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EFFECT OF NUTRIENT LEVELS AND SEAWEED SAP ON GROWTH AND YIELD OF BLACK GRAM (*Vigna mungo* L.)

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ABSTRACT
A field experiment was conducted during Kharif season 2019 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.) India. To evaluate the effect of Nutrient levels and Seaweed sap on growth and yield of Black gram. Foliar spray of Seaweed sap in different concentrations *i.e.* 2.5, 5, 7.5, 10 and 15% at 20 and 40 Days after sowing along with 100 and 75% RDF. The growth attributes which was plant height (59.42 cm), dry weight (14.68 gm plant-1), nodule count (26.44 number plant-1), number of branches (5.33 plant-1) were significantly increased with increasing concentration from 2.5 to 15%, maximum was obtained with 15% *Kappaphycus alvarezii* seaweed sap. Significantly highest Seed yield, net returns and benefit: cost ratio was obtained with 100% RDF + 5% K-sap (1110.31 kg/ha, 80052.62 Rs/ha, 2.38) and 75% RDF + 7.5% K-sap (1066.80 kg/ha, 75608.05 Rs/ha, 2.24). Application of 75% RDF + 7.5% K-Sap we can reduce the 25% recommended dose of fertilizers. By this we can reduce the soil pollution besides this it Produces significantly higher seed yield (26.51%) and higher net returns (34.14%) over control respectively.

INTRODUCTION

Black gram (*Vigna mungo*) is most extensively grown crop in India. Generally, it is consumed in the form of "Dal or Germinated seed". Urd is a chief constituent of "papad, idly and dosa". In 100 grams of raw matured seeds contain an energy of 341 Kcal, Carbohydrates 58.99 grams, Protein 25.21 grams, Fat 1.64 grams, Dietary fiber 18.3 grams (U. S. Department of Agriculture). It fixes Atmospheric Nitrogen through symbiotic Nitrogen fixation with the help of Rhizobium bacteria. It is a deep-rooted crop so it helps to retain drought and controls the soil erosion. In India Black gram is grown in 40.70 lakh ha area and with a production of 19.01 lakh tones (DES 2017-2018). Seaweed is a macroalgae that grow in the ocean as well as in rivers, lakes and other water bodies. Seaweed extracts contain major (N, P, K) and minor (Zn, Mn, Mg, Fe *etc.*,) nutrients, amino acids, vitamins, cytokinin's, auxin, abscisic acid like growth promoting substances and have been reported to stimulate the growth and yield of plants, develop tolerance to environmental stress (Zhang *et al*., 2003). In India as well as in other parts of the world seaweed products have been utilized as manure (Thivy, 1960).

According to world health organization (WHO) minimum requirement of pulses is 80 gm/ capita/ day but availability of pulses is very less. This is because of inadequate plant stand, heavy flower drops and immature pod abscission leading to poor seed setting besides unfavorable environment, water and nutrient deficiencies at critical periods.

Therefore, solution is to develop a method by which improve vegetative growth, flowering, pod filling, nutrient content of seed with maintaining the sustainability. Application of Seaweed (*Kappaphycus alvarezii*) improved productivity and quality of crop without impairing the soil fertility (Layak *et al.,* 2015; Rathore *et al*., 2009; Prasad *et al*., 2010; Zodape *et al*., 2010; Shah *et al*., 2013; Mondle *et al*., 2015). Considering the above points, this experiment was conducted to study the effect of nutrient levels and seaweed sap spray on growth and yield of Black gram (*Vigna mungo* L.) and to find out the economics of different treatment combinations.

MATERIALS AND METHODS

The experiment was conducted during Kharif season 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25º 39' 42''N latitude, 81º67'56" E longitude and 98 m altitude above the mean sea level (MSL). To study the Effect of nutrient levels and Seaweed sap on growth and yield Black gram (*Vigna mungo* L.)". Black gram crop requires about 650 mm annual rainfall, optimum temperature for better growth 25-350c during crop period for optimum production. The soil of experimental plot was sandy loam in texture, neutral in soil reaction (pH 7.3), low in organic carbon (0.487), medium in available N (219 kg/ ha), high in P (19.3 kg/ ha) and low in K (238.1 kg /ha).

