Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 292-296

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Effect Of Exogenous Application Of Marine Algal Sap On Physiological, Biological Parameter And Yield Of Soybean

R.V. MAHAJAN, V.M. BHALE, J.P. DESHMUKH, P.V. SHINGRUP AND S.P. PATIL
Department of Agronomy
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra
ram9962@gmail.com

ABSTRACT
A field experiment was conducted during the kharif season 2012 Research farm Department of Agronomy Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. (Maharashtra) to study the effect of exogenous application of marine algal sap on physiological, biochemical parameter and yield of soybean. Foliar spray was applied twice at different concentrations (0, 5, 10 and 15 v/v) of seaweed extracts (namely Kappaphycus and Gracilaria sap) once at vegetative stage (25-30 DAS) and second at flowering stage (35-40) of the crop. Foliar applications of marine algal saps significantly enhanced the physiological, biological and yield of soybean. Foliar application of Gracilaria-sap@15% + recommended dose of fertilizer (FS_6) was significantly enhanced the physiological parameters (leaf area index, leaf area duration, leaf production rate, biomass duration and specific leaf weight) and biochemical (chlorophyll content index %). Yield attributes i.e number of pod, pod weight, grain weight per plant were registered with foliar applications of 15% Gracilaria sap + recommended dose of fertilizer (RDF). Similarly, highest grain and straw yield was recorded with foliar applications of 15% Gracilaria sap + recommended dose of fertilizer (RDF) followed by K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2), resulting in an increase by 23.14% and 16.63% grain and straw yield, respectively compared to the control (RDF).
Keywords:*Soybean, Kappaphycus, Gracilaria sap, physiological, Biochemical and yield.*

Received 29.07.2017 Revised 09.08.2017 Accepted 27.08. 2017

INTRODUCTION

Marine algal seaweed species are often regarded as an underutilized bio-resource, many have been used as a source of food, industrial raw materials and in therapeutic and botanical applications for centuries. Seaweed extract is a new generation of natural organic fertilizers containing highly effective nutritious and promotes faster germination of seeds, increase yield, seed quality and resistant ability of many crops. Seaweed extracts are marine macro algae extract found in shallow coastal area and it contains many micro (Fe, Cu, Zn, Co, Mo, Mn, and Ni) and macro elements as well as it contains growth promoting hormones like auxins (IAA and IBA), Cytokinins, gibberellins (Crouch and Van staden, 1994) and metabolites like vitamins, fatty acids, organic matter and amino acids (Challen and Hemingway, 1965). Liquid extracts obtained from seaweeds are successfully used as foliar sprays for several crops (Bokil *et al*., 1974).

Seaweed extracts have been marketed for several years as fertilizer additives and beneficial results from their use have been reported (Booth, 1969). Liquid seaweed fertilizer is a unique combination of N, P, K, trace elements, alginates and simple sugars that are in dissolved form. These are easily absorbed through roots and leaves, besides releasing trace elements bound to the soil (Chapman and Chapman, 1980; Thivey, 1982). Liquid extracts obtained from seaweeds have recently gained importance as foliar sprays for many crops including various cereals, pulses and different vegetable species. In recent years, the use of marine algal sap have gained in popularity due to their potential use in organic and sustainable agriculture (Russo and Beryln, 1990), especially in rainfed crops, as a means to avoid excessive fertilizer applications and to improve mineral absorption.

At present, the use of natural seaweed products as substitutes to conventional inorganic fertilizers has gained importance. Seaweed fertilizers are better than other fertilizers and are very economical. Recent, research demonstrated that seaweed fertilizers can compete with other fertilizers and are very economical (Gandhiyappan and Perumal, 2001). Moreover, seaweed and seaweed-derived products have been widely used as amendments in crop production systems due to the presence of a number of plant growth-stimulating compounds. The objective of this study the effect of exogenous application of marine algal sap on physiological, biological and yield of soybean grown in rainfed fields.

Oilseed crops have always been the backbone of agricultural economics of India. Among the oilseeds, soybean; classed as an oilseed rather than a pulse by the Food and Agricultural Organization (FAO); registered the highest annual growth rate of area and production especially during the past few decades. Its early duration, ease for cultivation and suitability to double cropping ranks it first among oilseed crops in the world. Soybean is known as the miracle crop, a low cost food source high in protein and in calories, especially where other high protein foods are expensive, not available or prohibited or restricted by religion. Its economic importance for household and industrial use is increasing. Soybean occupies an intermediate position in pulses and oilseeds. It is truly a `Wonder crop' as its vast multiplicity uses as food, fodder, industrial products and residues in soil. The reasons for low productivity of this soybean crop are large scale cultivation under rainfed and low input conditions. The major physiological constraints which limit productivity are lack of seedling vigour, slow development of leaf area during first eight weeks after planting, profuse flowering but poor seed set, limitation of source at the time of seed development due to early leaf senescence, inefficient mobilization of carbon and nitrogen etc (Renukhanna *et al*., 1988).

