

Influence of organic and inorganic fertilization on soil fertility and productivity of soybean (*Glycine max*)

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ABSTRACT

A field experiment was conducted at Pantnagar, during the rainy season (*kharif*) of 2002 and 2003, to assess the effect of various fertilizer and manurial treatments on soybean [*Glycine max* (L.) Merr]. Integrated use of recommended fertilizers with supplementary nutrients increased the yield attributes and yield. Increase in yield varied from 58.7 to 124.4% and 61.9 to 136.9% during 2002 and 2003, respectively, over the control. Highest yield attributes (pods/plant, and 100-seed weight), harvest index, grain yield as well as NPK uptake was recorded with the application of 100% recommended dose of NPK + FYM @ 10 tonnes/ha. Use of organic sources helped in maintaining soil fertility in terms of available nutrients.

Key words : Organic manure, Mineral nutrients, Micro nutrients, Soybean, Harvest index, Nutrient uptake

Imbalanced nutrition is one of the important constraints of soybean productivity in the North Indian plains (Chandel, 1989; Tiwari, 2001). Continuous use of high level of chemical fertilizers has led to problems of soil degradation, which is proving detrimental to soybean production. A crop producing 6,720 kg/ha biomass removed about 614 kg N, 148 kg P and 486 kg K/ha (Nelson, 1989). Therefore adequate and balanced fertilization is necessary to increase soybean productivity. The supplementary and complementary use of organic manures and biofertilizer improve soil physical, chemical and biological properties, fertilizer-use efficiency, mitigates short supply of micronutrients, stimulates the proliferation of diverse group of soil micro-organisms and plays an important role in the maintenance of soil fertility and improves the ecological balance of rhizosphere. Hence an experiment was conducted to study the performance of soybean with different organic and inorganic sources of nutrient in terms of yield attributes, yield and N, P and K uptake.

MATERIALS AND METHODS

The field experiment was conducted at the Crop Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during rainy (*kharif*) season of 2002 and 2003. The experimental soil contains 0.792% organic carbon, 199 kg/ha available N, 20.1 kg/ha available P and 196 kg/ha available K. The ex-

periment consisted of 14 treatments, viz. different combinations of 2 fertility levels: 50% NPK (10+30+20 kg/ha) and 100% NPK (20 + 60 + 40 kg/ha) with FYM @ 10 tonnes/ha and supplementary nutrients, viz. boron @ 2 kg/ha, 0.5% borax spray and iron @ 5 kg/ha, 0.5% ferrous sulphate spray besides the control inoculated with *Bradyrhizobium japonicum*, was laid out in randomized block design with 3 replications. The FYM was incorporated in to soil, 15 days before sowing of soybean crop. Soybean cv. 'PK 1042' was grown during July–November, sown at a row spacing of 60 cm. Soil fertility was characterized on the basis of available N, P and K in soil. Since data followed the homogeneity test, pooling was done over the seasons and mean data are given.

RESULTS AND DISCUSSION

Yield-contributing characters

Yield-contributing characters of soybean were influenced significantly by the application of organics in combination with inorganic (Table 1). Recommended fertilizer dose of NPK resulted in significantly higher pods/plant, 100-grain weight and harvest index than the control. The pods/plant, 100-grain weight and harvest index also increased significantly by integrating FYM and supplementary nutrients like, iron and boron with NPK. However, maximum values of yield-contributing characters were recorded in combined application of 100% recommended

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Table 1. Yield and yield-attributing characters, total nutrient uptake by soybean and soil fertility after harvest as influenced by fertilizer treatments

