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Influence of seaweed saps on growth, yield and quality of greengram

■ N. Leindah Devi **and** S. Mani

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MEMBERS OF RESEARCH FORUM:

Corresponding author :
N. Leindah Devi, Department of Soil Science and Agricultural Chemistry, Central Agricultural University, **Iroisemba (Manipur) India**
Email: leindahnong@gmail.com

Co-authors :
S. Mani, Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University **Coimbatore (T.N.) India**
Email: smanierode@rediffmail.com

Summary

Effect of seaweed saps of two red algae *Kappaphycus alvarezii* and *Glacilaria* spp. on greengram (Co.6) were studied in pot culture. The seaweeds were given with foliar spray twice at 30 DAS (days after sowing) and 45 DAS. Significant changes in plant growth, yield and quality were observed in the plants that received seaweed foliar spray. Treatment with 100%RDF and 15% seaweed extracts of *Kappaphycus alvarezii* improved the yield by17.2% over the control and 14.1 % increased with100% RDF and 15% seaweed extracts of *Glacilaria* spp. Thus, foliar application of seaweed extract could be a promising option for yield enhancement in greengram.

Key words : Plant growth, Yield, Seaweeds, Greengram

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Introduction

In advancement of agriculture system, it is important to have improvements which result in higher production, reducing the environmental burden and enhance the sustainability of the system. There is growing concern that environmental pollution caused by imbalanced use and misuse of chemical fertilizers and pesticides that are directly or indirectly related to human health problems. Consequently, there is in need for farmers shift from chemical-based conventional farming methods to organic, alternative or low input sustainable agriculture. Seaweeds are biostimulants, which can enhance the effectiveness of conventional mineral fertilizers. Seaweed liquid extracts had gained importance as foliar spray. Seaweed extracts contain all essential nutrients, amino acids, vitamins, cytokinins and auxins like growth promoting substances and have been reported to stimulate the growth, yield, tolerance to biotic and abiotic stress, increase nutrient uptake from soil and enhance antioxidant properties (Chapman and Chapman, 1980). Seaweed extracts are new generation of natural organic fertilizer containing highly effective, nutritious and promotes faster generation of seeds, increasing yield and resistant ability of many crops (Kumar and Sahoo, 2011). Increase in demand on agricultural production due to the growing population has imposed higher fertilizer needs to great extent in order to achieve higher yield. The seaweed extracts contain plant growth hormone such as auxins, gibberellins and other growth promoters, carbohydrates, amino acids, antibiotics and vitamins thereby enhance the yield and quality of the produce that induce seed germination, resistance to frost, fungal and insect attacks (Erulan *et al.*, 2009). Though the beneficial effect of seaweed extract application is well documented as a

result of many components that may work synergistically at different concentrations, the mode of its action still remains unknown (Fornes *et al.,* 2002). Use of seaweed extracts has gained recognition due to their potential use in organic and sustainable agriculture to avoid excessive fertilizer applications and to improve mineral absorption (Russo and Beryln, 1991). Keeping these in view, this experiment was carried out to study the effect of seaweed saps on growth, yield and quality of greengram.

Resource and Research Methods

Experimental sites and treatment details:

For the present study pot experiment of greengram (var. Co. 6) was conducted under green house condition at Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore, Tamil Nadu. The experimental soils were brought from the field of Eastern Block, TNAU, Coimbatore. The experimental soil type was found to be sandy clay loam with medium in organic carbon content 0.66 per cent. Nitrogen content was low (176.4 kg ha^{-1}), medium in P_2O_5 (11.46kg ha^{-1}) and low in K_2O (264.2 kg ha^{-1}). The variety of greengram Co.6 was used for study and three seeds were sown in each pot. Recommended dose of fertilizer of 25:50:25 kg N, P_2O_5 and K_2O ha^{-1} in the form of urea, single super phosphate and muriate of potash were applied in the soil. Experiment was laid out in a Completely Randomized Block Design with three replications. The seaweed extracts used in this study were obtained from red algae such as *Kappaphycus alvarezii* (Doty) ex *P. silva* belonging to the family Solieraceae and *Glacilaria edulis* (*S. gmelin*) *P. silva* belonging to the family Gracilariaceae. The seaweed saps were collected from the Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavanagar, Gujarat, India. Seaweed extracts of *Kappaphycus alvarezii* (K sap) and *Glacilaria edulis* (G sap) were applied at different concentrations *viz.*, 2.5 per cent, 5.0 per cent, 6.5 per cent, 7.5 per cent, 10.0 per cent and 15.0 per cent for two times at 30 and 45 days after sowing (DAS). Details of treatments are given below:

