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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

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Abstract

A field experiment was conducted at Department of Agronomy, JNKVV, Jabalpur (MP) during, *kharif* season of 2012 to study the effect of Integrated Nutrient Management on growth and yield of soybean. Ten treatments comprising of recommended dose of fertilizer (20:60:20 kg NPK/ha) with different levels of seaweed saps *i.e.* K-sap (Kappaphycus sap) or G-sap (Gracilaria sap) *viz.,* 2.5% K-sap + RDF, 5.0% K-sap + RDF, 7.5% K-sap + RDF, 10.0% K-sap + RDF, 2.5% G-sap + RDF, 5.0% G-sap + RDF, 7.5% G-sap + RDF, 10.0% G-sap + RDF, water spray + RDF (control) and 6.25% K-sap + 50% RDF, were evaluated in randomized block design with three replications. Different observations on the crop parameters were carried out during the course of investigation. Growth parameters *viz.,* Plant population, plant height (cm), branches/plant, leaves/plant, leaf area index, chlorophyll content of leaf, root length (cm)/plant, root nodules/plant, dry weight (g)/plant and crop growth rate were recorded at periodic interval. Yield attributing traits *viz.,* pods/plant, seeds/pod and seed index were recorded treatment wise at the time of harvesting. Harvest index and economic viability of treatments were done from data generated. Soil samples also taken before sowing and after the harvest of crop to find out the changes in soil properties over their initial status. Finally economic viability of the treatments was also determined in terms of cost of cultivation, gross monetary returns, net monetary returns and B:C ratio on per hectare area basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results. After the investigation 10.0% K-sap + RDF was found superior. All the growth parameters, yield attributing characters and yield of soybean were found significantly superior under 10.0% K-sap + RDF closely followed by 10.0% G-sap + RDF, While, minimum under RDF alone.

Key words : Integrated Nutrient Management, soybean, seaweed sap.

Introduction

Soybean [*Glycine max* (L.) Merrill.] is one of the most important *kharif* season oilseed crop of Madhya Pradesh. Besides high yield potential (25-30 q/ha), it also provides cholesterol free oil (20%) and high quality protein (42%). It is rich source of amino acid, vitamins, minerals, fats and nutritive value. Being a leguminous crop, it is capable of fixing atmospheric nitrogen at the rate of 85-115 kg/ha/year.

The production of soybean in M.P. is decreasing day by day due to ill effects of soil fertility. Continuous use of inorganic fertilizer play a vital role in reducing the soil fertility, but integrated nutrient management (INM) approach can improve the soil health. The primary goal of INM is to combine old and new methods of nutrient management into ecologically sound and economically viable farming systems that utilize available organic and inorganic sources of nutrients in a judicious and efficient way. Some plant stimulants like marine bioactive substances extracted from marine algae are used in agricultural and horticultural crops, and many beneficial effects in the terms of enhancement of yield and quality have been reported. Liquid extracts obtained from seaweeds have recently gained importance as foliar sprays for many crops. Seaweed extracts contains major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abscisic acid like growth promoting substances and have been reported to stimulate the growth and yield of plants and also used to enhance the yield potential without impairing the soil health. Hence, the study was conducted to study the effect of Integrated Nutrient Management on growth and yield of Soybean (*Glycine max* L. Merrill).

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Materials and Methods

A field experiment entitled "Effect of Integrated Nutrient Management on growth and yield of soybean [*Glycine max* (L.) Merrill]" has been conducted at Department of Agronomy, JNKVV, Jabalpur (M.P.) during *kharif* season of 2012. The object of study was to assess the productivity of soybean under different levels of seaweed saps *i.e.* K-sap (Kappaphycus sap) or G-sap (Gracilaria sap) along with RDF (20:60:20 kg NPK ha^{-1}) and their subsequent effect on soil properties and plant.

The soil of experimental field was clayey in texture, neutral in reaction (pH-7.1) with normal EC (0.31) and low organic carbon (0.60) contents. The NPK availability was medium (372 kg/ha), low (11.20 kg/ha) and high (295 kg/ha) respectively. The rainfall was 1282.1 mm and weather condition was normal throughout the crop season.

Ten treatments comprising of recommended dose of fertilizer (RDF) with different doses of K-sap or G-sap *viz.,* T_1- 2.5% (12.5 lit/ha) K-sap + RDF, T_2- 5.0% (25.0 lit/ha) K-sap + RDF, T_3- 7.5% (37.5 lit/ha) K-sap + RDF, T_4- 10.0% (50.0 lit/ha) K-sap + RDF, T_5- 2.5% (12.5 lit/ha) G-sap + RDF, T_6- 5.0% (25.0 lit/ha) G-sap + RDF, T_7- 7.5% (37.5 lit/ha) G-sap + RDF, T_8- 10.0% (50.0 lit/ha) G-sap + RDF, T_9- water spray + RDF (control) and T_{10}- 6.25% (31.25 lit/ha) K-sap + 50% RDF, were tested in a randomized block design having 3 replications. Soybean var. JS 97-52 was sown 45 cm apart with 8 cm plant to plant spacing on 2nd week of July, 2012. Recommended dose of fertilizers along with K-sap or G-sap were applied as per treatments at different intervals. Weed control and other protection measures were performed under all treatments as recommended package of practice. All treatments were applied in 500 liters of water per hectare, using flat fan nozzle. Different observations on the crop parameters were carried out during the course of investigation.

