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## Effect of organic sources in combination with fertilizers on nodulation, growth and yield of soybean (*Glycine max*) in soybean-wheat cropping system in Vindhyan plateau of Madhya Pradesh

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**Abstract**

Field experiments were conducted for consecutive two years (2014-15 and 2015-16) during kharif season on clay soil of Vindhyan Plateau of Madhya Pradesh to evaluate the effect of different organic sources (FYM, vermicompost and poultry manure) in combinations with variable levels of optimal NPK on nodulation, growth and yield of soybean in soybean-wheat cropping system. The value of different attributes associated with 75 per cent optimal NPK coupled with application of poultry manure @ 5 t per ha was maximum followed by 100 per cent optimal NPK. As compared with no fertilizer, the enhancement in seed yield 48.6 per cent and stover yield were 39.7 per cent by best treatment. Thus, the combined use of different organic sources played a significant role in increasing seed and stover yields of soybean.

**Keywords:** Growth, fertilizers, nodulation, organic sources, soybean-wheat system

**Introduction**

Soybean [*Glycine max* (L.) Merrill] is an important oil and protein yielding *kharif* season crop. It covers the largest area of 12.20 m ha among the oilseeds in India (2013-14). Soybean-wheat is a predominant and more remunerative system as compared to other cropping system in Vidisha District of Madhya Pradesh. In Madhya Pradesh soybean occupied 6.38 m ha and 5.79 m ha under wheat in 2013-14 (<http://eands.dacnet.nic.in>). In spite of significant contribution of both the crops in total production, the productivity of both crops is much below (soybean 842 kg/ha and wheat 2,405 kg/ha in Madhya Pradesh) than the potentials realized under real farm situations. Sub-optimal and skewed nutrition management in practice in soybean (Joshi, 2004) [3] is considered to be one of the limiting factors in productivity from soybean-wheat cropping system. Since, nutrient management plays a key role in augmenting the productivity of crops, a study to visualize the effects of integration of chemical fertilizers with FYM, vermicompost and poultry manure on soybean in soybean-wheat cropping system was carried out and results pertaining to soybean are discussed.

**Material and Methods**

Field experiment were conducted during *kharif* and *rabi* seasons of 2014-15 and 2015-16 at a fixed site of farmers field Village Kakravada, Tehsil Ganj Basoda district Vidisha of Vindhyan Plateau of Madhya Pradesh. The soil of experimental site was clay in texture with pH 7.58, organic carbon 0.56% and EC 0.14 dSm<sup>-1</sup>. The available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S contents were 252, 20.4, 360 and 16.22 kg per ha, respectively. The experiment was laid out in a randomized block design (RBD) with four replications and thirteen treatments encompassing graded doses of optimal NPK and their combinations with different manures along with control (Table 1). The total rainfall received during the first (2014) and second (2015) year (June to October) of experimentation was 1239.4 and 678.4 mm, respectively. All the agronomic operations were carried out as per recommendations. The crop soybean JS 93-05 was sown on 5<sup>th</sup> July 2014 and 26<sup>th</sup> June 2015 and harvested on 16<sup>th</sup> October 2014 and 10<sup>th</sup> October, 2015 during the experimentations.

The recommended dose of nutrients for soybean (20:60:20:20 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:S/ha) was applied as basal through urea, single super phosphate and murate of potash. The recommended dose of nutrient for wheat (120:80:40 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O/ha), was also applied using the same nutrient carries. Full dose of phosphorus and potassium along with one third dose of nitrogen were applied as basal and the remaining dose of nitrogen was applied in two equal splits at the time of first and second irrigation to wheat. FYM, vermicompost and poultry manure were incorporated 15 days prior to sowing of soybean. The data on plant population, dry matter accumulation, nodulation and yields were recorded in different treatments and analyzed statistically (Panse and Sukhatme, 1978) [6] and pooled data for two years are utilized for presenting results. The economics of different treatments was also worked out and analyzed statistically. The prevailing cost of inputs and produce were used to perform economic evaluation of the treatments.

### Result and Discussion

Dry matter accumulation recorded at 30, 60 and 90 days after sowing (DAS) revealed that it increased gradually with advancement of crop age; the maximum rate of increase was between 30 and 60 DAS in almost all the treatments (Table 1). The dry matter accumulation was significantly higher in nutrient management treatments over control. The combination treatments of organic resources and fertilizers invariably showed higher values of dry matter accumulation over sole fertilizer treatments. Maximum dry matter accumulation (6.92 g/plant) was noticed in 75 per cent optimal NPK + poultry manure @ 5 t per ha, which was superior over other combination treatments and statistically higher over control as well as sole fertilizer treatments at all the growth stages. These results gain support from the findings of Paliwal *et al.* (2011) [5], who reported similar growth responses due to combined application of vermicompost with fertilizers.

Different nutrient management recorded significantly higher number of nodules as well as their dry weight over control as recorded at 45 DAS (Table 1). Numerically these two parameters showed an increasing trend with increase in sole fertilization level, but the values were significantly higher than control. In general, fertilizer combinations with poultry manure recorded higher number and dry weight of nodules followed by vermicompost and FYM. Maximum values of both parameters were recorded in 75 per cent optimal NPK + poultry manure @ 5 t per ha followed by 100 per cent optimal NPK + poultry manure, and these two treatments were significantly superior over remaining treatments in case of nodule dry weight. The effect of treatments was more conspicuous in case of dry weight of nodules. The improvement in these parameters might be the result of

improved soil environment due to fertilizer application alone and in combination with organic sources (Das and Dkhar, 2011) and Thakur *et al.* (2011) [9].

