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Influence of seaweed sap and phosphorus on growth and yield of soybean under Prayagraj condition

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ABSTRACT

A field experiment was carried out during *Kharif* season of 2022, at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.). The experiment field was entitled as "Influence of seaweed sap and phosphorus on growth and yield of soybean". The treatment consisted of 3 levels of seaweed sap foliar application (10, 15 and 20%) and phosphorus (50, 60 and 70 kg/ha) basal application and a control. The experiment was layout in Randomized Block Design (RBD) with 10 treatments and replicated thrice. Application of seaweed sap 20% along with phosphorus 60 kg/ha recorded highest plant height (68.20 cm), maximum number of root nodules per plant (63.83), root length (26.13 cm), highest SPAD value (chlorophyll content) (48.22), leaf area index (7.89), higher seed yield (2.39 t/ha), oil yield (461.99 kg/ha), protein yield (914.89 kg/ha) post harvest chemical properties of soil, pH (6.90), EC (0.487), organic carbon (0.313 %) available plant nutrient Nitrogen (279.79 kg/ha), Phosphorus (11.70 kg/ha), Potassium (215.89 kg/ha) and the maximum net return (1,01,073.53 INR/ha) and B:C ratio (2.47). This study show that application of seaweed sap (*Kappaphycus alvarezii* and *Sargassum spp*.) 20% along with combination of phosphorus 60 kg/ha (Treatment 8) recorded higher Growth, yield and benefit cost ratio of soybean.

Key words: *Soybean, Seaweed sap, Phosphorus, Growth, Yield and Economics.*

Introduction

Soybean (*Glycine max* L.) is a diploidized tetraploid (2n=40), belongs to the family *Fabaceae*. It is native to Eastern Asia, (Nagata, 1960). In India, it is known by several names as *Bhat, Bhatman, Bhatmas, Kulthi, Ramkulthi, Bhut, Kalitur, Teliakulth, and Gerakalay*. Being the rich source of protein, it is also called "poor man's meat". It contains about 40-42% high quality protein, 20-22%, edible oil, 20-30% carbohydrates, 4.5% minerals, 3.7% fiber, 8.1% water, large amount of Phosphorus, high level of amino acids such as lysine, lucien, lecithin and vitamins (Barik and Chandel, 2001). Soybean products are widely used for human consumption seed is used for making various food products common soybean products include; for seed making food - soy milk, soy beverage, soy curd, soy ice-cream, soy candy, weany foods (Protein+), soy nuts, cheese, soy snacks, nutria nuggets-50% protein (Gahukar and Balpande, 1997). World production of soybean is 333.67 million tons. From a total area of 120.50 million hectares. In India, it occupies an area of 12.1 million hectare with production of 12.9 million tons with an average productivity of 991 kg/hectare. Madhya Pradesh contributing 45.86% of the total production of soybean in the country and deserves to be called 'Soya state'. Followed by Maharashtra with 37.79% contribution and Rajasthan with an 8.72% contribution (Source: *Soybean Outlook, October 2021*).

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Seaweed sap from Red algae (*Kappaphycus alvarezii)* and Brown algae (*Sargassum spp*.) Seaweed extracts contains major and minor nutrients, amino acids, vitamins, minerals and growth regulators like; Cytokinins (Durand *et al*., 2003), Auxin the presence of indole-3-acetic acid (Sahoo, 2000), Gibberellins GA_3 and GA_7, (Strik and Staden, 1997) and Abscisic Acid **(**Hussain and Boney, 1973). Seaweed sap promote root and shoot growth, mineral absorption, also enhance photosynthesis rate and plant chlorophyll content (Blunden *et al*., 1997). It promotes growth and yield as well as enhances the resistant ability of many crops from biotic and abiotic stress. Unlike chemical fertilizers, extract derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animal and birds (Dhargalkar and Perira, 2005).

