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Effect of integrated nutrient management on growth, yield attributes and yield of soybean (*Glycine max*) under semi-acid condition

PRADIP KUMAR AND H.B. SHARMA

Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra-283105 (U.P.)

ABSTRACT

A field experiment was conducted at research farm R.B.S. College, Bichpuri, Agra (U.P.) to study the effect of inorganic fertilizers and bio-fertilizers on growth yield attributes and yield and economics of soybean [Glycine max (L.)]. The sixteen treatments were evaluated in a randomized block design with three replications. Application of 100% RDF resulted in significantly taller plants (53.3 cm), greater number of bromhes/plant (3.41), dry matter accumulation / plant (13.01g) and leaf area index (0.41) as compared to control. Yield attributes and yield of soybean also increased significantly with 100% RDF over control The maximum values of plant height (58.6 cm), number of brauches / plant (3.92), dry matter yield / plant (14.98 g), leaj area index (0.37), pods/ plant (41.0) seeds/pod (2.8) and 100 seeds weight (11.90 g) and seed (22.60 q ha^{-1}) and straw yield (29.19 q ha^{-1}) were recorded under 75% RDF + Rhi + PSB + VAM treatment closely followed by 75% RDF + Rhi + VAM. The increases in yield due to 75% NPK + Rhi + PSB + VAM were 12.4, 14.3, 14.6 and 12.4 per cent over 100% NPK, 75% RDF + Rhi, 75% RDF + PSB and 75% RDF + VAM treatments respectively. Significantly higher net returns (Rs.36250 ha^{-1}) and BIC ratio (3.35) were recorded with 75% RDF + Rhi + PSB + VAM treatment. The minimum values of net returns and B:C ratio were recorded in control plots.

Keywords: Economics, bio inoculants, seed yield, soybean

INTRODUCTION

Soybean has emerged as one of the major oil seed crops in India. It is considered as cash crop and is more important because of its yield potential and nutritionally ideal component to the Indian diet as its seed. It is a rich source of protein (40%) and oil (20%). Soybean helps in maintaining soil fertility by fixing atmospheric nitrogen. The low productivity of the crop is primarily due to factors like low organic matter in the soil due to imbalanced and less use of major nutrients under continuous cropping system. There is ample potential for increasing the average yield of soybean by way of using appropriate rhizobium and phosphate solubilized bacteria. These cultures not only increase the yield, but also save nitrogenous and phosphatic fertilizers, as well as upgrade fertility status of soil. The seed treatment with suitable rlizobium culture before sowing can increase pulse production to the extent of 10-15 per cent. It liberates growth promoting substances and vitamins and helps to maintain soil fertility. PSB can prove to be an effective low technology for the farmers as expense on costlier fertilizer can be lowered down. There is a need to improve the nutrient supply system in terms of integrated nutrient management involving the use of fertilizers in conjunction with organic manures and bio-fertilizers. Therefore, the present experiment was undertaken to study the effect of nutrient management options on the crop growth and yield of soybean.

MATERIALS AND METHODS

The experiment was conducted at research farm R.B.S. College, Bichpuri, Agra (U.P.) (27° 2' latitude, 77° 9' longitude with an elevation of 163.4m above mean sea level). The experimental soil was sandy loam in texture with pH 7.8, EC 0.48 dSm^{-1}, organic carbon 4.1 g kg^{-1}, available N 187 kg ha^{-1}, P 16.5 kg ha^{-1}, K 186 kg ha^{-1} and DTPA-Zn 0.52 mg kg^{-1}. There were 16 treatments namely T_1 control, T_2 100% RDF (30 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}, T_3 50% RDF + rhizobeum, T_4 50% RDF + PSB, T_5 50% RDF + VAM, T_6 50% RDF + rhizobeum + PSB, T_7 50% RDF + rhizobeum + VAM, T_8 50% RDF + PSB + VAM, T_9 50% RDF + rhizobium + PSB + VAM, T_{10} 750% RDF + rhizobium, T_{11} 75% RDF + PSB, T_{12} 75% RDF + VAM, T_{13} + rhizobium + PSB, T_{14} 75% NPK + rhizobium + VAM, T_{15} 75% RDF + PSB + VAM, T_{15} RDF + rhizobium + PSB + VAM. The treatments were laid out in a randomized block design with three replications. Nitrogen, phosphorus and potassium were applied as diammonium phosphate and muriate of potash, respectively. Seeds were treated

before sowing with rhizobeum and PSB as per treatments and VAM was applied in furrows before sowing. Seeds of soybean (JS-335) were sown in lines at 45 cm apart using a seed rate of 75 kg ha^{-1} during July. The crop was raised with recommended agronomic practices. Data on growth and yield attributes and yield were recorded at maturity. The data were statistically analysed using standard procedures of ANOVA at 5% level of significance.