The experiment was laid out in randomized block design replicated thrice. A total of 12 treatments comprises of *Kappaphycus alvarezii* (K-Sap) which was applied at 5 different concentrations (2.5, 5, 7.5, 10 and 15%) in combination with

100% recommended dose of fertilizer and 75% recommended dose of fertilizers.

Foliar spraying of *Kappaphycus alvarezii* was done at 20 and 40 Days after sowing. The total spray volume at first spray was 500 and 550 liters/ha at second spray. Chemical composition of *Kappaphycus alvarezii* was given in Table 1.

Data courtesy

National Institute of Nutrition, Hyderabad, India (except growth hormone data generated by CSMCRI using quantitative MS-MS and LC-MS techniques (Singh *et al*., 2015)

Crop management

The Black gram variety Shekar-2 (KU300) sown at the rate 20 kg/ha with a spacing of 30 cm × 10 cm. The fertilizer (recommended dose N: P_2O_5: K_2O 15: 30: 15 kg/ha) sources N (15 kg/ha) as urea and P_2O_5(30 kg/ha) as Di ammonium phosphate (DAP) while K_2O (15 kg/ha) was applied as Murate of Potash (MOP) at the time of sowing in all the treatments. Hand weeding was done twice at 20 and 40 days after sowing. Spraying of dimethoate @30% EC 500 ml ha^{-1} to control whiteflies. No irrigations were given to the crop during crop growth period, because the crop received required rainfall during the crop growth.

Plant analysis

Plant protection measures were followed as per recommendation for the region. Five random plants were selected from each plot to record pre and post harvest observations of black gram. The economic analysis *viz*., cost of cultivation, gross income, net income and B:C ratio was worked out at the prevailing market prices of the inputs and outputs at the time of harvest.

Statistical analysis

Experimental data collected was subjected to statistical analysis by adopting Fisher's method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (1984). Critical Difference (CD) values were calculated whenever the 'F' test was found significant at 5 per cent level.

RESULTS AND DISCUSSION

Effect of Nutrient levels and Seaweed sap on growth attributes of the Black gram

Growth attributes

The results on growth attributes *i.e.* plant height, number of branches/plant, nodules/plant and dry matter accumulation are presented in table 2 and 3.

In the present investigation plant height was increased with crop age and maximum was obtained at 60 DAS. Plant height was increased with increasing concentrations of seaweed sap from 2.5% to 15% K-sap. At 15 DAS there was no significant difference among the treatments was found. Whereas at 30, 45 and 60 DAS followed the same trend. Maximum plant height was recorded with application of 100% RDF + 15% K-sap (59.42 cm), which was significantly superior over control *i.e.* 100% RDF + water spray (48.13 cm) and 75% (RDF) + water spray (47.15 cm). Whereas all other treatments are at par with each other. Plant height was 19 and 20.64% higher than the control. This result was supported by Sathapathy *et al*., 2014. Significantly highest plant height is due to the seaweed extract contains major and minor nutrients, amino acids, vitamins, cytokinin's, auxin and abscisic acid like growth promoting substances (Mooney and Van Staden, 1986). Similar results were observed by Pramanick *et al*., 2014; Lodhi *et al*., 2015; Pramanick *et al*.,2016.