Phosphorus is non-renewable and second most important macro nutrient. Role of Phosphorus is root development, stalk and stem strength, cell division, photosynthesis, Flower and seed formation, resistance to plant diseases, crop maturity and production all the attributes associated with phosphorus nutrition. The most obvious effect of phosphorus is on the plant root system. It promotes early root formation and thus formation of lateral fibrous and healthy roots, which is very important for nodule formation and fixing atmospheric nitrogen in soybean. Phosphorus application significantly increases dry matter production as well as yield and yield contributing characters of soybean (Singh *et al.,* 1973).

Materials and Methods

A field experiment entitled "Influence of Seaweed Sap and Phosphorus on Growth and Yield of Soybean under prayagraj condition". Has been conducted at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj 211007, Uttar Pradesh During the *Kharif* season of 2022, with the following objectives to study the effect of seaweed sap and phosphorus on growth and yield of soybean and to work out the economics of different treatment combinations. The Crop Research Farm is situated at 25.770 North latitude, 81.500 East longitude and 98 m altitude from the sea level, in the Northern Gangetic alluvial plains, Uttar Pradesh. The soil of experimental field was Sandy loam in texture, sand (59.25 %), silt (23.25 %) and clay (18.63 %). Chemical properties soil pH (6.9), with normal EC (0.296 ds/m), and organic carbon (0.29) contents. The NPK availability was medium (278.93 kg/ha), low (10.8 kg/ha) and high (206.4 kg/ha) respectively. The weekly minimum and maximum temperature ranged from 18.09 to 36.43 ^{o}C. Relative humidity ranged from 50.43 to 94.29 % and rainfall was 1282.1 mm, weather condition was normal throughout the crop season. The experiment was laid out in Randomized Block Design along with 10 treatment combinations and replicated thrice. Treatments were randomly arranged in each replication, divided into 30 plots. The recommended dose of fertilizer, NPK 20:60:40 kg/ha and soybean variety JS-335 was sown 30 cm row spacing with 10 cm plant to plant spacing on 4th week of July 2022. Sowing time application of nutrient and as per treatment basal application of phosphorus and as per treatment seaweed sap species from Red algae (*Kappaphycus alvarezii)* and Brown algae (*Sargassum spp*.) was foliar spray applied 20, 40, 60 and 80 DAS of intervals. Different observations on the crop parameters were carried out during the course of investigation. Data were recorded on growth attributes of soybean at 20, 40, 60, 80 days after sowing are plant height length from (base to tip of the main axis), number of nodules per plant, the root length (cm) measured with the help of scale, Chlorophyll content was measured by SPAD meter, the leaf area was measured help of electronic leaf area meter. The crop was harvest on 1st week of November, 2022 as per the treatments. The recorded data were further computed for an average hectare. Yield traits of soybean are seed yields and stover yield was recorded after threshing and the grains obtained were weighed plot-wise. The amount obtained in kilograms from the net area was converted into t/ha. Post-Harvest qualitative observations oil yield (kg/ha) and protein yield (kg/ha) was calculated multiply by seed yield (q/ha). The post harvest soil samples were collected and analyzed to determine the physico-chemical properties of the soil, pH (m.m/l), EC (m.m/cm), OC (%) available plant nutrient N, P, K (kg/ha). And calculate net monetary return, and benefit cost ratio on per hectare area basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis as per method of analysis of variance (Fisher *et al*., 1921). The significant differences between the means were tested against the critical difference at 5% probability level.