METHODOLOGY

Field experiment was conducted during *kharif* season of 2013-14 at the Research farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The experiment was laid in Randomised block design with seven treatments and replicated three times. The details of treatments are FS_0-(No application of seaweed sap, RDF is applied), FS_1:K-sap@5%+RDF, FS_2:K-sap@10%+RDF, FS_3:K-sap@15%+RDF, FS_4:G-sap@5%+RDF, FS_5:G-sap@10%+RDF and FS_6:G-sap@15%+RDF. Two sprays of *Kappaphycus* and *Gracilaria* saps extract were applied at different growth stages vegetative stage (25-30 days) and flowering stage (35-40 day) through knapsack sprayer. Spraying of sea weed saps was done in the field as per the treatment. The quantity of water used was 500-600 liter ha^{-1} with adjuvant. Weekly average meteorological data during the span of experimentation, recorded at meteorological observatory, Dr. PDKV, Akola. The soil of experimental site was clayey in nature, pH 7.7, EC 0.27 dSm^{-1}, organic carbon 0.39%, available N 194.58 kg ha^{-1}, P 14.29 kg ha^{-1} and K 315.73 kg ha^{-1}. The recommended nutrient dose of N, P_2O_5, and K_2O was applied @20:40:00 kg ha^{-1} for the soybean crop.

RESULTS:

Leaf Area (dm^2) and Leaf Area Index (%)

There was an increasing trend of leaf area (dm^2) and leaf area index of soybean upto 60 DAS and thereafter declined towards maturity, probably due to senescence of lower leaves (Table 1). Foliar application of marine algal sap i.e. G-sap@15%+RDF (FS_6) recorded highest leaf area and leaf area index of soybean which was statistically at par with K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2) at 40, 60 and 80 DAS. Lowest leaf area and leaf area index recorded in control.

This effect might be reflected in terms of application of marine algal sap increased leaf area due to positive effects on cell division and cell elongation leading to increased plant height thereby increased number of functional leaves and ultimately leaf area per plant and increase the leaf area index. Similar results were also reported by Renuka Bai *et. al* (2010), El-Yazied *et. al*. (2012). Sujatha and Vijayalakshmi (2013) and Shankar *et al.* (2014).

Leaf Area Duration (LAD, days) and Leaf Production Rate, (leaves/day):

The data presented in Table 1 revealed that, foliar application of marine algal sap G-sap@15%+RDF (FS_6) registered highest leaf area duration (63.70, 120.43 and 115.33, days) and leaf production rate (0.725 and 0.367, leaves/day) followed by K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2) at 20-40 DAS, 40-60 DAS and 60-80 DAS of leaf area duration and 20-40 DAS, 40-60 DAS of leaf production rate. Among that at 40-60 DAS interval highest leaf area duration (120.43, days) and at 20-40 DAS interval highest leaf production rate (0.725, leaves/day) noted with G-sap@15%+RDF (FS_6).

Increased the leaf area duration probably due to their positive effect on cell division and cell elongation leading to enhanced leaf growth, number of leaves, leaf area eventually increase the leaf area duration and leaf production rate. Results analogous to this have also been reported by Sujatha and Vijayalakshmi (2013) and Shankar *et. al* (2014).

Biomass Duration (days) and Specific Leaf Weight (mg/cm^2)

Biomass duration (days) and specific leaf weight (mg/cm^2) significantly influenced by various marine algal sap treatments and recorded at various growth stages presented table 2. Maximum biomass duration recorded with treatment receiving foliar spraying of G-sap@15%+RDF (FS_6) with respective values i.e. 303.18, 441.78 and 497.07, days, which was at par with K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2) at between 40-60 DAS, 60-80 DAS and 80-at harvest stage. Lower biomass duration was noted in no foliar spraying of marine algal sap i.e. control. Increased biomass duration might be due to increase the leaf area index. Leaf area duration, total dry matter production and specific leaf weight and finally resulted in increased biomass duration.