Plant population of soybean was recorded at 25 DAS and harvest and other growth parameters *viz.,* plant height (cm), number of branches per plant, number of leaves per plant, leaf area index, chlorophyll content of leaf, root length (cm) per plant, dry weight (g) per plant and crop growth rate were recorded at periodic interval. Number of root nodules per plant was recorded at 60 DAS. Yield attributing traits *viz.,* pods per plant, seeds per pod and seed index (100 seed weight) were recorded treatment wise at the time of harvesting. The crop was harvest on 3rd week of October, 2012 as per the treatments. The recorded data were further computed for an average hectare. Harvest index and economic viability of treatments were done from data generated. Soil samples also taken before sowing and after the harvest of crop from each plot subjected to chemical analysis in order to find out the changes in soil properties over their initial status. Finally economic viability of the treatments was also determined in terms of cost of cultivation, gross monetary returns, net monetary returns and B:C ratio on per hectare area basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results.

Results and Discussion

Growth parameters

Treatment T_4 (10.0% K-sap + RDF) gave exhibited significantly higher plant height (73.60 cm) over T_9 (RDF alone) 55.83 cm at maturity of crop. Similarly, number of branches/plant (5.73), number of leaves/plant (18.27) and leaf area index (7.99), chlorophyll content (46.20), root length (27.95 cm), number of root nodules/plant (77.27), dry weight/plant (25.97 g) and crop growth rate (8.00 g/m^2/day) were highest under T_4, while minimum under T_9 (Table 1). The increase in growth parameters was attributed to the fact that application of organic manure increased the soil organic carbon, that holds greater moisture in soil and creates of suitable condition for better root growth and proliferation and also opportunity to extract water from larger profile area. These results were in conformity with the findings of Saxena *et al.,* (2001), Kadam *et al*., (2008), Ramana *et al*., (2008), Mandal *et al.,* (2009), Thenua Shyam Veer (2011), Thenua and Bist (2011), Viqar *et al*., (2011), Chaturvedi *et al*., (2012), Shah and Jaiswal (2012) and Yamika *et al.,* (2012).

Yield attributes and yield

Number of pods per plant (92.67), seeds per pod (2.42) and seed index (10.51 g) were found highest under T_4 (10.0% K-sap + RDF) closely followed by T_8 (10.0% G-sap + RDF) (89.07, 2.40 and 10.50 g respectively). While, all the above yield attributes were found minimum under T_9 (73.33, 1.98 and 10.30 g, respectively). Similarly, highest seed yield (29.13 q/ha), stover yield (45.78 q/ha) and harvest index (38.88) were observed under T_4 closely followed by T_8 (28.24, 45.03 and 38.54 respectively). While, minimum were found under T_9 (RDF alone) 20.38 q/ha, 38.28 q/ha and 34.74 respectively (Table 2). Increase in yield attributes and yield might be due to the favorable effect of K-sap or G-sap along with RDF on the availability of nutrients to the crop, that enhanced the yield attributes and yield of soybean. These results are closely conformity to the findings of Singh *et al*., (2007), Shivakumar and Ahlawat (2008), Rathore *et al*., (2009), Dabhi *et al*., (2010), Chaturvedi *et al.,* (2010), Shah and Jaiswal (2012), Singh *et al*., (2012) and Yamika *et al.,*

Table 1: Growth and growth parameters of soybean as influenced by different treatments.

T.No.	Plant population (row/meter)	Plant height (cm)	Branches/ Plant	Leaves/ Plant	LAI	Chlorophyll content	Root length	Root nodules/ plant	Dry weight (g)/plant	CGR (g/m²/day)
T_1	10.25	65.19	3.13	15.60	7.09	41.82	25.48	69.60	21.22	7.80
T_2	10.42	69.39	4.00	16.33	7.57	42.80	26.21	71.93	21.95	7.69
T_3	10.58	73.06	4.73	17.07	7.71	44.42	26.62	75.27	23.74	7.08
T_4	10.75	73.60	5.73	18.27	7.99	46.20	27.95	77.27	25.97	8.00
T_5	10.17	64.86	3.07	15.53	6.69	41.45	25.21	69.57	19.39	6.57
T_6	10.33	69.13	3.53	15.87	7.35	42.77	26.11	70.60	21.26	7.74
T_7	10.50	71.74	4.27	16.53	7.69	42.97	26.39	72.93	22.37	7.69
T_8	10.67	73.31	5.20	17.87	7.73	45.35	27.06	76.80	25.47	7.84
T_9	10.00	55.83	2.67	13.73	6.27	39.70	23.69	65.20	16.44	6.15
T_{10}	10.08	59.15	2.87	14.67	6.53	40.22	24.73	66.67	18.45	6.51
SEm±	0.28	1.05	0.20	0.59	0.12	0.58	0.45	1.46	0.82	0.40
CD(P=0.05)	NS	3.13	0.61	1.75	0.36	1.73	1.35	4.35	2.45	1.19

Table 2: Yield attributes and yield of soybean as influenced by different treatments.