T_1: 100% Recommended dose of fertilizer (RDF)
T_2: 100% RDF+ water spray
T_3: 50% RDF+ 7.5% *Kappaphycus* sap (K sap)
T_4: 100% RDF+2.5% K sap
T_5: 100% RDF+5% K sap
T_6: 100% RDF+10% K sap
T_7: 100% RDF+ 15% K sap
T_8: 100% RDF+ 2.5% *Gracilaria* sap (G sap)
T_9: 100% RDF+5% G sap
T_{10}: 100% RDF+ 10% G sap
T_{11}: 100% RDF+15% G sap
T_{12}: 50% RDF+7.5% G sap.

Observations:

Plant height was measured at 15, 30, 45 DAS and at harvest of the crop. Number of pods per plant, pod length, number of seeds per pod and test weight were recorded. Dry matter production, grain yield and haulm yield were determined at the time of harvest. Greengram gains were used for analysing quality parameters. Total carbohydrate in greengram grain sample were estimated by Anthrone method (Clegg, 1956). Crude protein was estimated from total N content in grains and was estimated by micro-Kjeldhal method (Humphries, 1956), then multiplied by the factor 6.25 to obtain the crude protein content and expressed in percentage (%) (Doubetz and Wells, 1968).

Statistical analysis:

All the data of observations recorded in the experiments were statistically analysed and the critical differences (CD) were worked out at 5 per cent probability level (Panse and Sukhatme, 1985).

Research Findings and Discussion

Plant growth and yield attributes, yield of grains, dray matter production of crop and quality of greengram were significantly influenced by foliar application of seaweed saps.

Influence of seaweed saps on crop growth and yield of greengram:

Foliar application of seaweed saps had significantly influenced on the growth and yield of greengram such as number of pods per plant, pod length, number of seeds per pod, test weight, seed yield and haulm yield. Results reveals that maximum plant growth and yield attributes were obtained in 15 per cent K sap with 100 per cent RDF which was followed by foliar application of 15 per cent G sap with 100 per cent RDF in all growth stages. Plant height of greengram crop that received 100 per cent RDF+15 % K sap (T_7) recorded the highest with a height of 10.1, 18.8, 37.6 and 57.1 cm at 15, 30, 45 DAS and at harvest stage, respectively (Table 1). This was followed by 100% RDF+10% G sap (T_{11}) that recorded with a plant height of 9.32, 18.6, 31.2 and 50.0 cm at 15,

30, 45 DAS and at harvest stage correspondingly. Similar finding was reported that plant height were increased by foliar application 15 pe cent of *Kappaphycus alvarezii* with RDF and 15 per cent *Graciliaria* sp. on rice (Leindah and Mani, 2015). The increased 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 contain growth regulators like betaines and oligosaccharides that induced growth responses in plant (Balakrishnan *et al.*, 2007). This was also supported that seaweed extract *Caulerpara cemosa* contains phytol, squalene, β stigmasterol and stigmastan compounds that greatly accelerate growth attributes thereby increase in yield (Leindah and Mani, 2015). Minimum plant height was found in T_3 (50% RDF + 7.5% K sap) with 6.40, 15.7, 25.2 and 31.8 cm at all the growth stages, respectively which was at par with T_{12} (50% RDF+7.5% K sap) with 6.40, 15.0, 23.1 and 31.0 cm, respectively.