Number of branches was increased with crop age up to 60 DAS and maximum was obtained at 60 DAS. At 30 DAS there

Table 1: Chemical composition of *Kappaphycus alvarezii* sap

Constituents	Amount in mg/lit
Indole 3-acetic acid IAA	27
Zeatin	20
Gibberellin (GA3)	24
Choline	57
Glycine betaine	79
Betaine aldehyde	Present
Na^+	198
K^+	33654
Ca^{2+}	321
Mg^{2+}	1112
Zn^{2+}	4.7
Mn^{2+}	2.1
Fe^{2+}	86
Cr^{3+}	32
Cu^{2+}	0.65
Ni^{3+}	3.5
P^{3+}	17

Table 2: Effect of nutrient levels and Seaweed sap on Plant height, Number of branches and Nodules/plant

Treatment	Plant height (cm)				Branches/plant (No.)			Nodules/plant (No.)			
	15DAS	30DAS	45DAS	60DAS	30DAS	45DAS	60DAS	15DAS	30DAS	45DAS	60DAS
100% RDF + Water spray	11.69	23.69	40.16	48.43	2.87	4.2	4.47	15.33	27	28.11	19.89
75% RDF + Water spray	11.58	24.12	39.97	47.15	2.73	3.69	4.27	14.11	24.89	26.56	19.44
75% RDF + 2.5% K-sap	11.71	24.86	42.67	50.94	2.67	5.33	5.2	13.22	25.3	28.78	17.89
75% RDF + 5% K-sap	11.73	25.79	44.83	52.33	2.87	5.13	4.93	16.33	28.67	29.22	23.11
75% RDF + 7.5% K-sap	11.71	25.69	46.24	53.77	2.93	4.87	5.27	15.67	31.89	29.22	24.67
75% RDF + 10% K-sap	12.77	26.93	46.84	52.28	3	5	5.13	13.56	29	26.22	21.44
75% RDF + 15% K-sap	11.64	25.25	46.81	53.6	2.6	5.47	5.53	16.22	31.78	30.67	25.56
100% RD F+ 2.5% K-sap	11.79	25.47	45.57	52.7	2.73	5.33	5.47	11.67	31.22	31.22	22.67
100% RDF + 5% K-sap	11.89	26.55	45.73	52.06	3	5.07	5	9.33	31.56	30.56	22.44
100% RDF + 7.5% K-sap	11.67	27.3	46	54.39	2.73	5	5.4	15.22	29.89	28.89	24.89
100% RDF + 10% K-sap	11.85	27.55	48.23	56.77	2.93	5.4	5.13	12.78	33	31.11	23.11
100% RDF + 15% K-sap	11.65	27.69	48.63	59.42	2.67	5.4	5.33	12.44	32.67	35.11	26.44
SEm (±)	0.41	1	2.47	3.16	0.16	0.4	0.38	2.85	2.62	2.11	1.87
CD (P=0.05)	NS	2.93	7.26	9.25	NS	1.19	1.12	NS	7.68	6.19	5.47

Table 3: Effect of nutrient levels and Seaweed sap on plant dry weight (gm/plant) in Black gram

Treatments	15 DAS	30 DAS	45 DAS	60 DAS
100% RDF + Water spray	0.45	1.74	7.3	8.03
75% RDF + Water spray	0.42	1.64	6.74	7.92
75% RDF + 2.5% K-sap	0.47	1.93	7.77	8.24
75% RDF + 5% K-sap	0.47	2.19	12.58	12.24
75% RDF + 7.5% K-sap	0.49	2.16	9.74	10.45
75% RDF + 10% K-sap	0.5	2.21	8.3	10.22
75% RDF + 15% K-sap	0.52	2.72	8.34	11.46
100% RD F+ 2.5% K-sap	0.5	2.41	12.37	11.78
100% RDF + 5% K-sap	0.48	2.47	8.63	11.13
100% RDF + 7.5% K-sap	0.49	2.42	8.83	13.82
100% RDF + 10% K-sap	0.55	2.69	8.49	12.39
100% RDF + 15% K-sap	0.6	2.86	9.49	14.68
SEm (±)	0.08	0.3	1.48	1.94
CD (P=0.05)	NS	0.89	4.34	5.68

