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# Response of seaweed saps on soybean (*Glycine max* (L.) Merrill.) Nutrient uptake

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**Abstract**
Soybean is an important oil seed crop grown in *Vertisols* in Chhattisgarh state. The stagnated yield of soybean demands technology, which may break the yield ceiling of the crop. Therefore, different type and level of seaweed saps have been used which plays a major role in enhancing yield & nutrient uptake of soybean. In the present study seaweed extracts (*Kappaphycus* and *Gracilaria*) were sprayed over leaves twice at various concentrations (0%, 2.5%, 5%, 7.5%, 10% and 15% v/v). Seaweed extract applied topically considerably improved the parameters of nutrient absorption. Under 15% K Sap + RDN, the crop absorbed the most nutrients.

**Keywords:** Soybean, NPK uptake, nutrient uptake, *Kappaphycus*, *Gracilaria*, seaweed saps, RDN

## Introduction

According to Pimental *et al*. (2006) [5], Leguminous soybean (*Glycine max* (L.) Merrill.) is a prominent nitrogen-fixing crop produced for food and feed in many parts of the world. Among the key products of the soybean are soymeal, soymilk, and soybean oil. It is among the most significant and affordable sources of plant-based proteins and oils. It is referred to as a "wonder crop" because to the variety of uses it has in both food and industry. In addition, it has a lot of phosphorus and a high concentration of amino acids like Leucine, lysine, and lecithin. Its oil is higher in linoleic acid (54%) and is high in poly-unsaturated fatty acids. It is a two-dimensional crop since it includes 20–22% oil and 40–42% good grade protein.

Additionally, 20–30% of it is made up of carbs. Soybean protein is on par with that found in meat, dairy products, and eggs. Soybean is a widely accepted truth to be an inexpensive source of protein and edible oil. Like most legumes, soybeans have roots that are home to microorganisms that fix nitrogen from the air, allowing the plant to flourish in restricted or marginal soil that cannot support the majority of other crops. Additionally, soybeans have the capacity to leave 35–40 kg $ha^{-1}$ of residual nitrogen for future crops. Due to these qualities, soybean fits the environment well in environmentally sound farming. Soybean is aptly referred to as the "Golden Bean" of the twentieth century due to its many uses.

Any enhancement to the agricultural system that boosts output should also lessen its detrimental effects on the environment and increase the system's sustainability. Utilizing bio-stimulants, which can improve the efficiency of conventional mineral fertilizers, is one such strategy. Their long-term, careless use invites the serious issue of soil health condition due to decreased input use efficiency, more specifically, fertilizer use efficiency. These factors are forcing farmers to increasingly rely more on alternatives such organic manures, biostimulants, growth regulators, etc. Use of seaweed extracts as plant fertilizer that contains nutrients is one of these options. Agricultural and horticultural crops can benefit greatly from the usage of marine bioactive compounds derived from marine algae in terms of improved productivity and quality (Pramanick *et al*., 2013) [6].

According to studies by Zhang *et al*. (2003) [11] and Turan and Kose (2004) [9], seaweed extracts have been proven to promote plant growth and yield, build resistance to environmental stress, and enhance soil nutrient uptake. They also contain vitamins, Cytokinins, auxin, major and minor nutrients, amino acids, and compounds that resemble growth-promoting chemicals (such abscisic acid). The main objective of this study is to determine the impact of foliar application of seaweed saps on nutrient uptake of Soybean cv. JS-97-52 in research trials.

## Materials and Methods

The experiment was conducted in 2013's Kharif season at the IGKV's Research and Instructional Farm in Raipur (Chhattisgarh). The experimental location in Raipur is located in the Eastern Plateau and Hills, India's eighth agroclimatic region, which is described as Subhumid with hot summers and chilly winters. For the year 2013, the meteorological observatory at the IGKV in Raipur collected weekly average meteorological data over the course of the experiment. 1324.3 millimeters of rain fell overall during the 2013 kharif seasons. During the 2013 kharif season, the highest temperature recorded during crop seasons ranged from 27.9 °C to 34.4 °C. The minimum temperatures ranged from 21.4 °C to 25 °C throughout the same seasons.

