Effect of different nutrient management practices on crop growth, yield and yield attributes of soybean (*Glycine max L.*) under Kymore Plateau and Satpura Hillsagro-climatic zone

ABSTRACT

The field trial was conducted at Krishi Nagar Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India, during the *kharif* season of 2021. The field experiment consisted with 06 treatments and they were tested in randomized block design with 04 replications. The study revealed that maximum plant height (50.35 cm), branches per plant (5.74), effective root nodules (57), Leaf area index (4.90), dry weight plant^{-1}(45.16 g),yields attributes parameters like seed per pod (57.74), pods per plant (2.91) as well as seed index (11.88), seed yield (1009 kg ha^{-1}), stover yield (2087 kg ha^{-1})and HI (32.59%)of soybean was found higher under 100 % Organic NM followed by 25% Organic + NF inputs BJG +25% Inorganic NM.

Keywords: Soybean;natural farming;Beejamrit;Jeevamrit;Ghanjeevamrit; seed yield; organic; inorganic; nutrient management.

1. INTRODUCTION

Soybean (*Glycinemax L.*) is the world's most important seed legume;it is a native of North-eastern China belongs to family *Fabaceae*. It can grow well in tropical and subtropical climate and require warm and moist season. A temperature range of 25 to 30°C appears to be the optimum. Soybean is extensively grown in all over India especially in Madhya Pradesh because of its wide adaptability to agro-climatic conditions and better market value. It has great nutritive value and very high protein content (42-43%) and oil (18-20%) with major essential fatty acids and vitamins (A and D). It also having high carbohydrate (30%) and fiber (4%) content. Therefore, it also known as golden bean, wonder crop and man-made meat [1]. According to USDA, world soybean production in 2021-22 is estimated 372.5 million tons from total area of 120.50 million hectare [2]. Area under soybean in India is 11.34 million hectare and production are estimated 11.99 million tons (SOPA) in 2021-22. Madhya Pradesh stood first with 5.51 million hectares area and production of 5.56 million tons in 2021-22 [3]. Being a leguminous crop, it improves soil fertility by fixing atmospheric nitrogen at the rate of 65 to 115 kg per hectare per year with the process of symbiosis through *Rhizobium japonicum*. Nitrogen (N) is the most demanded nutrient by the soybean crop. It is estimated that it takes 80 kg of N to make 1000 kg of seeds. The content of soil reserve-derived nitrogen taken up by the whole soybean plants averaged 61.29 kg N/kg[4]. Chemical fertilizers cannot sustain productivity of land under modern farming system. Similarly, nutrient supply through organic manures and bio-fertilizers can hardly fulfill the need of a crop. Application of organic manure in conjunction with inorganic fertilizers in an integrated manner, proved to be the best alternative [5]. Integrating chemical fertilizer with organic manures has been proven to be highly promising in terms of not only preserving higher output but also increasing crop production stability [6]. When used with lower dosages of

inorganic fertilizers, farmyard manure or vermicompost enhanced soil fertility, crop growth, and yield. Chemical fertilizers, on the other hand, have a negative impact on soil fertility leading to unsustainable yields, while integration of chemical fertilizers with organic manures and bio-fertilizers would be able to maintain soil fertility and sustain crop productivity [7]. Nutrient supply plays an important role in the crop production but under intensive cultivation, use of chemical fertilizers alone for a longer period would result in deterioration of soil fertility and quality of produce [8].Integrated nutrient management (INM) is an integral part of the sustainable agriculture which requires the management of resources in a way to fulfill the changing human needs without deteriorating the quality of environment and conserving vital natural resources. It comprises of application of organic manures, green manures, blue-green algae, bio-fertilizers and crop rotation with legumes along with minimum use of chemical fertilizers to produce optimum crop yield without deteriorating the soil health [9].

2. MATERIAL AND METHODS

A field experiment entitled “Studies on the effect of varying nutrient management practices on growth and yield of soybean (*Glycinemax L.*)” was conducted during *kharif* 2021. The district Jabalpur is located in Madhya Pradesh, India, and is located between 23°18' N latitude and 79°98' E longitude, with an average altitude of approximately 411.78 meters (1387.73 ft) above mean sea level with a total area of 5198 km^2. According to the National Agricultural Research Program's criteria, Jabalpur is located in the "Kymore Plateau and Satpura Hills" agro-climatic zone. In the Jabalpur area, the average annual rainfall is 1350 mm. Though rainfall was less abundant during the crop season (from planting to harvesting), its distribution was not uniform. As a result, it encouraged crop establishment, followed by crop growth, development, and yield. These conditions were also quite congenial at this stage. Entire weather conditions were almost favorable for proper growth, development and yield of crops.