was no significant difference among the treatments was found. Whereas at 45 and 60 DAS followed the same trend. These days application of K-sap in Black gram significantly enhanced the number of branches over the control. At 45 and 60 DAS significantly highest number of branches was recorded in 75% RDF + 15% K-sap (5.53) over the control *i.e.* 100% RDF + water spray (4.47) and 75% RDF + water spray (4.27). However, this was closely followed by 100% RDF + 15% K-sap (5.33). The percent increase of number of branches/plant over control was 19.16% and 22.78%. Whereas all other treatments are statistically at par with each other. Increased in number of branches/plant was due to the beneficial effect of seaweed extract on growth of plants due to the seaweed extract contain nutrients, growth regulators such as auxins (IAA, IBA), gibberellins, cytokinin's. Increase in number of branches were also found in Black gram (Ganesh *et al*., 2015; Rathore *et al*., 2009).

Foliar application of K-sap with nutrient levels significantly influenced the nodule count. Nodule count was increased with increasing crop age up to 45 DAS and there after it was declined at 60DAS. At 15 DAS, there was no significance difference among the treatments was found. At 30, 45 and 60 DAS significantly enhanced the number of nodules per plant over the control. Maximum nodules per plant was recorded with the application of 100% RDF + 15% K-sap (26.44), which was significantly superior over control *i.e.* 100% RDF + water spray (19.89), 75% RDF + water spray (19.44) and 75% RDF + 2.5% K-sap (17.89). Whereas remaining all are statistically at par with each other. The increased in effective root nodules per plant might be due to increased activity of rhizobia in soil due to application of foliar spray of *Kappaphycus alvarezii* at 20 and 40 DAS and due to increase in chlorophyll content in leaves, thereby increasing photosynthetic efficiency through foliar spray of *Kappaphycus alvarezii*. These results are in agreement with pramanick *et al*., 2018.

Plant Dry weight

Present study revealed that dry weight of plants was increased with increasing age of crop and maximum was obtained with increasing age of crop.

At 15 DAS, there was no significance difference among the treatments. At 30, 45 and 60 DAS fallowed the similar trend. Maximum dry matter accumulation was recorded with the application of 100% RDF + 15% K-sap (14.68 g/plant), which was significantly superior over control *i.e.* 100% RDF + water spray (8.03 g/plant) and 75% RDF + water spray (7.92 g/plant). Whereas rest of the treatments are statistically at par with each other.

Increased in dry matter might be due to foliar application of seaweed sap that improved the nutrient mobilization, partitioning in increase leaf area, dry matter production and crop growth rate (Zodape *et al*., 2009). The enhanced vegetative growth of Black gram plants was due to the seaweed sap spray this might be attributed by the presence of plant growth hormones like cytokinin's in them which promote cell division and cell enlargement (Bluden *et al*., 1979; Crouch *et al*., 1990; Crouch and Van Staden 1993; Mondal *et al*., 2015).

Yield attributes

No. of pods/ plant, maximum was obtained with the application of 100% RDF + 5% K-sap (37.47) which was significantly superior over 100% RDF+ water (32.27) and 75% RDF + water spray (31.27), whereas all other treatments are at par with each other.

No. of seeds/pod, maximum was obtained with the application of 100% RDF + 10% K-sap (7.33) and minimum was recorded in the 75% RDF + water spray (4.67). There is no significance difference among the treatments.

Test weight (gm), maximum was recorded with the application of 100% RDF + 5% K-sap (34.73 g/1000 seed) which was significantly superior over 100% RDF + water spray (28.90 g), 75% RDF + water spray (28.33 g) and 75% RDF + 2.5% K-sap (28.90 g). Whereas all other treatments are at par with each other. In 100% RDF + 5% K-sap recorded 16.78 and 18.42% higher seed weight when compared with the control treatments