Maximum number of branches per plant was recorded in T_7 (100% RDF+15% K sap) with 5.8 which

Table 1: Effect of seaweed saps on plant height (cm) at different growth stages of greengram

Treatments	15 DAS	30 DAS	45 DAS	Harvest
T_1: 100% RDF	7.31	15.9	26.9	34.7
T_2: RDF+ water spray	7.32	16.3	29.1	35.4
T_3: 50% RDF+ 7.5% K sap	6.40	15.7	25.2	31.8
T_4: RDF+2.5% K sap	8.55	16.9	27.5	39.0
T_5: RDF+5.0% K sap	8.80	18.1	31.6	50.6
T_6: RDF+10% K sap	9.31	18.3	33.4	55.2
T_7: RDF+ 15% K sap	10.1	18.8	37.6	57.1
T_8: RDF+ 2.5% G sap	7.37	16.7	24.5	36.3
T_9: RDF+5.0% G sap	8.45	17.4	26.5	43.2
T_{10}: RDF+ 10% G sap	8.77	18.3	29.8	47.8
T_{11}: RDF+15% G sap	9.32	18.6	31.2	50.6
T_{12}: 50%RDF+7.5% G sap	6.40	15.0	23.1	31.0
S.E. ±	0.85	0.54	0.82	1.86
C.D. (P=0.05)	1.8	1.1	1.7	3.9

RDF-Recommended dose of fertilizer

Table 2: Effect of seaweed saps on yield attributes of greengram

Treatments	No. of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	Test weight (g)
T_1: 100% RDF	3.6	42.0	7.17	6.6	3.11
T_2: RDF+ water spray	3.4	41.3	7.26	6.6	3.12
T_3: 50% RDF+ 7.5% K sap	3.0	34.7	6.74	6.4	2.95
T_4: RDF+2.5% K sap	3.6	46.3	7.51	7.2	3.24
T_5: RDF+5.0% K sap	4.2	52.3	7.79	7.6	3.36
T_6: RDF+10% K sap	5.2	56.2	7.91	7.8	3.44
T_7: RDF+ 15% K sap	5.8	62.7	8.56	8.2	3.58
T_8: RDF+ 2.5% G sap	3.0	44.6	7.29	6.8	3.17
T_9: RDF+5.0% G sap	3.4	50.3	7.31	7.0	3.25
T_{10}: RDF+ 10% G sap	4.2	54.6	7.71	7.2	3.37
T_{11}: RDF+15% G sap	5.0	58.3	7.86	7.6	3.49
T_{12}: 50%RDF+7.5% G sap	3.0	34.0	6.27	6.0	2.93
S.E.±	0.479	1.359	0.100	0.497	0.031
C.D. (P=0.05)	0.97	2.84	0.21	1.01	0.07

RDF-Recommended dose of fertilizer

was followed by T_{11} (100% RDF+15% G sap) with 5.0 (Table 2). The least number of branches per plant of 3.0 was recorded in T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% K sap). The highest number of pods per plant recorded in T_7 (100% RDF+15% K sap) was 62.7 (Table 2). This was followed by T_{11} (100% RDF+15% G sap) with 58.3. The least number of pods per plant was recorded in T_3 (50% RDF+7.5% K sap) and was followed by T_{12} (50% RDF+7.5% G sap) with 34.7 and 34.0, respectively. Pod length of greengram was higher in T_7 (100% RDF+15% K sap) which was comparable with T_{11} (100% RDF+15% G sap) by 8.56 and 7.86 cm, respectively (Table 2). The least pod length was found in T_3 (50% RDF+7.5% K sap) which was at par with T_{12} (50% RDF+7.5% G sap) with 6.74 and 6.27 cm correspondingly. The treatment, T_7 (100% RDF+15% K sap) recorded maximum number of seeds per pod with 8.2 and was at par with T_{11} (100% RDF+15% G sap) with 7.6 (Table 2). The treatment, T_3 (50% RDF+7.5% K sap) recorded minimum number of seeds per pod and was comparable with T_{12} (50% RDF+7.5% G sap) with 6.4 and 6.0.The test weight of greengram was recorded maximum in T_7 (100% RDF+15% K sap) which was comparable with T_{11} (100% RDF+15% G sap) with 3.58 g and 3.49 g correspondingly (Table 2). The lowest test weight of greengram was found in T_3 (50% RDF+7.5% K sap) which was at par with T_{12} (50% RDF+7.5% G sap) with 2.95 g and 2.93 g, respectively. Similar finding was reported that test weight were increased by foliar application 15% of *Kappaphycus alvarezii* with RDF and 15% *Graciliaria* sp. and was also found decreased in 50% RDF+7.5% K sap) which was at par with T_{12} (50% RDF+7.5% G sap) on soybean (Sujatha and Vijayalakshmi, 2013).The increased in yield attributes may be due to higher uptake of macro and micronutrients by plant and also presence of growth promoting substances like auxins and cytokinins in seaweed saps. Similar finding was reported that number of pods per plant, weight of pods per plant and number of seeds per pod were increased by foliar application 10 per cent of *Kappaphycus alvarezii* on greengram (Leindah and Mani, 2015). Similar observation was also reported that foliar application of seaweed extract *Sargassum wightii* increased the number of flower, pods and seeds in *Phaseolus aureus* (Bai *et al.,* 2007).