Table 1: Physico-chemical properties of soil of experimental field

Texture	Sandy clay loam (Sand:54%, Silt:24%, and Clay:21.69%
Soil reaction	7.16
Electrical conductivity (dS/m)	0.28
Soil organic carbon (%)	0.60
Available N kg ha^{-1}	216
Available P_2O_5 kg ha^{-1}	12.41
Available K_2O kg ha^{-1}	240

The field experiment consisted with 06 treatments and they were tested in randomized block design with 04 replications. The details of the treatments are given below:

Table2: Treatments details

	Treatments
T_1	100% Organic nutrient management
T_2	50% Organic NM +NF inputsBeejamrit+ Jeevamrit+Ghanjeevamrit
T_3	50% Organic NM + 50% Inorganic NM

T_4	25% Organic +NF inputs Beejamrit+Jeevamrit+Ghanjeevamrit 25% Inorganic NM
T_5	Farmer practices
T_6	100% Inorganic nutrient management

3. RESULTS AND DISCUSSION

3.1 Effect of Different Nutrient Management Practices on Crop Growth

3.1.1 Plant Height

The mean data on plant height of soybean crop as influenced by different nutrient management treatments (organic, inorganic and integrated nutrient management) which is given in Table 3. The plant height was recorded at two growth intervals as like at 60 DAS and harvest of crop. The dataindicate that the applied organic, inorganic and INM treatments have significant impact on plant height. The maximum plant height at 60 DAS and harvest (46.66 and 50.35 cm respectively) was recorded in case of 100 % Organic NM,followed by 25% Organic + NF inputs BJG +25% Inorganic NM (42.24 and 47.74 cmrespectively). Thereafter the height was significantly lowered down (35.91 and 45.52 cm respectively)in case of Farmer Practice treatments.This might bedue to the combine application of FYM,vermicompost and neemcake which enhanced the availability of nitrogen being a major constituent of chlorophyll, which facilitated more synthesis of food materials which caused greater cell division and cell enlargement. This could have contributed towards the increase in plant height with the inclusion of different organic manures sources[10, 11].

3.1.2Number of branches plant^{-1}

The mean data in relation to branches per plant at 60 DAS are presented in Table 3. The mean data on branches per plant of soybean crop as influenced by different nutrient management treatments under different treatments. The results of mean data studies revealed that number of branches plant^{-1} was significantly affected under different treatments. The maximum number of branches (5.74 plant^{-1}) was recorded under treatment*i.e.,*100 % Organic NM which is at par with T_4(5.41 plant^{-1}), T_6 (4.99 plant^{-1}) and T_2 (4.66 plant^{-1}).The minimum number of branches (4.16 plant^{-1}) was found underFarmer Practice treatment.This might bedue to inclusion of different organic manures *i.e.,* FYM, vermicompost and neemcakeunder T_1would have facilitated better growth and development ultimately a greater number of branches per plant [12, 13, 14].

3.1.3 Leaf area index (LAI)

The data related to LAI of soybean at 60 DAS was significantly influenced under different treatments as like (organic, inorganic and integrated nutrient management) as revealed from Table 3. Among all the treatments thehighest LAI (4.90) was found underT_1 (100 % Organic NM) which is at par with T_4 (25% Organic + NF inputs BJG +25% Inorganic NM) (4.84) and T_6 (100 % Inorganic NM) (4.81). The significantly lowest value of LAI (4.59) was recorded under T_5. This, might be due to maximum number of leaves was found under T_1 and minimum leaves was found under T_5 and LAI is positively correlated with number of leaves per plant [15, 16, 17,].

3.1.4Number of root nodules plant^{-1}

Number of root nodules plant^{-1}at 45 DAS was counted treatment wise and data were subjected to statistical analysis. The data presented in

Table 3.The study revealed that root nodules per plant showed significant difference under different treatments with highest number of root nodules (57.00 plant^{-1})was found underthe treatment with addition of 100 % Organic NM which is at par with T_3 (56.33 plant^{-1}) and T_4 (55.91 plant^{-1}). However, minimum root nodules count was observed when application of 100 % Inorganic NMi.e., 52.58 root nodules plant^{-1}.This might be due to organic sources provide good moisture and aeration in soil which facilitate the vigorous and synchronized root system and enhances the microbial activity in rhizosphereregion of plant root [18, 19,].

3.1.5Dry weight plant^{-1}

Data pertaining to dry weight per plant is presented in Table 3. The results revealed that significantly higher plant dry weight (45.16 g) at harvest was found in T_1(100 % Organic NM) which is at par with T_4 (40.75 g) and T_6 (37.31 g). The significantly lowest plant dry weight (25.83 g) was observed under Farmer Practice treatments.This might be due to increased supply of nutrients sources to the crop as well as indirect effect resulting from reduced loss ofnutrients from organic source [20, 21].

3.2 Effect of Different Nutrient Management Practices on yield attributes characters

3.2.1Number of pods per plant

The number of pods plants^{-1}was counted under each treatment and data were subjected to statistical analysis which is presented in Table 4. Among all different treatments significantly higher number of podsplant^{-1}(57.24) were found in 100 % Organic NM which is followed by T_4 (51.74) pods plant^{-1}(25% Organic + NF inputs BJG +25% Inorganic NM). However, significantly minimum number of pods per plant (37.66) was recorded under Farmer Practice. This might be due to inclusion of different organic manures which improved agronomic performance of soybean and increased crop yield [22, 23].