Seed yield (Kg/ha) when compared the overall treatments maximum seed yield was obtained in 100% RDF + 5% K-sap (1110.30 Kg/ha), which was significantly superior over the control treatments *i.e.* 100% RDF + water spray (800.02 Kg/ha) and 75% RDF + water spray (783.94 Kg/ha). But when compared the 100 and 75% RDF treated plots separately, in 100% RDF +K-sap treated plots maximum seed yield was obtained in 100% RDF + 5% K-sap (1110.30 Kg/ha), which was significantly superior over the control 100% RDF + water spray (800.02 Kg/ha) and in 75% RDF treated plots highest seed yield was obtained in 75% RDF + 7.5% K-sap (1066 Kg/ha) which was significantly superior over control i.e. 75% RDF + water spray (783.94 Kg/ha). Seed yield was increased with increasing concentration from 2.5% K-sap to 7.5% then it was declined in 75% RDF and in 100% RDF it was increased up to 5% then again, the yield was in decreasing manner, But up to 10% the yield was significantly higher than the control in 75% RDF + seaweed extract treated plots and up to 7.5% in 100% RDF + seaweed extract treated plots.

Stover yield (kg/ha), maximum was obtained with application of 100% RDF + 15% K-sap (3969.71 kg/ha) which was significantly superior over 100% RDF + water spray (2882.92 kg/ha) and 75% RDF + water spray (2586.64 kg/ha). Whereas all other treatments are at par with each other. Stover yield was increased with increasing concentration. Harvest Index (%), maximum was obtained with the application of 100% RDF +

Table 4: Effect of nutrient levels and Seaweed sap on yield attributes and yield of Black gram

TREATMENTS	No of Pods/plant	No of Seeds/pod	1000 Seed weight	Seed yield kg/ha	Stover yield kg/ha	Harvest index
100% RDF + Water spray	32.27	5	28.9	800.02	2882.92	21.88
75% RDF + Water spray	31.27	4.67	28.33	783.94	2586.64	23.64
75% RDF + 2.5% K-sap	34.87	5.67	28.9	866.17	3369.52	20.38
75% RDF + 5% K-sap	35.13	5.33	33.03	960.53	3465.41	21.68
75% RDF + 7.5% K-sap	36.93	6.33	34.33	1066.8	3524.38	23.52
75% RDF + 10% K-sap	35.03	5.33	33.1	991.49	3782.15	20.79
75% RDF + 15% K-sap	35.6	6	30.4	870.26	3777.26	18.49
100% RD F+ 2.5% K-sap	35.13	6.33	30.5	878.06	3397.39	21.03
100% RDF + 5% K-sap	37.47	6.67	34.73	1110.31	3461.21	24.17
100% RDF + 7.5% K-sap	36.67	5.67	31.43	931.39	3704.8	20.26
100% RDF + 10% K-sap	35.2	7.33	30.4	772.76	3733.97	17.32
100% RDF + 15% K-sap	35.53	6.33	30.33	748.84	3969.71	15.88
SEm (±)	1.4	1.12	1.66	78.49	266.12	1.68
CD (P=0.05)	4.04	NS	4.87	230.21	780.5	4.94

Table 5: Effect of Nutrient levels and Seaweed sap on economics of Black gram

Treatment	Cost of cultiv ation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
100% RDF + Water spray	31224.12	82164.19	50940.07	1.63
75% RDF + Water spray	30540.4	80334.32	49793.92	1.63
75% RDF + 2.5% K-sap	32065.4	89143.98	57078.58	1.78
75% RDF + 5% K-sap	32890.4	98651.72	65761.32	2
75% RDF + 7.5% K-sap	33715.4	109323.5	75608.05	2.24
75% RDF + 10% K-sap	34540.4	101985.5	67445.05	1.95
75% RDF + 15% K-sap	36190.4	89859.28	53668.88	1.48
100% RD F+ 2.5% K-sap	32749.12	90354.38	57605.26	1.76
100% RDF + 5% K-sap	33574.12	113626.7	80052.62	2.38
100% RDF + 7.5% K-sap	34399.12	95917.1	61517.98	1.79
100% RDF + 10% K-sap	35224.12	80076.81	44852.69	1.27
100% RDF + 15% K-sap	36874.12	77861.62	40987.5	1.11
SEm (±)	-	7903.45	7903.446	0.23
CD (P=0.05)	-	23180.01	23180.01	0.68

5% K-sap (24.17%) and minimum was obtained with application of 100% RDF + 15% K-sap (15.88%). There is no significant difference among the treatments.