T.No.	Pods/ plant	Seeds/ Pod	Seed index (g)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
T_1	77.40	2.17	10.38	22.52	40.90	35.50
T_2	82.27	2.32	10.47	24.82	42.44	36.90
T_3	85.87	2.35	10.49	27.56	44.71	38.13
T_4	92.67	2.42	10.51	29.13	45.78	38.88
T_5	76.93	2.08	10.37	22.40	40.80	35.44
T_6	79.67	2.18	10.46	23.96	41.25	36.74
T_7	83.73	2.33	10.48	26.21	43.02	37.86
T_8	89.07	2.40	10.50	28.24	45.03	38.54
T_9	73.33	1.98	10.30	20.38	38.28	34.74
T_{10}	75.27	2.05	10.33	21.77	39.88	35.31
SEm±	1.11	0.02	0.02	0.73	0.85	—
CD(P=0.05)	3.31	0.06	0.06	2.18	2.53	—

Table 3: Soil chemical properties as influenced by different treatments.

T.No.	Soil pH	E.C. (dS/m)	O.C. (%)	Available plant nutrients(kg/ha)		
				N	P	K
Initial status	7.10	0.31	0.60	372.00	11.20	295.00
T_1	7.10	0.31	0.61	374.37	11.31	294.49
T_2	7.11	0.31	0.62	374.49	11.41	295.16
T_3	7.11	0.32	0.62	374.34	11.31	294.97
T_4	7.12	0.33	0.62	375.24	11.22	295.48
T_5	7.11	0.31	0.60	373.25	11.22	294.37
T_6	7.11	0.32	0.61	374.74	11.34	294.50
T_7	7.12	0.31	0.62	374.41	11.44	294.69
T_8	7.12	0.32	0.62	374.74	11.34	295.33
T_9	7.11	0.31	0.60	372.24	11.20	294.25
T_{10}	7.11	0.31	0.60	373.00	11.21	295.00
SEm±	0.02	0.01	0.02	2.55	0.16	0.82
CD(P=0.05)	NS	NS	NS	NS	NS	NS

(2012).

Effect on soil properties

Chemical properties of soil *viz.,* pH, EC, OC and available N, P and K status were determine before sowing and after harvest of crop under different treatments indicated that the improvement in soil pH, EC, OC but different treatments did not found to alter the various properties of soil significantly (Table 3). Since the present study concerned with the effect of K-sap and G-sap on soybean in experimental field only for one season, hence remarkable changes in soil properties was not observed but there was a definite change in positive side was observed under application of 10.0% K-sap along with RDF followed by 10.0% G-sap along with RDF slightly brought out. These findings are in line of Singh *et al*., (2007), Shivakumar and Ahlawat (2008), Chaturvedi *et al.,* (2010), Chaturvedi *et al.,* (2012) and Singh *et al.,* (2012).

Economic viability of treatments

The gross monetary returns was maximum (Rs 65293/ha) under T_4 closely followed by T_8 (Rs 63357/ha). The gross monetary returns was remarkably minimum (Rs 46243/ha) under T_9 among all treatments. Cost of cultivation was found maximum (27710 Rs/ha) under T_4 and T_8 while minimum under T_9 (23210 Rs/ha) and with increases the dose of K-sap or G-sap it increases gradually. Treatment T_4 recorded maximum net monetary returns (Rs 37583/ha) with 2.35 B:C ratio among all treatments followed by T_8 with NMR of Rs 35647/ha. While, treatment T_9 gave minimum net monetary returns up to Rs 23033/ha with 1.99 B:C ratio. The benefit cost ratio was maximum in

Table 4: Economics of soybean cultivation as influenced by different treatments.

T.No.	Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B:C Ratio
T_1	24335	50973	26638	2.09
T_2	25460	55942	30482	2.19
T_3	26585	61900	35315	2.32
T_4	27710	65293	37583	2.35
T_5	24335	50712	26377	2.08
T_6	25460	54029	28569	2.12
T_7	26585	58913	32328	2.21
T_8	27710	63357	35647	2.28
T_9	23210	46243	23033	1.99
T_{10}	25053	49306	24253	1.97

T_4 (2.35) and T_{10} (1.97) fetched the minimum B:C ratio among all treatments (Table no. 4). After the calculation of treatment cost it was found that one litre K-sap or G-sap valued about Rs. 30 and it increased the cost of cultivation about 1125 Rs/ha as every increase of 2.5% K-sap or G-sap. Therefore, all the treatments show gradually increase in cost of cultivation with increasing dose of K-sap or G-sap. These results are in conformity with the findings of Shivakumar and Ahlawat (2008), Chaturvedi *et al*., (2010), Dabhi *et al*., (2010), Ramesh *et al.,* (2010), Chaturvedi *et al.,* (2012) and Shah and Jaiswal (2012).

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