3.2.2Number of Seeds per pod

The data related to number of seeds per pod was recorded treatment wise. The data presented in Table 4. Itindicates that no significant difference on seeds per pod was found under all treatments but variation in number of seeds per pod from 2.58 to 2.91.

3.2.3Seed index (g)

The seed index was recorded in each treatment and the data were statistically calculated and presented in Table 4. Seed index is significantly affected under different treatments. Among different treatments the maximum seed index (11.88 g) was found in T_1 (100 % Organic NM) which is at par with T_4 11.50g (25% Organic + NF inputs BJG +25% Inorganic NM) and minimum seed index (10.04 g) was recorded in T_5 (Farmer Practice)[24, 25].

Table 3: Plant height, branches, LAI, effective root nodules and dry weight plant^{-1} as influenced by different nutrient management practices in soybean

Treatment No.	Plant height (cm)		Branches Plant^{-1}	LAI	Root nodules Plant^{-1}	Dry weight Plant^{-1}
	60 DAS	At harvest	60 DAS	60 DAS	45 DAS	At harvest
T_1 100 % Organic NM	46.66	50.35	5.74	4.90	57.00	45.16
T_2 50 % Organic NM +NF inputs BJG	40.07	46.27	4.66	4.71	55.25	35.25
T_3 50% Organic+50% Inorganic NM	38.33	45.85	4.24	4.65	56.33	32..25
T_4 25% Organic + NF inputs BJG +25% Inorganic NM	42.24	47.74	5.41	4.84	55.91	40.75
T_5 Farmer Practice	35.91	45.52	4.16	4.59	53.50	25.83
T_6 100 % Inorganic NM	40.66	46.49	4.99	4.81	52.58	37.31
SEm±	**1.59**	**1.16**	**0.45**	**0.06**	**0.39**	**2.94**
CD (p= 0.05%)	**4.78**	**3.51**	**1.37**	**0.17**	**1.16**	**8.85**

Table4: Number of Pods plant^{-1}, Seeds pod^{-1} and Seed index as influenced by different nutrient management practices in soybean

Treatment No.	Pods plant^{-1}	Seeds pod^{-1}	Seed index (g)
T_1 100 % Organic NM	57.24	2.91	11.88
T_2 50 % Organic NM +NF inputs BJG	50.41	2.74	10.87
T_3 50% Organic+50% Inorganic NM	48.24	2.66	10.62
T_4 25% Organic + NF inputs BJG +25% Inorganic NM	51.74	2.91	11.50
T_5 Farmer Practice	37.66	2.58	10.04
T_6 100 % Inorganic NM	50.58	2.75	10.15
SEm±	**1.74**	**0.20**	**0.20**
CD (p= 0.05%)	**5.25**	**NS**	**0.61**

3.3 Effect of Different Nutrient Management Practices on soybean yields

3.3.1 Seed and stover yield (kg ha^{-1})

The data related to seed as well as stover yield of soybean presented in Table 5. The data pertaining to seed and stoveryield ha^{-1}showed significant difference under all treatments. Among different treatment the maximum seed yield and stoveryield (1009 and 2087 kg ha^{-1}respectively) was recorded underthe treatment of 100 % Organic NM in terms of percentage it is (35%) higher as compared to farmer practice,followed by T_4(25% Organic + NF inputs BJG +25% Inorganic NM) which is (20%) higher than farmer practicethan T_2(50 % Organic NM +NF inputs BJG)which is (16%) higher as compare to farmer practice. However, significantly lower seed yield and stoveryield (746 and 1736 kg ha^{-1}respectively) was observed under the treatment of Farmer Practice [26, 27, 28].

3.3.2Harvest index (%)

The harvest index was calculatedas per given formula under each treatment. The data presented in Table 5 were statistically computed and study revealed that harvest index is significantly influenced under different treatments. Among all the treatments highest harvest index 32.59% was found in T_1(100 % Organic NM)which is at par with T_4(32.57%).However, the lowest harvest index was observed in Farmer Practice*i.e.,*30.06%.This might be due to excellent growth and development of soybean plant under higher nutrient content [29, 30].

Table 5: Seed yield and stover yield (kg ha^{-1}) as influenced by different nutrient management practices in soybean

Treatment No.	Seed yield	Stover yield	Harvest index (%)
T_1 100 % Organic NM	1009	2087	32.59
T_2 50 % Organic NM +NF inputs BJG	871	1931	31.08
T_3 50% Organic+50% Inorganic NM	861	1914	31.02
T_4 25% Organic + NF inputs BJG +25% Inorganic NM	899	1861	32.57
T_5 Farmer Practice	746	1736	30.06
T_6 100 % Inorganic NM	808	1846	30.44
SEm±	**31.56**	**69.00**	**0.46**
CD (p= 0.05%)	**95.12**	**208.00**	**1.39**

4. CONCLUSION

Based on the foregoing results and discussion above it can be concluded that maximum plant height, branches per plant, effective root nodules, LAI, dry weight plant^{-1}, yields attributes parameters like seed per pod, pods per plant as well as seed index, yields and HI of soybean was found higher under 100 % Organic NM followed by 25% Organic + NF inputs BJG +25% Inorganic NM.

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