This might be due to nutrient supply through seaweed sap foliar spray and supply of all nutrients, plant growth regulators, cytokinin's, auxins, gibberellins ext. at vegetative and flowering stages of crop growth. Which might be responsible for beneficial effects in the study. Singh *et al.* (2015) while working with maize, also observed that yield increased with increasing concentration of K sap up to (7.5%) and G sap up to (5%) and in higher concentration (above 7.5% K sap and 5% G sap) it decreased the yield attributes which might be due to the spraying of seaweed extract on critical growth stages which was effectively utilized by the crop and expressed higher growth and yield.

Economics

Data pertaining to economic aspect of black gram cultivation have been presented in Table 4.9. It is clear from the data that economics of Black gram was significantly influenced by nutrient levels and seaweed sap application.

Cost of cultivation

Data pertaining to cost of cultivation revealed that higher cost of cultivation was obtained with 100% RDF + 15% K-sap spray (Rs.36874.12/ha) while the minimum cost of cultivation (Rs. 31224.12/ha and 30540.40/ha) was found in control (100% and 75% RDF). In both the levels of cost of cultivation was increased with increasing concentration of seaweed sap.

Gross return

It is found that foliar application of seaweed sap has significant effect on gross return of Black gram. When compared the overall treatments Black gram crop treated with 100% RDF + 5% K-sap generate maximum and significantly higher gross return (Rs.113626.74/ha) and minimum was observed in 75% RDF + water spray (Rs. 80334.32/ha) and 100% RDF + water spray (82164.19/ha). And in 75% RDF + K-sap treated plots highest gross returns obtained in 75% RDF + 7.5% K-sap (Rs. 109323.45/ha) which was significantly superior over control treatments and 2.5 and 15% K-sap treated plots in 75% RDF level and in 2.5, 10 and 15% K-sap treated plots in 100% RDF level. There is an increase of 27.68% gross returns in 100% RDF + 5% K-sap over control (100% RDF + water spray) and 26.51% increase in 75% RDF + 7.5% K-sap treated plot over control (75% RDF + water spray).

Net returns

The maximum net returns obtained in 100% RDF + 5% K-sap (Rs.80052.62/ha) when compared the overall treatments, which was significantly superior over control treatments 75% RDF + water spray (Rs.49793.92/ha) and 100% RDF + water spray (Rs. 50940.07/ha). When come to the 75% RDF treated plots highest net returns observed in 75% RDF + 7.5% K-sap (Rs.75608.05/ha) which was significantly superior over control

Benefit-cost ratio

The maximum B:C ratio obtained in 100% RDF + 5% K-sap (2.38) when compared the overall treatments, which was significantly superior over control treatments 75% RDF + water spray (1.63) and 100% RDF + water spray (1.63). When come to the 75% RDF treated plots highest B:C ratio observed in 75% RDF + 7.5% K-sap (2.24) which was significantly superior over control *i.e.* 75% RDF + water spray (1.63). There is an increase of 31.51% in 100% RDF + 5% K-sap over the control treatments (100% RDF + water spray and 75% RDF + water spray and 27.23% increased the B:C ratio in 75% RDF + 7.5% K-sap over control (75% RDF + water spray).

Economics of this study revealed that gross returns, net returns and B:C ratio was increased significantly with increasing concentration up to 5% in 100% RDF level and up to 7.5% in 75% RDF but significantly highest was obtained up to 7.5% in 100% RDF level and up to 10% in 75% RDF level. Similar results were also found by Sathapathy *et al*. (2014) and Singh *et al*. (2015).

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