Highest value of specific leaf weight was recorded with foliar application of G-sap@15%+RDF (FS_6) than rest of the treatments at (4.390 mg/cm^2) flowering stage, (4.897 mg/cm^2) fruiting stage and (4.638 mg/cm^2) pod development stage (Table 2). However it may at par with treatment K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2). Among the growth stages fruiting stage recorded highest specific leaf weight (4.897, mg/cm^2) than flowering and pod development stages in treatment (FS_6) G-sap@15%+RDF. Control plant recorded lowest value of specific leaf weight. The increase in specific leaf weight indicates increased leaf thickness due to stacking of palisade cells and moreover, such increased leaf thickness could probably enhance the photosynthetic efficiency due to stacking of mesophyll and bundle sheath cells there by recapturing the CO2 released in photo respiratory process and leading to increase in dry matter production, similarly increased specific leaf weight.

Table-1: Leaf area, LAI, LAD and LPR as influenced by different concentration of *Kappaphycus-sap* and *Gracilaria sap.*

Treatment	Leaf area (dm^2)			Leaf area Index			Leaf Area Duration (LAD, days)			Leaf Production Rate, (leaves/day)	
	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS	20-40 DAS	40-60 DAS	60-80 DAS	20-40 DAS	40-60 DAS
FS_0	8.53	11.82	10.47	3.79	5.25	4.65	47.85	90.46	83.78	0.495	0.323
FS_1	9.68	12.93	12.03	4.30	5.75	5.35	53.44	100.50	96.50	0.581	0.339
FS_2	11.01	14.17	12.91	4.89	6.30	5.74	59.14	111.88	106.30	0.648	0.357
FS_3	11.70	14.87	13.72	5.20	6.61	6.10	62.56	118.10	112.98	0.706	0.362
FS_4	9.95	13.34	12.35	4.42	5.93	5.49	54.70	103.51	99.13	0.592	0.345
FS_5	11.33	14.45	13.26	5.04	6.42	5.89	61.04	114.59	109.30	0.679	0.359
FS_6	11.97	15.14	13.98	5.32	6.73	6.21	63.70	120.47	115.33	0.725	0.367
SE (m)$\pm$	0.50	0.44	0.36	0.22	0.19	0.17	2.15	3.21	3.58	--	--
CD (P= 0.05)	1.56	1.37	1.11	0.69	0.60	0.54	6.65	9.92	10.82	--	--
GM	10.60	13.82	12.67	4.7096	6.1407	5.6330	57.49	108.50	103.33	0.632	0.350

Chlorophyll Content Index

Chlorophyll content index (CCI) did not changed to a level of significance when measured before spraying of marine algal sap. After the foliar spray application of marine algal sap (K-sap and G-sap) at 30 and 40 DAS, significant rise in the value of CCI were recorded with treatments. Foliar application of marine algal sap G-sap@15%+RDF (FS_6) significantly recorded highest chlorophyll content index i.e. 28.56% at 30 DAS and 33.98% at 40 DAS and it may at par with treatment (FS_3) K-sap@15%+RDF, (FS_5) G-sap@10%+RDF and (FS_2) K-sap@10%+RDF. Control recorded lowest value (23.66%) chlorophyll content index at 30 DAS and 50 DAS.

Cumulatively it was observed that percent increased of chlorophyll content index at 30 and 540 DAS were 20.27% and 30.34% respectively. Increase the chlorophyll content index might be due presence of trace element and growth promoter especially, cytokinin inhibits degradation of chlorophyll, breakdown of protein molecules and aids in the increase of chlorophyll level. The results obtained in this regard are in close accordance with those of Shanker *et. al* (2014) and El-Yazied *et. al* (2012).

Table-2: Biomass duration (days), specific leaf weight (mg/cm²) and chlorophyll content index (%) as influenced by different concentration of *Kappaphycus-sap and Gracilaria sap.*

Treatment	Biomass duration (BMD, days)			Specific leaf weight (SLW, mg/cm²)			Chlorophyll content index (%)		
	40-60 DAS	60-80 DAS	80-at harvest	Flowering (mg/cm²)	Fruiting (mg/cm²)	Pod Development (mg/cm²)	Before 25 DAS	After 30 DAS	After 50 DAS
FS_0	210.70	319.87	367.15	3.897	4.514	4.221	22.96	23.66	26.07
FS_1	242.40	364.48	418.30	4.118	4.666	4.393	22.93	25.3	28.7
FS_2	272.22	402.82	455.51	4.206	4.768	4.485	23.55	27.04	31.25
FS_3	292.68	428.65	482.24	4.327	4.857	4.593	23.45	28.16	33.14
FS_4	251.75	375.98	425.76	4.153	4.702	4.429	22.73	25.67	29.55
FS_5	282.43	415.47	470.80	4.262	4.806	4.543	23.46	27.42	32.15
FS_6	303.18	441.78	497.07	4.390	4.897	4.638	23.62	28.56	33.98
SE (m)±	11.26	13.71	15.55	0.0639	0.0468	0.0522	0.43	0.71	1.03
CD (P= 0.05)	34.72	42.26	47.92	0.197	0.144	0.161	NS	2.19	3.18
GM	265.05	392.72	445.26	4.193	4.744	4.472	23.24	26.54	30.69