The yield attributes were reduced at T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% G sap). The decrease in yield attributes may be due to insufficient availability of nutrients from 50 per cent RDF that resulted lower growth and yield attributes of crop. Even though 7.5 per cent seaweed saps with 50 per cent RDF were applied, it did not meet the nutrient requirement for improved growth and yield attributes. Similar finding was observed that plant height of soybean was decreased in 50 per cent RDF (Leindah and Mani, 2015).

Influence of seaweed saps on dry matter production:

Experimental result showed that increasing

Table 3: Effect of seaweed saps on yield and dry matter production of greengram

Treatments	Grain yield(g pot^{-1})	Haulm (g pot^{-1})	Yield increase over control (%)
T_1: 100% RDF	22.6	35.4	0
T_2: RDF+ water spray	22.9	35.6	1.31
T_3: 50% RDF+ 7.5% K sap	19.4	29.4	-16.5
T_4: RDF+2.5% K sap	24.3	40.2	7.00
T_5: RDF+5.0% K sap	25.1	47.3	9.96
T_6: RDF+10% K sap	25.8	51.5	12.4
T_7: RDF+ 15% K sap	27.3	59.1	17.2
T_8: RDF+ 2.5% G sap	23.9	38.6	5.7
T_9: RDF+5.0% G sap	24.9	45.3	9.2
T_{10}: RDF+ 10% G sap	25.2	50.1	10.3
T_{11}: RDF+15% G sap	26.3	57.7	14.1
T_{12}: 50%RDF+7.5% G sap	19.0	28.1	-18.9
S.E.±	0.525	0.995	-
C.D. (P=0.05)	1.09	2.07	-

RDF-Recommended dose of fertilizer

seaweed saps concentration increased haulm yield of greengram (Table 3). Among the treatments, T_7 (100% RDF+15% K sap) and T_{11} (100% RDF+15% G sap) were recorded higher haulm yield with 59.1 g pot^{-1} and 57.7g pot^{-1}, respectively. The increase in dry matter production may also be due to higher nutrient availability of the plant. This was proved by positively correlation studies between dry matter production and available nutrients (Table 4). The increased in dry mater production may also be due to foliar application of seaweed saps which contain growth hormones like IAA and IBA that enhanced vigorous plant growth by increasing the shoot length, number of leaves, number of branches and plant growth etc. Identical results were observed that root and shoot length, leaves area and dry matter production increased in *Sorghum bicolar* when seaweed liquid fertilizer (*Gracilaria corticata*) was applied to the plant (Kumar *et al.,* 2006). Similar result was reported that the maximum shoot length, total fresh and dry weight were recorded at 1.5 per cent *Sargassum wightii* and 1.0 per cent *Ulvalactuca* extracts in *Cyamopsis tetragonolaba*. Plant physical parameters like total plant height, shoot length, number of branches and leaf area of *Arachis hypogea* were increased by foliar application of seaweed extract *Sargassum wightii* and *Ulvalactuca* which contain growth promoting hormones that lead to increase the total dry matter production (Sivasangari Ramya *et al.,* 2010).

Dry matter production was decreased in T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% G sap) with 29.4 g pot^{-1} and 28.1 g pot^{-1}, respectively which was even lower than control (T_1:100% RDF) with 35.4g pot^{-1}. The reduction in dry matter production may be due to the decrease of nutrient availability that caused stunted in plant growth. The foliar application of 7.5 per cent K sap or G sap was applied it may be insufficient to produce vigorous plant growth to increase dry matter production since the plant was supplied with 50 per cent RDF. Similar findings were reported that the dry matter production of maize was decreased due to 50 per cent RDF (Sekaran and Ramasamy, 2010).