Results and Discussion

Growth Attributes

Application of seaweed sap 20 % with combination of phosphorus 60 kg/ha (Treatment 8) recorded significantly higher growth attributes; plant height (68.20 cm), highest number of root nodules per plant (63.83) and higher chlorophyll content SPAD (48.22 %) was observed at 60 DAS. Similarly, significantly higher root length (26.13 cm) and Leaf area index (7.89) was recorded at 80 days after sowing. Treatment 5, 7 and 9 was found to be statistically at par with treatment 8. Were growth attributes observed highest under (treatment 8) in combination of seaweed sap 20 % along with phosphorus 60 kg/ha while minimum under (Treatment 10) with application of control (Table 1). The considerable result growth attributes in plant height, root length, root nodules per plant increase the activity of rhizobia in soil due to application of foliar spray of seaweed sap results 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). And leaf area may be attributable to the usage of seaweed sap, which contains macro and micronutrients, natural enzymes, and plant growth hormones. The plant can develop more quickly since these nutrients help to increase metabolic rate, cell division, and cell elongation. In addition, given the confirmed improvement in development traits demonstrated by (Lingakumar *et al.* 2004). Increase the chlorophyll content presence of high amount of potassium salts, micronutrients and growth substances in this seaweed sap and their absorption in plant leaves at an accelerated rate resulting in greater formation of chlorophyll pigments. The results obtained in this regard are in close accordance with those of (Shanker *et al.* 2014).

Yield, Quality Parameters and Economics of Soybean

Application of seaweed sap 20% with combination of phosphorus 60 kg/ha (Treatment 8) recorded significantly higher yield traits; Seed yield **(**2.39 t/ha), However, (Treatment 5) was found to be statistically at par with (Treatment 8), minimum seed yield (1.15 t/ha) was observed in (Treatment 10) with application of control. Significantly maximum straw yield (5.65 t/ha) was recorded in (Treatment 9) with application of seaweed sap 20% along with phosphorus 70 kg/ha, which was superior over all other treatments. Highest oil yield (461.99 kg/ha) and protein yield (914.89 kg/ha) was recorded in (Treatment 8) in which seaweed sap 20% was applied with combination of phosphorus 60 kg/ha. Which was superior found over all other treatments. Maximum net return (101073.53 INR/ha) and Benefit Cost ratio (2.47) recorded in (Treatment 8) in combination of seaweed sap 20 % along with phosphorus 60 kg/ha. While closely found (90917.73 INR/ha and 2.27 respectively). And minimum net return (37727.13 INR/ha) and Benefit Cost ratio (1.04) recorded in (Treatment 10) with application of control (Table 2). Physiological responses due to seaweed extract spray include improved nutrient mobilization and partitioning, the development of a vigorous root system, increased chlorophyll content and leaf

Table 1. Effect of seaweed sap and phosphorus on growth attributes of soybean.

Treatment	Plant height (cm)	Root nodules per plant	Root length (cm)	Chlorophyll content (%)	Leaf area index (LAI)
1.	57.87	52.42	22.53	40.14	5.37
2.	59.87	54.03	23.93	42.38	6.33
3.	58.27	56.66	24.23	41.04	5.77
4.	59.27	55.96	23.53	45.33	5.67
5.	62.20	58.86	25.93	46.46	7.13
6.	59.53	57.14	25.20	43.41	6.66
7.	59.93	56.90	24.87	46.40	7.21
8.	68.20	63.83	26.13	48.22	7.89
9.	64.73	59.81	25.77	47.11	7.00
10.	55.73	47.01	21.90	36.42	4.05
SEm (±)	1.78	1.80	0.79	1.47	0.39
CD (P=0.05)	5.29	5.35	2.36	4.39	1.17

area and senescence retardation due to result increase yield traits. Similar findings were reported by (Metting *et al.*, 1990). Oil and Protein yield increased with the application of seaweed sap on different crop due to growth hormones and micronutrient present in seaweed sap reported by (Babu and Rengasamy, 2012). Application of seaweed extract enhanced the early growth and yield attribute properties in legume plants and yield return 12-25% more than that of control achievement. Net return and Benefit : Cost ratio is the indicators to evaluate the economic viability of any crop production system. Variation in cost of cultivation was due to differential cost of concentration of seaweed sap associated with different treatments applied. Similar reported by (Sethi and Adhikary, 2008).