RESULS AND DISCUSSION

Growth Parameters

Application of 100% RDF resulted significantly taller plants of soybean. Significantly lower plant height was recorded in the control plots where no fertilizers and bio-fertilizers were used (Table 1). The combined application of 75% RDF and bio-fertilizers further improved the plant height and maximum value of plant height (58.6 cm) was recorded with 75% RDF + Rhi + PSB + VAM treatment. Jadhav *et al.* (2009) and Bondey *et al.* (2017) reported similar results. The dual inoculation of rhizobuim and PSB with 75% RDF produced significantly higher dry matter accumulation / plant, number of branches / plant over single inoculation of rhizobium or PSB. This may be due to the fact that nitrogen plays a key role in enhancing the photosynthetic activity which results in higher dry matter production. Higher leaf area index was recorded with 100% RDF. The control plots recorded significantly lower leaf area index (Table 1). The maximum value of leaf area index (0.45 was recorded with 75% RDF + PSB + VAM and 75% RDF + Rhi + VAM. The LAI is the resultant of leaf growth of the plant. In the present study, better nutrition of plants owing to N, P and K fertilizers and bio-fertilizers might have resulted in improving leaf size, which might have led to significant increase in LAI. It is evident from the data (Table 1) that different INM treatments did not vary significantly in respect of days taken to complete maturity. However, treatment 75% RDF + Rhi + PSB + VAM took the maximum day for maturity whereas control plots took lesser day for maturity.

Table 1: Effect of integrated nutrient management on growth characters of soybean

Treatment	Plant height (cm)	Branches /plant	Dry matter yield/plant (g)	Leaf area index	Days taken to complete maturity
T_1 Control	42.1	2.50	7.21	0.29	100.5
T_2 100% RDF	53.3	3.41	13.01	0.41	106.0
T_3 50% RDF + Rhi	45.0	3.08	9.25	0.39	105.2
T_4 50% RDF + PSB	45.1	3.17	8.94	0.38	106.7
T_5 50% RDF + VAM	46.7	3.25	9.62	0.34	104.0
T_6 50% RDF + Rhi + PSB	50.3	3.50	10.31	0.38	106.5
T_7 50% RDF + Rhi + VAM	51.5	3.41	10.39	0.36	106.0
T_8 50% RDF + PSB + VAM	49.3	3.33	10.13	0.35	105.7
T_9 50% RDF + Rhi + PSB + VAM	52.7	3.41	11.73	0.42	104.2
T_{10} 75% RDF + Rhi	51.4	3.25	11.95	0.36	106.5
T_{11} 75% RDF + PSB	51.3	3.33	12.14	0.35	108.2
T_{12} 75% RDF + VAM	53.0	3.25	12.40	0.40	107.7
T_{13} 75% RDF + Rhi + PSB	56.0	3.50	13.02	0.37	107.7
T_{14} 75% RDF + Rhi + VAM	56.4	3.70	13.53	0.45	105.2
T_{15} 75% RDF + PSB + VAM	53.9	3.41	12.73	0.45	108.0
T_{16} 75% RDF + Rhi + PSB + VAM	58.6	3.92	14.98	0.37	109.0
CD (P=0.05)	1.81	0.40	0.76	0.11	NS

Yield Attributes

Application of fertilizers increased the pods/ plant and seeds/ plant significantly which further increased successively and significantly with the increasing level of NPK fertilizer upto 100% RDF. Rana and Badiyala (2014) also reported higher number of pods/plant with 100% NPK application. Test weight increased with increasing level of NPK fertilizer from 0 to 100% RDF over the control but the difference were not significant. Inoculation of seeds with bio-fertilizers also improved these yield attributes of soybean. Significantly higher number of

pods/plant and grains/pod were recorded with 75% NPK + Rhi + PSB + VAM treatment. Since the plants were healthy under the treatment having combination of fertilizers and bio-fertilizers, they produced more dry matter which was then reflected in their yield attributes. The minimum number of yield attributes were recorded in the control plots. Combined application of bio-fertilizers did not influence the 100-seed weight significantly, being a varietal character, is less sensitive to management levels (Rana and Badijala 2014, Dhange and Kachhave 2008).