Influence of seaweed saps on yield of greengram:

Results showed that grain yield of greengram significantly increased with increased in concentrations of seaweed saps foliar spray (Table 3). Grain yield of greengram was maximum in T_7 (100% RDF+15% K sap) which was at par with T_{11} (100% RDF+15% G sap) with 27.3 g pot^{-1} and 26.3 g pot^{-1} and it increased to 17.2 per centa and 14.1 per cent correspondingly over control. Grain yield over control was reduced in T_3 (50% RDF+7.5% K sap) by 16.5 per cent and inT_{12} (50% RDF+7.5% G sap) with 18.9 per cent. The increase in yield may be due to the presence of some growth promoting substances such as IAA, IBA, gibberellins, cytokinins, micronutrients, vitamins and amino acids and also due to increase in number of pods per plant, weight of the pods per plant and number of seeds per pod. Similar finding was observed that growth hormones like cytokinins and gibberellins have been detected in the extract of *Kappaphycus alvarezii* which might be responsible for increased in yield of wheat (Zodape *et al.,* 2009). Significant increase in seed yield of black gram by 24 per cent was reported with the foliar application of seaweed extract (Temple and Bomke, 1989 and Venkataraman and Mohan, 1997). This result is also accordance that yield of greengram was increased by 16.78 per cent in the foliar application of *Kappaphycus alvarezii* extract when compared to control (Sujatha and Vijayalakshmi, 2013).

Table 4: Correlation studies between available nutrients and dry matter production of greengram

	Av.N	Av.P	Av.K	Av.Fe	Av.Mn	Av.Zn	Av.Cu	Dry matter production
Av.N	1							
Av.P	0.964**	1						
Av.K	0.984**	0.964**	1					
Av.Fe	0.985**	0.992**	0.985**	1				
Av.Mn	0.978**	0.991**	0.979**	0.991**	1			
Av.Zn	0.921**	0.986**	0.922**	0.970**	0.972**	1		
Av.Cu	0.972**	0.990**	0.971**	0.994**	0.997**	0.984**	1	
Dry matter production	0.693	0.853**	0.697	0.799**	0.820**	0.903**	0.835**	1

* and ** indicate significance of values at P=0.05 and 0.01, respectively

The minimum yield was observed in T_3 (50% RDF+7.5% K sap) with 19.4 g pot^{-1} and T_{12} (50% RDF+7.5% G sap) 19.0 g pot^{-1} (Table 3). The decrease in yield over control was by 16.5 per cent in T_3 (50% RDF+7.5% K sap) and 18.9 per cent in T_{12} (50% RDF+7.5% G sap). The decrease in yield may be due to 50 per cent RDF that resulted minimum nutrient availability and insufficient nutrient for growth and development that lead to decrease in number of pods per plant, number of seeds per pod and test weight of the plant. In these treatments, 7.5 per cent seaweed saps were applied but it was inadequate for the plant because basal application was only the half of the recommended dose that caused nutrient insufficient even though it was given 7.5 per cent seaweed saps. Similar results were obtained that yield of wheat and rice was reduced in 50 per cent RDF (Urkurkar *et al.,* 2010**)**. Fibre yield in jute was also reduced by application 50 per cent RDF (Majumdar *et al.,* 2014).

Influence of seaweed saps on quality parameters of greengram:

Quality parameters like crude protein and carbohydrate are quality assessment for greengram. Results revealed that there was a significant variation among the treatments. Crude protein content in grain of greengram was significantly influenced by foliar application of seaweed saps (Table 5). Higher crude protein content in grain of greengram was recorded in T_7 (100% RDF+15% K sap) which was at par with T_{11} (100% RDF+15% G sap) with 26.8 per cent and 26.3 per cent, respectively. The lowest crude protein content in grain of greengram was recorded in T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% G sap) with 18.3 per cent each. Similar results was obtained in crude protein of soybean that was increased in 100 per cent RDF with 15 per cent *Kappaphycus alvarezii* and 100 per cent RDF with 15 per cent *Gracilaria* sp. (Leindah and Mani, 2015). Improvement in protein is of paramount importance as it is considered as the building block of living system. The increased in crude protein content may be due to foliar application of seaweed saps that enhanced higher uptake of nutrients which are constituents in protein (nitrogen, phosphorus and sulphur).