Nutrient Status if Soil After Harvest of Soybean

Chemical properties of soil; pH and EC were found no statistically significant difference among all the treatment. However, maximum pH (6.90) and EC (0.487) was recorded in (Treatment 8) with application of seaweed sap 20% and phosphorus 60 kg/ha. Significantly higher organic carbon (0.313 %) was recorded in (Treatment 8) with application of seaweed sap 20% along with phosphorus 60 kg/ha. However, treatment 4, 5, 7 and 9 was found to be statistically at par with (Treatment 8). Significantly highest Nitrogen (279.79 kg/ha) was observed in (Treatment 8). However, (Treatment 9) was found to be statistically at par with (Treatment 8). Maximum Phosphorus (11.70 kg/ha) was observed in (Treatment 8). However, treatment 3, 5, 7 and 9 was found to be statistically at par with (Treatment 8). And Highest Potassium (215.89 kg/ha) was recorded again in (Treatment 8) with application of seaweed sap 20% along with combination of phosphorus 60 kg/ha. However, treatment 5, 7 and 9 was found to

Table 2. Effect of seaweed sap and phosphorus on yield, Quality parameters and economics of soybean.

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Oil yield (kg/ha)	Protein yield (kg/ha)	Net return (INR/ha)	Benefit cost ratio (B:C)
1.	1.83	5.48	322.65	672.34	88066.13	2.26
2.	1.74	4.85	301.02	641.47	66632.30	1.71
3.	1.42	5.00	240.89	533.50	49122.03	1.26
4.	1.53	5.23	278.77	563.81	55094.13	1.38
5.	2.18	5.29	414.20	830.58	90917.73	2.27
6.	1.61	5.10	286.05	593.79	58964.20	1.47
7.	1.83	5.16	341.48	682.22	70378.97	1.72
8.	2.39	5.20	461.99	914.89	101073.53	2.47
9.	2.02	5.65	374.26	755.19	81706.73	1.99
10.	1.15	4.18	196.13	420.85	37727.13	1.04
SEm (±)	0.08	0.25	-	-	-	-
CD (P=0.05)	0.24	0.75	-	-	-	-

Table 3. Effect of seaweed sap and phosphorus on chemical properties and N, P, K status of soil after harvest of soybean.

Treatment	Chemical properties of soil			Available plant nutrient (kg/ha)		
	pH(m.m/l)	EC(m.m/cm)	OC (%)	N	P	K
1.	6.70	0.453	0.260	279.29	11.35	215.42
2.	6.73	0.460	0.270	279.52	11.44	215.43
3.	6.77	0.470	0.273	279.61	11.49	215.52
4.	6.70	0.463	0.280	279.32	11.36	215.59
5.	6.87	0.467	0.290	279.68	11.46	215.80
6.	6.80	0.477	0.270	279.69	11.41	215.63
7.	6.73	0.473	0.287	279.55	11.45	215.75
8.	6.90	0.487	0.313	279.79	11.70	215.89
9.	6.83	0.480	0.300	279.71	11.66	215.84
10.	6.80	0.433	0.250	279.22	11.27	215.40
SEm (±)	0.06	0.011	0.011	0.03	0.08	0.07
CD (P=0.05)	NS	NS	0.035	0.09	0.25	0.21

(A). Initial trifoliate (V1) stage. (B). R5 Beginning of seed formation stage. (C) Field overview 80 DAS.

be statistically at par with (Treatment 8). Minimum soil nutrient content observed in (Treatment 10) with application of control (Table 3). Application of seaweed extract has been shown to enhance the moisture holding capacity of the soil as well nutrient status in soil (Mohanty *et al*., 2013). Application of seaweed extract triggers the growth of beneficial microbes and secretion of soil conducting substances by these microbes. Due to their microbial substances and soil improvement ability it acts as soil conditioners for several important crops reported by (Thirumaran *et al.*, 2006).

Conclusion

It is concluded that application of seaweed sap (*Kappaphycus alvarezii* and *Sargassum spp.*) 20% along with combination of phosphorus 60 kg/ha (Treatment 8) recorded higher growth, yield and benefit cost ratio of soybean.

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Conflict of Interest

None

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