Yield

The 100% RDF resulted in significantly higher seed yield over control. Increases in seed and straw yield with 100% RDF over control were 92.3 and 77.9%, respectively (Table 2). On an average, the yield increase was more where fertilizer level increased from 0 to 50% RDF compared to next increase from 50 to 100% RDF. Similar results were reported by Bonde *et al.* (2017), Chaturvedi *et al.* (2010) and Rana and Badiyala (2014). Application of 50 or 75% RDF with bio-fertilizers significantly increased the seed and stover yield of soybean over control. The maximum seed (22.60 q ha^{-1}) and straw (29.19 q ha^{-1}) yield of soybean increased with 75% NPK + Rhi + PSB + VAM treatment. This increase in yield due ot dual inoculation of rhizobium and PSB / VAM with NPK fertilizer may be due to enhanced availability of P and its active involvement in shoot and root growth led to better plant growth which later translate in to higher yield attributes and yield of soybean. Similar results were reported by Dhange *et al.* (2008) and Bonde *et al.* (2017).

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

Treatment	Pods/ Plant	Seeds/ pod	100 seeds weight (g)	Yield (q ha^{-1})		Net return (Rs ha^{-1})	B:C ratio
				Seed	Straw		
T_1 Control	13.8	2.3	9.82	10.56	15.21	10732	1.82
T_2 100% RDF	34.0	2.7	11.21	20.31	27.06	29989	2.88
T_3 50% RDF + Rhi	20.6	2.5	10.26	15.73	19.58	20139	2.39
T_4 50% RDF + PSB	22.2	2.6	10.41	15.90	20.46	21503	2.48
T_5 50% RDF + VAM	23.7	2.6	10.48	16.15	22.81	22132	2.53
T_6 50% RDF + Rhi + PSB	29.2	2.6	10.85	18.08	24.52	27128	2.86
T_7 50% RDF + Rhi + VAM	29.8	2.7	10.92	20.10	22.96	30489	3.08
T_8 50% RDF + PSB + VAM	29.1	2.5	10.84	19.98	22.71	29708	3.03
T_9 50% RDF + Rhi + PSB + VAM	34.6	2.7	11.17	20.04	24.13	30977	3.11
T_{10} 75% RDF + Rhi	26.5	2.5	11.24	19.92	21.13	29922	2.96
T_{11} 75% RDF + PSB	28.5	2.7	11.28	19.90	20.92	29823	2.95
T_{12} 75% RDF + VAM	29.7	2.7	11.25	19.92	23.31	30632	3.00
T_{13} 75% RDF + Rhi + PSB	40.0	2.7	11.64	21.04	25.92	32940	3.15
T_{14} 75% RDF + Rhi + VAM	39.6	2.7	11.69	21.90	26.65	34200	3.23
T_{15} 75% RDF + PSB + VAM	37.5	2.7	11.73	20.86	26.27	31978	3.08
T_{16} 75% RDF + Rhi + PSB + VAM	41.0	2.8	11.90	22.60	29.19	36250	3.35
CD (P=0.05)	1.60	0.13	NS	1.36	1.47	-	-

Economics

Significantly higher net returns (Rs.36250 ha^{-1}) and net returns per rupee invested (3.35) were obtained from the crop received 75% RDF + Rhi + PSB + VAM followed by 75% RDf + Rhi + VAM. The lowest net returns and B:C ratio were recorded in the control plots. Application of 75% RDF + Rhi + PSP + VAM resulted in highest yield of soybean, hence the net returns and B:C ratio. The 100% RDF recorded significantly higher net returns and B:C ratio among the nutrient levels. The results confirm the findings of Rana and Badiyala (2014).

It may be concluded that the combined application of 75% RDF + Rhi + PSB + VAM was fond to be beneficial in increasing the production and economics of soybean crop in Agra region of Uttar Pradesh.

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