Treatment	Pods/ plant	100-seed weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index	Total N uptake (kg/ha)	Total P uptake (kg/ha)	Total K uptake (kg/ha)	Available nitrogen (kg/ha)	Available phospho- rus (kg/ha)	Available potassium (kg/ha)
Control	50.8	9.1	17.00	29.77	0.37	118.0	16.1	32.8	197.4	18.5	195.0
Recommended NPK	83.7	10.6	31.29	36.12	0.47	224.8	30.8	75.1	207.4	21.2	200.0
50% recommended NPK	68.6	9.8	24.54	33.05	0.43	173.4	24.4	52.8	202.3	20.9	197.1
Boron @ 2.0 kg/ha	53.4	9.1	19.25	30.27	0.39	134.5	18.4	116.2	197.7	20.5	196.6
Iron @ 5.0 kg/ha	55.0	9.1	21.19	29.32	0.42	144.6	19.2	37.1	198.0	20.5	196.2
FYM@ 10 tonnes/ha	66.7	9.7	26.15	29.46	0.44	187.7	25.6	52.1	201.2	20.2	198.9
Recommended NPK + boron @ 2.0 kg/ha	88.8	10.7	35.44	37.30	0.49	253.6	34.5	83.3	209.0	21.1	200.9
Recommended NPK + iron @ 5.0 kg/ha	90.2	10.7	35.80	38.40	0.49	164.4	35.3	86.7	209.4	21.6	202.1
Recommended NPK + FYM @ 10 tonnes	94.4	10.7	39.20	40.22	0.50	280.6	39.0	99.9	215.8	22.9	203.4
50% recommended NPK + boron @ 2.0 kg/ha	72.5	10.1	27.25	34.30	0.44	193.3	27.1	66.2	204.1	20.0	198.9
50% recommended NPK + iron @ 5.0 kg/ha	75.6	10.3	27.95	35.28	0.45	199.3	28.1	68.8	205.4	20.9	197.0
50% recommended NPK + FYM @ 10 tonnes/ha	84.3	10.5	32.55	35.46	0.48	225.0	31.6	75.8	206.2	21.7	202.7
Recommended NPK + 0.5% ferrous sulphate spray at 45 DAS	87.9	10.9	34.54	37.57	0.48	249.8	34.6	87.4	209.1	20.2	199.9
Recommended NPK + 0.5% borax spray at 45 DAS	86.0	10.7	35.19	36.51	0.49	260.0	34.4	85.8	208.7	21.4	200.2
CD (P=0.05)	11.3	1.3	4.06	7.21	0.01	25.6	3.1	7.5	17.2	2.0	NS
*Initial values of soil :									199.0	20.1	196.0

dose of NPK + FYM @ 10 tonnes/ha, indicating that supplementing the inorganic fertilizers with organic sources like FYM improved the general soil environment, physico-chemical and biological conditions which helped to improve the soybean growth and yield contributing characters.

Yield

Grain and straw yields of soybean were affected significantly (Table 1) by treatments. Recommended rate of fertilizer (NPK) gave higher grain yield of soybean than the control. Increased application of chemical fertilizers from 50 to 100% NPK, also increased yield significantly. Combined application of FYM and supplementary nutrients (Fe and B) with chemical fertilizer also increased the grain and straw yields of soybean. Recommended dose of NPK + FYM 10 tonnes/ha gave the maximum yield which was 25.7, 60.2, 94.9, 84.7 and 82.0% higher in 2002 and 24.9, 59.4, 112.8, 85.4 and 48.0% higher in 2003 over the recommended NPK, 50% recommended NPK, boron @ 2.0 kg/ha, iron @ 5.0 kg/ha and FYM @ 10 tonnes applied alone respectively. Application of FYM @ 10 tonnes/ha with 50% NPK gave yield higher than recommended NPK dose when applied alone. The results on grain yield thus confirmed the trend observed earlier for the yield-contributing characters and upheld the need of supplementing the 100% chemical fertilizer level with 10 tonnes/ha of FYM. This emphasized the need for organic manuring along with chemical fertilizers.

Soil-fertility status

Integrated nutrient management had significantly increased the available nitrogen and phosphorus content in soil; however, K could not increase significantly in soil compared to initial values whereas in the control plots they declined significantly. The higher available nitrogen, phosphorus and potassium were recorded with the application of recommended dose of NPK with FYM @ 10 tonnes/ha, showing 10.3, 24.0 and 4.3% increase over the control respectively.

Integrated nutrient management significantly increased the available nitrogen and phosphorus in soil compared to initial values, whereas in the control plots they declined significantly. The highest available nitrogen and phosphorus were recorded with the application of recommended

dose of NPK with FYM @ 10 tonnes/ha, showing 10.3 and 24.0% increase over the control, respectively, indicating the benefits from the integrated use of fertilizers and manures which is also evident from the yield data. These findings confirm those of Shapira *et al.* (1987) and Bharadwaj and Omanvar (1994).

NPK uptake

The NPK uptake differed significantly due to different treatments during both the years (Table 1). Recommended dose of fertilizer when applied with organics, i.e. FYM @ 10 tonnes/ha supplementary nutrients, viz. boron @ 2.0 kg/ha or 0.5% borax spray and iron @ 5.0 kg/ha or 0.5% ferrous sulphate spray recorded significantly higher total uptake of N, P and K over the control. Increasing the fertility level up to 100% recommended NPK and integration with FYM and with supplementary nutrients (Fe and B) also resulted in higher uptake of N, P and K in general. Moreover, FYM treatment was found superior to the other treatments. Highest total uptake of N, P and K was observed with recommended NPK + FYM @ 10 tonnes/ha followed by recommended NPK + iron @ 5.0 kg/ha, 50% recommended NPK + FYM @ 10 tonnes/ha resulted in higher uptake than recommended NPK alone. This might be owing to increased supply of nutrient sources to the crop, as well as due to the indirect effect resulting from reduced loss of organically supplied nutrients.

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