sap*) and *Gracilaria edulis* (*G.sap*) extract (Singh *et al.,* 2015) [18]. 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 blackgram significantly increased dry matter production. [11] noted similar results. 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 [10] & [16]. [4] experimented to study that the application of 40kg ha^{-1} of phosphorus with spacing 30x10cm in blackgram had also shown almost similar results.

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

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).

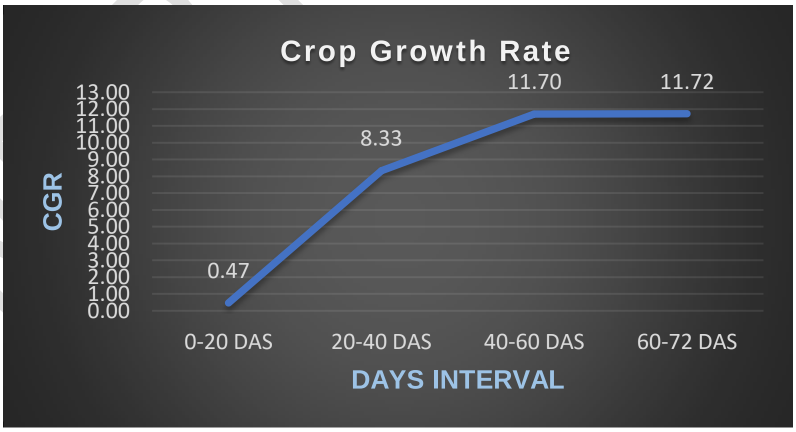

Fig.7. Crop Growth Rate

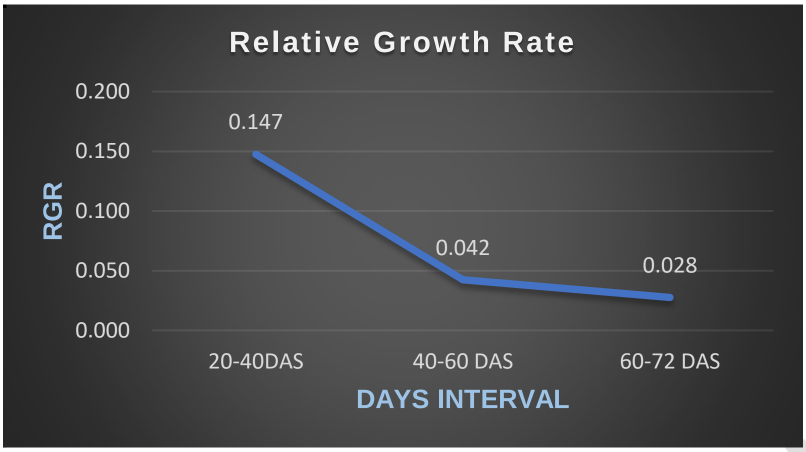

Fig.8. Relative Growth Rate

Economic analysis of blackgram. 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. Cost of cultivation (₹ 36,457.00/ha) was found to be highest in 15% *G.Sap* + Phosphorus 40 kg ha^{-1} and the minimum cost of cultivation (₹ 31,957.00/ha) was found to be in treatment with Control plot with water spray (20:40:20 NPK kg/ha) as compared to other treatments. The maximum gross return was observed in the treatment combination of blackgram was 15% *G.Sap* + Phosphorus 40 kg ha^{-1} (₹ 62,716.50/ha). The maximum net return was observed in the treatment combination of blackgram was 15% *G.Sap* + Phosphorus 40 kg ha^{-1} (₹ 26,259.50/ha). The maximum benefit cost ratio was observed in the treatment combination of blackgram was 15% *G.Sap* + Phosphorus 40 kg ha^{-1} (1.72).The higher economic parameter was recorded with higher concentration and doses of treatment. Application of seaweed extracts and RDF increased the gross and net returns as compared to sole RDF application of control plot. These results are in accordance with earlier findings of (Narendra *et al*., 2018) [12] and (Nayak *et al*., 2020) [13].

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

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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DECLARATION

Authors have declared that no competing interests exit.

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