**Annals of Plant and Soil Research 20 (Supplement) pp S57 – S60 (2018)**

# Effect of integrated nutrient management on yield, quality and nutrient uptake of soybean (*Glycine max*)

**PRADIP KUMAR AND H.B. SHARMA**

*Department of Agronomy, Raja Balwant Singh College Bichpuri, Agra (U.P.) 283 105*

## ABSTRACT

*A field experiment was conducted during rainy season at R.B S. College research farm, Bichpuri, Agra (U.P.) to study the effect of integrated nutrient management on yield, quality and nutrient uptake of soybean [Glycine max (L.) Merr.]. Sixteen treatments were evaluated in randomized block design with three replications. The results revealed that increasing levels of NPK fertilizers increased the seed and straw yield of soybean up to 100% RDF over control. The increases in seed and straw yield due to 100% RDF over control were 10.38 and 10.73 q ha$^{-}$, respectively. Application of 50% RDF + Rhi + PSB + VAM significantly increased the seed and straw yield of soybean over control. But the maximum seed (24.35 q ha$^{-1}$) and straw (28.48 q ha$^{-1}$) yields were recorded with 75% RDF + Rhi + PSB + VAM treatment. Application of 75% RDF + Rhi + PSB + VAM recorded significantly highest protein content in seed (38.9%), straw (5.7%) and oil (21.4%) content in soybean seed. Application of 100% RDF also recorded significantly higher protein and oil content in soybean over control. The uptake of N, P and K by soybean seed and straw increased significantly with 100% RDF and 50% RDF + Rhi + PSB + VAM over control. The maximum values of N, P and K uptake by soybean crop were recorded with 75% RDF + Rhi + PSB + VAM treatment.*

**Key words:** INM, yield, quality, nutrient uptake, soybean

## INTRODUCTION

Soybean (*Glycine max* L) is an important oil seed crop that is widely grown as a valuable source of protein and oil for human nutrition in the world. It has highest content of lysine, which is limiting factor in cereal. It is used in manufacturing of antibiotics in pharmaceutical industries and for producing soymilk and soya protein in food industry. In spite of its high yield potential, soybean productivity is much lower than developed countries mainly due to sub-optimal application of fertilizers. There is a need to improve the nutrient supply system in terms of integrated nutrient management involving the use of fertilizers in conjunction with biofertizers. There is ample potential for increasing the average yield of soybean by way of using appropriate rhizobium and phosphate solubilizing 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 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 + rhizobium, $T_4$ 50% RDF + PSB, $T_5$ 50% RDF + VAM, $T_6$ 50% RDF + rhizobium + PSB, $T_7$ 50% RDF + rhizobeum + VAM, $T_8$ 50% RDF + PSB + VAM, $T_9$ 50% RDF + rhizobium + PSB + VAM, $T_{10}$ 75% 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 rhizobium 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 yields were recorded at maturity. The seed and straw samples were analysed for nitrogen content by modified Keldahl method. Phosphorus and potassium in di acid ($HNO_3$:$HClO_4$) digest were determined by vanadomolybdate yellow colour method and flamephotometer (Jackson 1973). The uptake of nutrients was calculated by multiplying nutrient contents in seed and straw with their respective yield. The data were statistically analysed using standard procedures of ANOVA at 5% level of significance.