Yield attributes and yield

Economically, grain yield is ultimate product of soybean crop. Marine algal sap of *Kapaphycus* spp. and *Gracilaria* spp. Along with RDF showed the significant effect on yield, due to their application seed yield increase as per the increase dose of seaweed sap (Table 3). Different concentration of marine algal sap along with recommended dose of fertilizer showed the significant effect on yield attributes viz. number of pod, pod weight (g) and grain weight (g).

Data recorded, on number of pod, pod weight (g) and grain weight (g) were significantly higher i.e. 48.50, 12.84 g and 6.61 g respectively under foliar spray of G-sap@15%+RDF (FS_6) followed by K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2). Similarly, foliar application of G-sap@15%+RDF (FS_6) posed a great impact on grain and straw yield i.e. 2337 kg ha^{-1} and 3361 kg ha^{-1} while it was at par with foliar application of K-sap@15%+RDF (FS_3), G-sap@10%+RDF (FS_5) and K-sap@10%+RDF (FS_2). Compared to control the yield of grain and straw has increased irrespective of concentrations and maximum was 23.14% and 16.63 %.

The soybean crop gave better response to the higher doses of marine algal sap which stimulate the diversion of food material from leaves in acropetal and basipetal direction that resulted into improvement from the source to sink relation of soybean crop and eventually more number of pods, pod weight and grain yield per plant, ultimately resulted into increased grain yield. The increased grain yield could be attributed to higher chlorophyll content, dry matter production, net assimilation rate, biomass duration, leaf area duration and its accumulation in reproductive parts, as result increased the grain and straw yield. These results are in confirmation with Rathore *et al.* (2009), Zodape *et al*. (2010), Renuka Bai *et al.* (2011), Sharma *et al.* (2011), Raverkar *et al.* (2012) and Shankar *et. al* (2014).

Table 3: Yield attributes and yield of soybean influenced by marine algal saps.

Treatment	No. of Pod per plant	Pod Wt. Per plant (g)	Grain wt. Per plant (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
FS_0	38.75	8.73	4.80	1796	2802
FS_1	41.93	10.30	5.41	2035	3056
FS_2	43.72	11.64	6.00	2192	3237
FS_3	45.03	12.39	6.39	2283	3319
FS_4	42.44	10.67	5.61	2091	3106
FS_5	44.43	12.02	6.20	2241	3273
FS_6	45.80	12.84	6.61	2337	3361
SE (m)±	0.75	0.49	0.22	36.64	36.90
CD (P= 0.05)	2.32	1.52	0.68	112.90	110.93
GM	43.16	11.23	5.86	2140	3165

CONCLUSION

Thus it is concluded that, foliar application marine algal sap i.e. G-sap@15% to soybean at pre-flowering and flowering stage (25 and 35 DAS) significantly enhanced the physiological, biochemical parameters and yield of soybean. Beneficial as growth harmone present in marine algal saps gets quickly assimilated in the leaves which lead to build up healthy and reproductive plant. The grain and straw yield was enhanced by 23.14% and 16.63% with foliar spraying of G-sap@15% (FS_6) than the control.