Ten treatments were used in the experiment; the specifics of each are listed in Table 1. Kappaphycus and Gracilaria extracts were sprayed twice at various growth stages following 25, 50, and 75 DAS. As part of the therapy, sea weed sap was sprayed on the ground. Through a knapsack sprayer, the first spray was applied after 25 DAS on July 17, the second spray was applied at 50 DAS on August 11, and the last spray was applied at 75 DAS on September 4. 500–600 liters of water per hectare per year with adjuvant were used. The soil used for the experiment was 'Vertisol' (Clay), also known as 'Kanhar' locally. It had a pH of 7.4, an EC of 0.28 $dsm^{-1}$, and was made up of clay. The additional ingredients are available N (200.7 kg/ha), P (40 kg/ha), K (329.28 kg/ha), organic carbon (0.44%), and available N. The appropriate nutrient dose of N:P:K:S was applied to the soybean crop at a rate of 20:60:40:20 Kg $ha^{-1}$. Urea, single super phosphate (SSP), and muriate of potash (MOP), employed in that order, were used to apply the full amounts of nitrogen, phosphorus, potassium, and sulfur at the time of planting. SSP's sulfur content supplies the right amount of sulfur through application.

**Table 1:** Details of Treatments

| Doses Of Spray | Spray interval (DAS) |
|---|---|
| $T_1$: 2.5% **K Sap + *RDN | 25, 50 and 75 DAS |
| $T_2$: 5% K Sap + RDN | 25, 50 and 75 DAS |
| $T_3$: 10% K Sap + RDN | 25, 50 and 75 DAS |
| $T_4$: 15% K Sap + RDN | 25, 50 and 75 DAS |
| $T_5$: 2.5% ***G Sap + RDN | 25, 50 and 75 DAS |
| $T_6$: 5% G Sap + RDN | 25, 50 and 75 DAS |
| $T_7$: 10% G Sap + RDN | 25, 50 and 75 DAS |
| $T_8$: 15% G Sap + RDN | 25, 50 and 75 DAS |
| $T_9$: Water Spray+ RDN | 25, 50 and 75 DAS |
| $T_{10}$: 7.5% K SAP+50% RDN | 25, 50 and 75 DAS |

*RDN = Recommended dose of nutrients (10 t FYM + 20:60:40:20 $N:P_2O_5:K_2O:S$ kg $ha^{-1}$), **K sap = *Kappaphycus* sap and ***G sap = *Gracilaria* sap. (Red algae).

**Creating and analyzing a liquid sea weed extract's chemical makeup:** The seaweed species Kappaphycus sp. and Gracilaria sp. provided the extract used in this investigation. In September 2011, the algae were manually selected from Rameswaram, Tamil Nadu, India. It was carried to the field station at Mandapam, Rameswaram, after being cleaned with seawater to get rid of undesired impurities. The samples in this instance were thoroughly washed using tap water. After being homogenized by a grinder with stainless steel blades at room temperature, fresh seaweed samples were filtered and kept (Eswaran *et al*., 2005) [3]. The liquid filtrate was used to further dilute the seaweed extract at a 100% concentration, in accordance with the procedures. The nitrogen (N) content of seaweed extract (100% concentrate) could be ascertained by taking 20 ml of filtrate and oxidizing and decomposing it with concentrate sulfuric acid (10 ml) and digestion mixture (K2SO4: CuSO4 = 5:1) heated at 400 °C temperature for 2–12 hours as instructed in the semi-micro Kjeldahl method [AOAC International, 1995, method No. Ba 4b-87(90)]. The other nutritional components were examined by inductively coupled plasma-optical emission spectroscopy (ICP-OES) after wet digestion of filtrate (20 ml) with HNO3-HClO4 (10:4) di-acid combination and heating at 100 °C for 1 hour before raising the temperature to roughly 150 °C (Richards, 1954) [8].