## RESULTS AND DISCUSSION

### Yield

Increase in seed yield of soybean over control (11.06 q $ha^{-1}$) was 93.8 per cent due to addition of 100%RDF (Table 1). The corresponding increase in straw yield was 78.2 per cent. Higher response of soybean to the applied N, P and K was expected on the N, P and K deficient experimental soil. Similar results were reported by Bonde *et al.* (2017). The seed and straw yields of soybean were significantly influenced by different combinations of inorganic fertilizers and biofertilizers. Application of 50% RDF + Rhi + PSB + VAM recorded higher seed (21.46 q $ha^{-1}$) and straw (25.40 q $ha^{-1}$) yields of soybean over control and individual application of rhizobium or PSB or VAM with 50% RDF. This may be due to higher N availability to plants due to N fixation from atmosphere resulting in an increase in yield. Application of PSB and VAM increased the concentration of P in soil solution and ultimately helps in formation of more nodules, vigorous root development, better $N_2$-fixation and overall better development of plants. This ultimately resulted in an increase in yield attributing characters and yield. Dual inoculation of biofertilizers with 75% RDF (75% RDF + Rhi + PSB + VAM) produced the highest yield of seed (24.35 q $ha^{-1}$) and straw (28.48 q $ha^{-1}$) over other treatments. This increase in yield may be attributed to increased availability of nutrients in soil. Similar results were reported by Jadhav *et al.* (2009), Chauhan *et al.* (2011) and Bonde *et al.* (2017).

Table 1: Effect of various treatments on yield and quality of soybean

| Treatments | Yield (q $ha^{-1}$) | | Harvest index | Protein content (%) | | Oil content |
|---|---|---|---|---|---|---|
| | Seed | Straw | (%) | Seed | Straw | (%) |
| $T_1$ Control | 11.06 | 13.71 | 42.6 | 37.4 | 3.8 | 19.1 |
| $T_2$ 100% RDF | 21.44 | 24.44 | 46.7 | 38.5 | 5.3 | 20.5 |
| $T_3$ 50% RDF + Rhi | 15.79 | 18.69 | 45.8 | 37.8 | 4.0 | 19.5 |
| $T_4$ 50% RDF + PSB | 16.86 | 20.73 | 45.0 | 37.9 | 4.0 | 19.7 |
| $T_5$ 50% RDF + VAM | 17.40 | 22.40 | 43.7 | 38.3 | 4.0 | 19.8 |
| $T_6$ 50% RDF + Rhi + PSB | 19.83 | 23.81 | 45.3 | 38.6 | 4.2 | 19.9 |
| $T_7$ 50% RDF + Rhi + VAM | 20.92 | 26.90 | 43.7 | 38.6 | 4.3 | 20.0 |
| $T_8$ 50% RDF + PSB + VAM | 20.33 | 23.00 | 46.9 | 38.1 | 4.3 | 20.1 |
| $T_9$ 50% RDF + Rhi + PSB+ VAM | 21.46 | 25.40 | 45.8 | 38.4 | 4.5 | 20.1 |
| $T_{10}$ 75% RDF + Rhi | 21.15 | 23.21 | 47.7 | 38.6 | 4.6 | 20.4 |
| $T_{11}$ 75% RDF + PSB | 21.08 | 23.29 | 47.5 | 38.5 | 4.4 | 20.6 |
| $T_{12}$ 75% RDF + VAM | 21.85 | 24.40 | 47.3 | 38.6 | 4.4 | 20.7 |
| $T_{13}$ 75% RDF + Rhi + PSB | 22.81 | 25.52 | 47.3 | 38.6 | 5.4 | 21.0 |
| $T_{14}$ 75% RDF + Rhi + VAM | 23.15 | 26.75 | 46.4 | 38.7 | 5.7 | 21.3 |
| $T_{15}$ 75% RDF + PSB + VAM | 22.17 | 25.02 | 47.0 | 38.6 | 5.6 | 21.3 |
| $T_{16}$ 75% RDF + Rhi + PSB+ VAM | 24.35 | 28.48 | 46.0 | 38.9 | 5.7 | 21.4 |
| CD (P = 0.05) | 1.60 | 1.81 | NS | 0.38 | 0.1 | 0.11 |