The seed and stover yields increased with sole fertilization and combination of fertilizers with organic sources. However, in case of both the parameters, significant increase over other treatments was only noticed when vermicompost/poultry manure @ 5 t per ha with 75 per cent optimal NPK or vermicompost /poultry @ 2.5 t with 100 per cent optimal NPK or vermicompost @ 2.5 t per ha with 75 per cent optimal NPK was incorporated. Maximum seed yield (1585 kg/ha) was recorded when poultry manure @ 5 t per ha was coupled with 75 per cent optimal NPK, which was at par with application of poultry manure @ 2.5 t per ha with either 75 or 100 per cent of optimal NPK. The combinations of poultry manure with 75 or 100 per cent of optimal NPK were superior over combinations with vermicompost or FYM. This also brought out that 25 per cent of optimal NPK can be shunned with coupling with poultry manure @ 5 t per ha. Application organic sources in combination with fertilizer are known to increase the microbial activity, nutrient availability and improves soil physico-chemical environment in the soil for plant growth, the enhanced productivity was noticed in the combination treatments. The results reported (Mandal *et al.*, 2000; Sable, 2005) [4, 7] in the past provides support to these results. The harvest index values did not differ significantly with nutrient management treatments. Chakraborty Bhargabi and Hazari Sujoy. (2016) [1] also found a significantly higher yield by 100% RDF + FYM @5t/ha. Sharma *et al.* (2014) [8] also found a significantly higher yield by 75% NPKS + FYM +PSB+*Rhizobium*+Zn+Mo. Waghmare *et al.* (2014) [10] also found pod yield per plant, seed yield per plant, 100 seed weight, seed yield, protein and oil yield in soybean seed by 75% NPK with 5t FYM and biofertilizer *rhizobium* + PSB. The economic evaluation of the nutrient management treatments revealed that most of the treatments fetched significantly higher monetary returns over control except 50 per cent recommended fertilizer application. Although, the combination treatments invariably had higher net returns as compared to control, the combined treatments of sole fertilization, fertilizers with FYM, fertilizers with vermicompost and fertilizers with poultry manure led to higher monetary returns by 18, 32, 47 and 83 per cent. This brought out that to fetch higher returns; the fertilizers may be coupled with poultry manures as tested in the experiment. Among fertilizer and poultry manure combinations, incorporation of poultry manure @ 5 t per ha with 75 per cent of optimal NPK led to highest returns of Rs 27544 per ha followed by poultry manure @ 2.5 t per ha with 100 per cent optimal NPK. The B: C ratios for the different treatments showed non-significant differences, the said two treatments had higher values of 2.79 and 2.65, respectively.

**Table 1:** Effect of organic sources in combination with graded fertilizer levels on dry matter production, nodulation, seed and stover yields, harvest index and economic viability of soybean (Data pooled for two years)

Treatments	Dry matter accumulation (g/plant)			Nodulation at 45 DAS		Yield (kg/ha)		Harvest Index	Net returns (Rs/ha)	B:C ratio
	30 Das	60 Das	90 Das	Number/plant	Dry weight (g/plant)	Seed	Stover			
Control	1.33	3.36	4.32	29.0	0.172	815	1060	43.47	11400	2.05
50 % optimal NPK	1.53	3.88	4.96	45.2	0.244	910	1165	43.86	13059	2.11
75 % optimal NPK	1.63	4.12	5.28	51.4	0.256	955	1203	44.25	13797	2.13
100 % optimal NPK	1.70	4.28	5.52	51.6	0.267	995	1234	44.64	14511	2.15
75 % optimal NPK + FYM @ 5 t/ha	1.76	4.44	5.72	52.0	0.274	1010	1252	44.65	14821	2.17

75 % optimal NPK + FYM @ 10 t/ha	1.86	4.72	6.04	52.8	0.284	1100	1320	45.45	16320	2.20
100% optimal NPK + FYM @ 5 t/ha	1.80	4.52	5.88	52.7	0.280	1055	1277	45.24	15584	2.18
75 % optimal NPK + vermicompost @ 2.5 t/ha	1.90	4.80	6.18	52.9	0.293	1130	1345	45.66	16875	2.22
75 % optimal NPK + vermicompost @5 t/ha	2.00	5.04	6.48	54.9	0.307	1215	1434	45.87	18544	2.31
100% optimal NPK + vermicompost @ 2.5 t/ha	1.93	4.88	6.28	54.0	0.300	1190	1412	45.73	18092	2.27
75 % optimal NPK + poultry manure @ 2.5 t/ha	2.03	5.12	6.60	56.0	0.312	1325	1497	46.95	21027	2.41
75 % optimal NPK + poultry manure @5 t/ha	2.13	5.36	6.92	65.4	0.334	1585	1759	47.40	27544	2.79
100% optimal NPK + poultry manure @ 2.5 t/ha	2.06	5.24	6.72	61.0	0.319	1490	1669	47.16	25179	2.65
CD (P = 0.05)	0.08	0.09	0.09	1.45	0.06	252	261	NS	2432	NS

### Conclusion

The study suggested that combined application of fertilizers with organic sources leads to better performance of soybean than non application of nutrients. Higher yields and monetary returns can be achieved by combining poultry manure, vermicompost and FYM in that order. The treatment combination poultry manure @ 5 t per ha with 75 per cent optimal NPK followed by 2.5 t per ha poultry manure with 100 per cent optimal NPK proved to be best for higher yield and monetary returns.

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