REFERENCES

1. Abou El-Yazied, A., El-Gizawy, A. M., Ragab, M. I. and Hamed, E. S. 2012. Effect of seaweed extract and compost treatments on growth, yield and quality of snap bean. Journal of American *Science*. 8(6):1-20.
2. Bokil, K. K., Mehta, V. C. and Datar, D. S. 1974. Seaweeds as manure: II pot culture manorial experiments on wheat. *Phykos*. 13(1):1-5.
3. Challen, S. B. and Hemingway, J. C. 1965. Growth of higher plants in response to feeding with seaweed extracts. Proc. 5th Ind. *Seaweed Symp*.
4. Chapman, V. J. and Chapman, D. J. 1980. Seaweeds and their uses. 3 edition. Chapman and Hall, USA, pp. 334.
5. Crouch, I. J. and, Van Staden, J. 1994.Commercial seaweed products as Biostimulants in horticulture *J. Home and Consumer Horticulture.* 1: 19-76.
6. Gandhiyappan, K. and Perumal, P. 2001. Growth promoting effect of seaweed liquid fertilizer (Enteromorpha intestinalis) on the sesame crop plant. Seaweed Res. Utilization. 23: 23-25.
7. Kalaivanan, C., Chandrasekaran, M. and Venkatesalu, V. 2012. Effect of seaweed liquid extract of *Caulerpa scalpelliformis* on growth and biochemical constituents of black gram (*Vigna mungo*). *Phykos* 42 (2): 46-53.
8. Mooney, P. A. and Van Staden, J. 1986. Algae and cytokinins. *Journal of Plant Physiology* 123, 1–2.
9. Pramanick, B., Brahmachari, K. and Ghosh, A. 2013. Effect of seaweed saps on growth and yield improvement of green gram. *African Journal of Agricultural Research*. Vol. 8 (13) 1180-1186.
10. Rathore, S.S., Chaudhary, D.R., Boricha, G.N., Ghosh, A., Bhatt, B.P., Zodape, S.T. and Patolia, J.S. 2009. Effect of seaweed extract on the growth, yield and nutrient uptake of soybean (*Glycine max*) under rainfed conditions. *South African Journal of Botany* 75: 351–355.
11. Raverkar, K.P., Chandra, P., Chauhan, N.R., Md. Yaseen, S., Zodape, S.T. and A. Ghosh, 2012. Effect of foliar application of seaweed saps on yield and nutritional quality of blackgram. NASA International Symposium, Pantanagar, Uttrakhand.
12. Renuka Bai, N., Mary Christi, R. and Christy Kala, T. 2011. Seaweed liquid fertilizer as an alternate source of chemical fertilizer in improving the yield of *vigna radiata* l. *Plant Archives* 11(2): 895-898.
13. Renuka Bai, N., Thisya, K., Mary Christi, R. and Christy Kala, T. 2011. Integrated application of organic manures on the growth, yield and nutritional status of *vigna mungo* l. Plant Archives 11(2): 973-978.
14. Shankar, T., Malik, G .C., Banerjee, M. And A. Ghosh, 2014. Evaluation of foliar spray of seaweed liquid fertilizer on the growth and yield of sesame (*Sesamum indicum*.L) in the red and lateritic belt of West Bengal. National Seminar on Agricultural Diversification for Sustainable livelihood and Environmental Security November 18-20, 2014, Ludhiana, Punjab.
15. Sharma, J.D., Sapre, N., Dwivedi, B.S., Agrawal, S.B. and Sharma, A. 2011. Effect of sea weed extract on yield and uptake of soybean under rainfed conditions. NASA International Symposium, 2014 at Pantanagar, Uttrakhand.
16. Singh, G., Sekhon, N. and Manjit, K. 1980. Effect of phenolic compounds on the yield potential of gram (*Cicer arietinum* L.). *Indian J. Plant Physiol.,* 23: 21-25.
17. Singh, S., Singh, M. K., Pal, S. K., Thakur, R., Zodape S. T. and Ghosh, A. 2015. Use of seaweed sap for sustainable productivity of maize. *The Bioscan* 10 (3) 1349-1355.
18. Sujatha, K. and Vijayalakshmi, V. 2013. Foliar application of *Caulerpa racemosa* seaweed extract as bio-stimulant for enhancement of growth and yield of blackgram (*Vigna mungo* L.). *International Journal of Advancements in Research & Technology*, 2:(10) 216-230.
19. Thivey, F. 1982. On the importance and prospects of seaweed utilization in India. Seaweed Res. Utiln. 5(2): 53-60.
20. Zhang., X, Ervin, E. H. and Schmidt, E. R. 2003. Plant growth regulators can enhance the recovery of Kentucky bluegrass sod from heat injury. *Crop Sci.* 43:952-956.
21. Zodape, S. T., Mukhopadhayay, K., Eshwaran, K., Reddy, M.P. and Chakara, J. 2010. Enhancement of yield and nutritional quality in greengram treated with seaweed *Kappaphycus alvarezii*. *Journal of Scientific and industrial research* 69 (1): 468-471.

CITATION OF THIS ARTICLE

R.V. Mahajan, V.M. Bhale, J.P. Deshmukh, P.V. Shingrup And S.P. Patil . Effect Of Exogenous Application Of Marine Algal Sap On Physiological, Biological Parameter And Yield Of Soybean. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 292-296