### Quality

Seed protein and oil content are important parameters which govern the quality of soybean. The protein content in soybean was influenced significantly by most of the treatments. The protein content in seeds ranged from 37.4% to 38.9%, the minimum being in

control. As nitrogen is a basic constituent of protein and with the increase in rate of N application from fertilizers and biofertilizers, the N availability increased which resulted in enhanced protein content in soybean crop. The maximum values of protein content in seed (38.9%) and straw (5.7%) were recorded with 75% RDF + Rhi + PSB + VAM. Oil content was also influenced significantly by various treatments. The maximum value of oil content in soybean seeds (21.4%) was recorded with 75% RDF + Rhi + PSB + VAM treatment. Increase in oil content might be attributed to balanced nutrition and supply of these nutrients seems to be involved in an increased conversion of primary fatty acid metabolites to end products of fatty acid resulting in higher oil content. A lower value of oil content was recorded in control. Similar results were reported by Chaturvedi *et al.* (2010) and Bonde *et al.* (2017).

Table 2: Effect of various treatments on uptake of nutrients (kg ha$^{-1}$) by soybean crop

| Treatments | Nitrogen | | Phosphorus | | Potassium | |
|---|---|---|---|---|---|---|
| | Seed | Straw | Seed | Straw | Seed | Straw |
| $T_1$ Control | 66.2 | 8.4 | 4.5 | 1.4 | 22.7 | 12.8 |
| $T_2$ 100% RDF | 132.1 | 20.9 | 9.4 | 2.8 | 49.1 | 25.1 |
| $T_3$ 50% RDF + Rhi | 99.5 | 12.1 | 6.5 | 1.9 | 33.8 | 19.0 |
| $T_4$ 50% RDF + PSB | 102.0 | 13.2 | 7.0 | 2.2 | 36.7 | 21.1 |
| $T_5$ 50% RDF + VAM | 106.5 | 14.4 | 7.3 | 2.5 | 38.0 | 22.9 |
| $T_6$ 50% RDF + Rhi + PSB | 121.6 | 16.0 | 8.5 | 2.7 | 43.8 | 24.6 |
| $T_7$ 50% RDF + Rhi + VAM | 128.6 | 18.7 | 9.2 | 3.2 | 40.4 | 28.5 |
| $T_8$ 50% RDF + PSB + VAM | 124.0 | 16.0 | 9.2 | 2.8 | 45.5 | 25.0 |
| $T_9$ 50% RDF + Rhi + PSB+ VAM | 131.8 | 18.4 | 9.5 | 3.1 | 48.0 | 28.1 |
| $T_{10}$ 75% RDF + Rhi | 129.0 | 17.1 | 8.8 | 2.5 | 47.4 | 25.9 |
| $T_{11}$ 75% RDF + PSB | 129.7 | 16.5 | 8.9 | 2.8 | 47.8 | 26.1 |
| $T_{12}$ 75% RDF + VAM | 134.5 | 17.3 | 9.8 | 3.0 | 49.8 | 27.9 |
| $T_{13}$ 75% RDF + Rhi + PSB | 140.9 | 22.2 | 10.5 | 3.1 | 53.0 | 30.1 |
| $T_{14}$ 75% RDF + Rhi + VAM | 143.2 | 24.3 | 10.8 | 3.4 | 54.2 | 32.0 |
| $T_{15}$ 75% RDF + PSB + VAM | 137.0 | 22.2 | 10.3 | 3.3 | 51.9 | 30.1 |
| $T_{16}$ 75% RDF + Rhi + PSB+ VAM | 150.8 | 25.7 | 11.6 | 3.7 | 59.3 | 34.5 |
| CD (P = 0.05) | 9.49 | 1.39 | 0.73 | 0.24 | 3.94 | 2.02 |

