

# Integrated Nutrient Control for Enhancing Growth and Yield Properties, Monetary Performance and Soil Health in Soybean (Glycine Max) Cropping System

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**Abstract** – A field experiment was carried out at village Kanadia, Indore in Madhya Pradesh during kharif 2019 to study the impact of integrated nutrient control on growth, yield, nutrients uptake, monetary performance of soybean {Glycine max (L.) Merrill variety JS-9560. In this experiment six different treatments (T1: control, T2: 10t/ha organic manure, T3: 100% RDF (40N+60P<sub>2</sub>O<sub>5</sub>+20K<sub>2</sub>O/ha), T4: INM (50% of RDF Through chemical fertilizer +50% through organics), T5 farmers practices (50kg DAP/ha). Results indicated that maximum seed yield (953kg/ha) was obtained in the treatment T4. Economic efficiency, net returns and B: C ratio was the highest with T4 which was closely found with the treatment T2 and T3. All the growth parameters were statistically at par in the treatments T2, T3 and T4. The maximum shoot length (44.88cm), pod/plant (27), branch number (2.42) and seed yield (950kg/ha) was also recorded in T4. Test weight was also significantly affected by different treatment; the highest test weight was recorded (10.58gm) in treatment T4. Soil physico-chemical properties revealed that integrated application of organics and chemical fertilizers in T4 observed the highest nutrient uptake.

**Keywords** – Integrated Nutrient Management, Soybean, RDF, DAP.

## I. INTRODUCTION

Soybean is the cash crop of the 21st century. These golden beans consist ample amount of oil and protein. Looking to ever increasing demand of the vegetable oil intensive cropping systems is implemented to increase yield of crops. But the uncontrolled use of fertilizers disturbed the native soil fertility, which is posing a threat to the sustainable productivity. It is well documented that organic manures are good complementary sources of nutrients, improve the efficiency of the available macronutrient, and improve soil physical and biological properties (Chaudhary et al., 2004). Hence, in the present scenario looking to the negative impact of chemical fertilizers the integrated nutrient management would be an ecofriendly alternative to increase the productivity by maintaining the soil health. The organic amendments like farmyard manure and crop residues would increase the organic carbon and microbial activities in the soil, which will definitely affect the crop productivity and soil nutritional status. Therefore, an experiment was conducted to study the effect of different nutrient

Management options on growth yield of soybean and soil health under agro-climatic condition of Malwa region.

## II. MATERIAL AND METHOD

The experiment was conducted during rainy season (kharif) of 2018 at Kanadia village, Indore (Madhya Pradesh). Soil of the experimental field was having pH 8.4, organic C 0.51% and 183.4, 27.8 and 315.5 kg/ha, available N, P and K, respectively. The treatments comprised of five different nutrient management treatments viz. (T1: control, T2: 10t/ha organic manure, T3: 100% RDF (40N+60P<sub>2</sub>O<sub>5</sub>+20K<sub>2</sub>O/ha), T4: INM (50% of RDF Through chemical fertilizer +50% through organics), T5 farmers practices (50kg DAP/ha). The experiment

was laid-out in a factorial randomized block design with three replications. The recommended amount of chemical fertilizer and organic manure was applied at the time of sowing. The crop was sown on 7 July 2010 at 40 cm row spacing with seed rate of 80 kg/ha. The gross plot size was 9.50 × 7.20 m, whereas, the net plot size was 8.5 × 6.40m. During the crop seasons two manual weeding (30 and 45 days after sowing) were done to manage weeds in the experimental crop.

Soil analysis was done at the time of sowing and after 60 Days of sowing. The physical properties and nutrient status of soil with different treatments were analyzed. Soil pH was determined in a 1:5 soil: water (w/v) (McLean 1982), the conductivity of supernatant liquid was determined by using electrical conductivity meter (Janzen 1993). Organic carbon was determined by Walkley-Black titration method (Matus et.al, 2009). Kjeldahl method (Saez-Plazaet.al, 2013) was used to determine total nitrogen. Available phosphorus in soil determined by Olsen method (Latrou et. al., 2014). Ammonium acetate (1N) was used for extracting available potassium and its estimation done by flame photometer (Rowell 1994).

Morphological characters such as plant height, number of nodules and yield attributes viz Number of pods, and number of seeds/pod, 100 seed weight were measured at the time of harvest. Observation of each variable was carried out on five representative plants in each plot.

Net returns generated by a crop, was the amount of money which was left, when cost of cultivation were subtracted from the gross returns which corresponds to the value of the harvested crop. B: C ratio indicates the returns one gets after investing one rupee. It was calculated by dividing the gross returns with the cost of cultivation.