## Results and Discussion

### Soybean uptake of nitrogen, phosphorus, and potassium

The uptake of N, P, and K by the soybean crop was significantly influenced by the foliar application of seaweed sap combined with RDN; nutrient uptake increased with greater dosages of seaweed sap. (Table 2). Analysis of the nitrogen and phosphorus absorption by the seed, stover, and complete plant at harvest showed that, while greatly increasing absorption, the foliar application of 15% K Sap + RDN (T4) was comparable to 15% G Sap + RDN (T8). The foliar application of 15% K Sap + RDN (T4) resulted in the biggest and most statistically significant amount of potassium uptake in grain, stover, and total, but it was on par with 15% G Sap + RDN (T8) for uptake in seed stover and total, and on par with 10% G Sap + RDN (T7) for uptake in stover. These findings closely resemble those of Pramanick *et al*. (2013) [6], who found that applying seaweed sap to the leaves of crops increased their ability to absorb nutrients. Rathore *et al*. (2009) [7] findings also confirmed that the foliar application of 15% (v/v) aqueous extracts prepared from fresh *Kappaphycus alvarezii* resulted in 57% increase of Glycine max yield compare to the control and intensified nutrient uptake by soybean crop. These findings support the hypothesis that the presence of marine bioactive substance in seaweed sap improves stomata uptake efficiency in treated plants compared to non-treated ones.

**Table 2:** Soybean uptake of nitrogen, phosphorus, and potassium

| Treatment | Nitrogen uptake (kg $ha^{-1}$) | | | Phosphorus uptake (kg $ha^{-1}$) | | | Potassium uptake (kg $ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain | Stover | Total | Grain | Stover | Total | Grain | Stover | Total |
| $T_1$: 2.5% K Sap + RDN | 90.28 | 40.74 | 131.02 | 6.65 | 4.85 | 11.50 | 23.84 | 35.92 | 59.76 |
| $T_2$: 5% K Sap + RDN | 104.70 | 42.15 | 146.85 | 7.64 | 5.29 | 12.94 | 26.83 | 37.21 | 64.04 |
| $T_3$: 10% K Sap + RDN | 119.40 | 47.46 | 166.86 | 9.18 | 6.37 | 15.56 | 30.60 | 40.93 | 71.53 |
| $T_4$: 15% K Sap + RDN | 141.01 | 56.79 | 197.80 | 11.77 | 8.02 | 19.79 | 36.32 | 48.06 | 84.38 |
| $T_5$: 2.5% G Sap + RDN | 89.54 | 41.50 | 131.04 | 6.36 | 4.65 | 11.02 | 23.31 | 36.58 | 59.89 |
| $T_6$: 5% G Sap + RDN | 101.77 | 40.76 | 142.53 | 7.48 | 4.83 | 12.31 | 26.64 | 35.58 | 62.22 |
| $T_7$: 10% G Sap + RDN | 117.50 | 48.38 | 165.88 | 8.86 | 5.92 | 14.78 | 30.14 | 41.20 | 71.35 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $T_8$: 15% G Sap + RDN | 133.76 | 51.39 | 185.14 | 10.78 | 6.66 | 17.44 | 34.80 | 42.34 | 77.14 |
| $T_9$: Water Spray+ RDN | 82.55 | 37.31 | 119.86 | 5.66 | 4.25 | 9.91 | 21.57 | 33.19 | 54.76 |
| $T_{10}$: 7.5% K SAP+50% RDN | 86.97 | 36.76 | 123.73 | 5.89 | 3.92 | 9.81 | 22.59 | 35.80 | 58.39 |
| S.Em± | 5.89 | 2.81 | 6.03 | 0.5 | 0.53 | 0.8 | 1.69 | 2.34 | 2.73 |
| CD (P=0.05) | 17.51 | 8.35 | 17.9 | 1.5 | 1.57 | 2.38 | 5.03 | 6.94 | 8.13 |

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