**Uptake of nutrients**

Nitrogen uptake by soybean increased significantly with different treatments over control (Table 2). The mean increases in N uptake were from 66.2 to 132.1 kg ha$^{-1}$ and 8.4 to 20.9 kg ha$^{-1}$, respectively by seed and straw with increase in the level of NPK from control to 100% RDF. The highest N uptake by soybean crop was recorded with application of 75% RDF + Rhi + PSB + VAM. This increase in N uptake may be attributed to increased seed and straw production. Dual inoculation with 50% RDF also increased the uptake of N by seed and stover over control. Similar results were reported by Rana and Badiyala (2014). The P uptake by seed and straw ranged from 4.5 to 11.6 kg ha$^{-1}$ and 1.4 to 3.7 kg ha$^{-1}$, respectively. Application of 100% RDF increased the uptake of P by soybean crop which may be ascribed to increased seed and straw production and improvement in P content in the crop (Bonde *et al.* 2017). Combined application of 50 and 75% RDF along with bio-fertilizers also improved the uptake of P by soybean seed and straw over control. The maximum values of P uptake by seed (11.6 kg ha$^{-1}$) and straw (3.7 kg ha$^{-1}$) were recorded with 75% RDF + Rhi. + PSB + VAM. This may be more availability of P from soil due to the solubility action of PSB (Jain and Trivedi, 2005).

Addition of NPK fertilizers proved beneficial in increasing K uptake by soybean seed and straw which may be attributed to higher production of seed and straw. The higher yields of seed and straw with 100% RDF absorbed large quantities of K from the soil thus depleting the more K consequently showing its higher uptake. Bonde *et al.* (2017) reported similar results. Application of 50% RDF + Rhi + PSB + VAM also improved the utilization of K by seeds and straw over control. The maximum values of K uptake by seeds (59.3 kg ha$^{-1}$) and straw (34.5 kg ha$^{-1}$) were recorded with 75%

RDF + Rhi + PSB + VAM treatment (Dhange and Kachhave, 2008).

It may be concluded from the present study that the combined application of inorganic fertilizer and dual inoculation (75% RDF + Rhi + PSB + VAM) was found to be beneficial in increasing the productivity of soybean and uptake of nutrients by the crop. The quality in terms of protein and oil content was also improved with integrated use of chemical fertilizers and biofertilizers.

## REFERENCES


Bonde, A. S. and Gawande, S. N. (2017) Effect of integrated nutrient management on growth, yield and nutrient uptake by soybean (*Glycine max*). *Annals of Plant and Soil Research* **17**(2) : 154-158

Chaturvedi, S. Chandel, A.S., Dhyani, V.C. and Singh, A. P. (2010) Productivity, profitability and quality of soybean (Glycine max) and residual soil fertility as influenced by integrated nutrient management. *Indian Journal of Agronomy* **55**(2) : 133-137.

Chauhan, S.S., Kumar, V., Bhadauri, U.P.S. and Dwivedi, A. K. (2011) Effect of conjoint use of organic and inorganic fertilizer on soil fertility and productivity of soybean wheat crop sequence. *Annals of Plant and Soil Research* **12**(1) : 32-34.

Dhange, S.J. and Kachhave, K.G. (2008) Effect of dual inoculation of Rhizobium and PSB on yield contributing character and seed yield of soybean. *Journal of Maharashtra Agricultural University* **33**(2) : 209-211

*Jackson, M.L. (1973) Soil Chemical Analysis Prentice Hall of Idia Private Limited, New Delhi*

Jadhav, A.S. Andhale, R.P. and Patil, P.A. (2009) Effect of integrated nutrient management on yield attributes and yield of soybean. *Journal of Maharashtra Agricultural University* **34**(1) : 86-88.

Jain, P. C. and Trivedi, S. K. (2005) Response of soybean (*Glycine max*) to phosphorus and bio-fertilizers. *Legume Research* **28**(1) : 30-33.

Rana, R. and Badiyala, D. (2014) Effect of integrated nutrient management on seed yield, quality and nutrient uptake of soybean (*Glycine max*) under mid hill conditions of Himachal Pradesh. *Indian Journal of Agronomy* **59**(4) : 641-645.

Sarawgi, S.K., Sharma, G.K. and Rajput, R.S. (2008) Effect of phosphorus and bio-fertilizers on microbial activity yield and economics of soybean in Vertisol. *Annals of Plant and Soil Research* **10**(1) : 44-47.