#### *Statistical Analysis:*

The data of two years were pooled and analyzed using standard procedures of variance analysis with the help of statistical software WASP 1.0 (IARI)

### **III. RESULT AND DISCUSSION**

#### *Growth and Yield Attributes*

The table 01 indicates that highest seed yield (950kg/ha) was obtained due to treatment T4-50%of RDF through chemical fertilizer+ 50% through organics, followed by (889kg/ha) T3-RDF through chemical fertilizer (40N+60P2O5+20K2O/ha); T2 10t/ha organic manure for cropping sequence (884kg/ha). These treatment were significantly at par with each other and were higher as compare to the control. Similar trends were observed in the Stover yield.

It is clear from table01 highest Stover yield was obtained in treatment T4 (1010 Kg/ha) and T3, T2, T5 showed Stover yield 930,922,721 kg/ha respectively. All the treatments has shown significantly higher Stover yield as compare to control (706 kg/ha). It is observed previously that addition of inorganic fertilizers with organic sources like FYM improved the general soil environment physical, chemical and biological condition which helped to improve the soybean growth and yield characteristics (chaturvedi and chandel 2005). This findings are showing similarity Ghodke *et al.*, 2018 who reported that the treatment having 100% RDF + 10 t FYM+ 45 kg S/ ha +Biofertilizer recorded significantly higher number of flowers, pods, and grains per plant.

The results regarding plant height, number of branches, nodules, pod, grains per plant and test weight record-

-ed and presented in table 2. Taller plants and higher number of branches were observed with treatment T4 with 50% RDF+ 50% of organics. The Treatment T4 recorded significantly higher plant height (44.88 cm) than the rest of the treatments. The maximum number of branches plant-1 (2.42) was observed in T3 treatment which was statistically identical with T2 treatment, whereas the lowest number of branches plant-1 (2.2) in T1 (control) treatment. Pod number in plant and grains in one pod also shown a significant difference in the T4 showing the integrated nutrient control (Table 2). Maximum number of pods plant-1 (27.88) and Grain yield (4.21) was recorded in the treatment T4 followed by the treatment T2. The minimum pods plant-1 (12.6) and seeds pod-1 (2.02) was in T1. The formation of the good number of nodules indicates the compatibility of rhizobium with the rhizosphere. The maximum number of nodules was observed in T2 (102.53) followed by T4 (98.33). The minimum number of nodules was observed on T1 (84.03). The test weight observed in different treatments is represented in table 2. This increase in plant height, branches and leaves per plant might be due to greater availability of macro and micronutrients, form of organic and inorganic sources which helped in acceleration of various metabolic processes of N, P and k which help in better absorption of nutrients coupled with proper distribution, these results are in conformity with the reports of Dash et al. (2005). Improvement in nodule number and weight had been reported to be an outcome of improvement in the growth environment (soil pH, nutrient availability, and microbiological activity, physical and chemical properties of soil) among other factors (Brockwell et al. 1991 and Suryantini 2013).

#### **IV. ECONOMIC VIABILITY OF TREATMENTS**

Economic analysis is also an important factor for implementing the treatments in the field at large scale. The economic analysis among the different treatment was performed and represented in table 1. The gross monetary returns was maximum (Rs 23750/ha) under T4 closely followed by T3 (22225 Rs /ha). The gross monetary returns was remarkably minimum (Rs 16725 Rs/ha) in T1 among all treatments. Cost of cultivation was found maximum (15250 Rs/ha) under T4 while minimum under T1 (12000 Rs/ha). Treatment T4 recorded maximum net monetary returns (Rs 8500Rs/ha) with 1.56 B: C ratio among all treatments followed by T3 with NMR of Rs 7725/ha with 1.53 B: C ratio. While, treatment T1 gave minimum net monetary returns up to Rs 4725/ha with 1.39 B: C ratio.

#### **V. SOIL PROPERTIES**

Soil nutrient status was analyzed at 60 DAS and compared to soil nutrient status at the time of sowing. Mean Weight Diameter is one of the most widely used indicators to characterize soil aggregation (Zhou *et.al*, 2020). The soil aggregate consist of active microbial mass along with nutrient obtained from dead animals, plants and nutrients added from external source. These aggregate directly indicate the active microbe in the soil community.

Results (table03) showed that T2 treatment showed highest value of MWD, which was 71% higher that soil mean weight diameter as compare to control and 64.51% increase in treatment T4 is observed as compare to control. It is also evident from table 03 that 19.3% increase in MWD is observed as compare to control. A high value of soil MWD score reflects greater stability of soil (Zhou *et.al*, 2020). The stability of soil aggregates is important aspect for nutrient supply, which will directly affect the plant growth.