From the Table 5, T_7 (100% RDF+15% K sap) and T_{11} (100% RDF+15% G sap) showed maximum carbohydrate content in grain of greengram with 62.1 per cent and 61.9 per cent. The minimum carbohydrate content in grain of greengram was observed in T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% G sap) with 59.2 per cent and 59.0 per cent which was the least than control (T_1:100% RDF) with 61.2 per cent. Results also showed that carbohydrate content were increased with foliar application of seaweed saps which may be attributed to increase in availability, absorption of necessary elements and growth hormone present in the seaweed saps. Similar finding was agreed that 1.0 per cent *Kappaphycus alvarezii* extract of foliar spray to

Table 5 : Effect of seaweed saps on quality parameters of greengram

Treatments	Crude protein (%)	Carbohydrate (%)
T_1: 100% RDF	21.6	61.2
T_2: RDF+ water spray	21.7	61.3
T_3: 50% RDF+ 7.5% K sap	18.3	59.2
T_4: RDF+2.5% K sap	23.8	61.4
T_5: RDF+5.0% K sap	25.3	61.7
T_6: RDF+10% K sap	26.6	61.8
T_7: RDF+ 15% K sap	26.8	62.1
T_8: RDF+ 2.5% G sap	23.3	61.3
T_9: RDF+5.0% G sap	25.1	61.6
T_{10}: RDF+ 10% G sap	26.1	61.7
T_{11}: RDF+15% G sap	26.3	61.9
T_{12}: 50%RDF+7.5% G sap	18.3	59.0
S.E.±	0.538	1.24
C.D. (P=0.05)	1.12	0.78

RDF-Recommended dose of fertilizer

wheat plant showed increase in nutritional quality of wheat as: carbohydrate, protein and fat as 39.20 per cent, 21.74 per cent and 31.64 per cent, respectively (Zodape *et al.*, 2009). Fat and protein content had higher values in all the treatment concentrations in *Kappaphycus alvarezii* and *Gymnopilus edulis* saps over the control; and the maximum contents were found in plants receiving 7.5 per cent and 5.0 per cent concentrations of *Kappaphycus alvarezii* and *Gymnopilusedulis* sap, respectively (Shah *et al.*, 2013). Similarly seaweed liquid fertilizer of *Hypneamusci formis* increased in protein and carbohydrate content in *Arachis hypogeal* (Selvam and Sivakumar, 2014).

Quality parameter of greengram decreased in T_3 (50% RDF+7.5% K sap) and T_{12} (50% RDF+7.5% G sap). The decreased in quality parameter may be due to lower recommended dose of fertilizer that may insufficient to improve the quality in greengram grain. In these treatments 7.5 per cent foliar spray of seaweed saps was applied but it did not improve the quality. This may be due to 50 per cent RDF in which the nutrients were insufficient to improve the quality of grain even though 7.5 per cent foliar application was given. Similar result was also reported that quality of green chilli was decreased with 50 per cent RDF (Talukder and Jana, 2009).

Conclusion:

On the basis of the above obtained results it was concluded that growth, yield attributes, yield and quality of greengram were superior in treatments of 100 per cent RDF with 15 per cent K sap (T_7) and 100 per cent RDF with 15 per cent G sap (T_{11}). The increased in above parameter may be due to the presence of growth promoting substances such as IAA and IBA, gibberellins, cytokinins, macro and micronutrients, vitamins and amino acids etc. in both *Kappaphycus alvarezii* sap and *Glacilaria* sap. Irrespective of all treatments, 50 per cent RDF with 7.5 per cent K sap (T_3) and 50 per cent RDF with 7.5 per cent of G sap (T_{12}) were found lower in all the parameters of the crop when compared with that of control. This might be due to application of lower recommended dose which may be insufficient for plant growth even though 7.5 per cent seaweed saps was given. For the present investigation,100 per cent RDF with 15 per cent *Kapphaphycus alvarezii* sap and 100 per cent RDF with 15 per cent *Glacilaria* sap in greengram show remarkable improvement in growth, yield attributes, yield and quality parameters in crops. Among all seaweed saps, 15 per cent K sap with 100 per cent RDF in greengram has shown remarkable impact with regards to growth, yield attributes, yield and quality of the crop.

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