Bulk density of the soil is the important aspect and negatively correlated with the microbial populations & en-

-zyme activities (IiC.H.et.al, 2002) the highest soil bulk density was  $1.55 \text{ g/cm}^3$ , achieved by T1 treatment (Table 3), whereas the lowest bulk density was  $1.37 \text{ g/cm}^3$  observed in T2, which was approx. 11% lesser than the bulk density of control and T4 showed approx 7.6% decrease in the bulk density of the control. In terms of physical properties, low density of soil is quite porous and better for crop production. It is indicated that T2, T4 treatment because of the presence of organics affects soil pore network thereby enhancing the total surface area of soil, which enhances the water holding capacity of soil. Scientist reported that decrease of bulk density from 3.9 to 1.6 resulted in 26-39% decrease in microbial count and enzyme activity, which definitely will reduce the plant growth and yield.

Electrical conductivity (EC) shows the amount of soluble salt in the soil (Table 3). The higher value of the electrical conductivity results in increased osmotic pressure disable the nutrient uptake by plant and affect the plant growth. The lower value of EC results in the salt formation making the nutrient unavailability. This lowering of Electrical conductivity (EC, salinity) is one of the key characteristics of soil often measured for chemical analysis of soil filtrate. Effect of treatments on EC suggests that only T4 treatment showed slight increase in the level of soil. EC positively where other treatments led to no variations in soil EC.

Soil organic carbon (OC) is also a significant indicator for soil quality. Organic Carbon increased in all combination and was found to be highest in T4 treatment (0.27%) which is 93% higher than T1 (Table 3). One of the possible reasons to increase OC of soil is that ample amount of organic matter supports the rhizospheric microbes to flourish and results in increase in organic carbon content. The treatment (T5) had observed only 21 % increase in organic carbon content as compare to control.

Soil was found to be alkaline in nature (pH-7.9). Effects of different treatments on acidity of soil under soybean cultivation were observed non significant in all the treatments. The concentrations of P significantly enhanced in the T4 treatment (Table 3). The treatment T3 and T4 showed 54% and 66% rise in available P as compare to control while T5 is reported to have 38% increase of p availability as compare to control. Available N content also increased with the treatments, which indicate that combinations of inorganics and organism stimulate the rhizobia-legume symbioses and increased available N for soybean (Gopala Krishnanet. al, 2015). This supportive mutualistic association has resulted in 31 and 33% rise in available Nitrogen in T2, T4 as compare to control (Table 3) while T6 had shown only 5% enhancement in the available nitrogen content. The treatment T3 and T4 showed 54% and 66% rise in available K as compare to control, while T5 is reported to have 38% increase of K availability as compare to control organic soil amendments have been reported to improve the physical, chemical, and biological properties of the soil through the improvement of soil aeration, soil carbon exchange capacity (CEC), water holding capacity, and slow mineralization of organic materials (Yan et al. 2007; Zong et al. 2010; Gautam and Pathak 2014) could provide better economic and nutrition security along with environmental sustainability.

## VI. CONCLUSION

From the above work, it is concluded that the combined use of organics and inorganics in the farming system is efficiently increasing all the soil, plant properties as compare to use of inorganics singly. Integrated nutrient control besides the productivity is a promising approach as monetary performance. Integrated farming system had a positive effect on profitability through recycling the farm by-product.

Table 1. Effect of different treatments on the economic efficiency of cropping system.

Treatments	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Cost of Cultivation	Gross Return	Net Return	B:C ratio
T1	669	706	12000	16725	4725	1.39
T2	884	922	16000	22100	6100	1.38
T3	889	930	14500	22225	7725	1.53
T4	950	1010	15255	23750	8500	1.56
T5	688	721	13250	17200	3950	1.30
SEM ( $\pm$ )	44					
CD at 5%	135					

Table 2. Effect of different treatments on the growth and yield attributes of soybean.

Treatments	Shoot Length	Branch/Plant	Nodules/Plant	Pods/Plant	Grain Yield/ Plant	Test Weight (gm)
T1	38.9	2.20	84	12.6	2	8.71
T2	43.88	2.40	102	25.89	3.9	10.11
T3	41.29	2.30	90	24	4.1	10.20
T4	44.88	2.42	98	27	4.21	10.40
T5	42.37	2.36	86	20	2.88	9.12
SEM ( $\pm$ )	1.46	0.22	3.28	1.34	0.27	0.53
CD at 5%	4.49	0.67	10.10	4.13	0.83	1.63

Table 3. Effect of different treatments on physicochemical soil properties.

TR	BD	Porosity	MWD	OC	pH	EC (%)	N	P(kg/ha)	K(kg/ha)
T1	1.55	41.51	1.55	0.14	7.8	0.25	165	11	563
T2	1.37	55	2.66	0.22	7.7	0.24	218	15	618
T3	1.49	49.85	1.98	0.25	7.9	0.22	205	17	670
T4	1.44	55.44	2.55	0.27	7.8	0.26	219	18.13	657
T5	1.56	44.15	1.58	0.17	7.9	0.25	174	15.22	589

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