Journal of AgriSearch **5**(2):96-99
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.5.2.3

Effect of Nutrient Management on Yields, Economics and Nutrient Content and their Uptake of Soybean (*Glyscine max* L.) under Rainfed Conditions

IS TOMAR, RK YADAV[1], RK TRIPATHI[2], MAHENDER SINGH[1], JAGDEESH MORYA[1] AND NARENDRA KUMAWAT[2*]

Zonal Agricultural Research Station, Jhabua, Madhya Pradesh, India

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

ARTICLE INFO

Received on	:	08-01-2018
Accepted on	:	22-04-2018
Published online	:	07-06-2018

ABSTRACT

The field experiments were conducted during *kharif*2013, 2014 and 2015 at Research Farm of Zonal Agricultural Research Station, Jhabua to study the effect of nutrient management practices on yields, nutrient content and economics of the soybean grown under rainfed condition of Jhabuahill. The experiment laid out in randomized block design with nine nutrient levels *viz*., T_1-control, T_2-vermicompost (5t/ha), T_3-FYM (10 t/ha), T_4-Recommended dose of fertilizers (RDF=20 N: 30 P_2O_5: 20 K_2O kg/ha), T_5-50% RDF + *Rhizobium* + PSB, T_6- 50% RDF + 50% vermicompost, T_7-50% RDF + 25% vermicompost + *Rhizobium* + PSB, T_8- *Rhizobium* culture + PSB and T_9- 50% vermicompost + *Rhizobium* + PSB. Results revealed that application of application of 50% RDF + 50% vermicompost(T_6) gave significantly highest seed yield (22.62 q/ha), straw yield (23.86 q/ha), biological yield (46.48), gross return (Rs. 69,230/ha), net return (Rs. 49,571/ha), production efficiency (20.56 kg/ha/day) and economic efficiency (450.64 Rs./ha/day) as compared to control. Whereas maximum B:C ratio (3.84) was recorded in 100% RDF followed by vermicompost @ 5 t/ha. Similarly, higher nutrient content (N, P and K) in seed as well as straw and their uptake were recorded under 50% RDF + 50% vermicompost. The highest protein content (41.99%) and protein yield (94,864 kg/ha) was also observed with the application of 50% RDF + 50% vermicompost. Hence, application of 50% RDF + 50% vermicompost better for obtain higher yields, economics and nutrient content and their uptake of soybean under rainfed condition of Jhabuahill of Madhya Pradesh.

Keywords: Economics, Nutrient management, Production efficiency, Protein content, Yield

INTRODUCTION

Soybean (*Glycine max*) is an economically important legume crops for being one among the global sources of protein and oil, as a food and livestock feed (Khan *et al*., 2016).It is the important pulse as well as oil seed crop in India. Among the oil seed crops, soybean has occupied 4th rank in the edible oil in India, next to groundnut, rapeseed and mustard. The area is the 11.60 Mha and production8.57 million tonnes in the India. Madhya Pradesh is the leading state in India, grown on an area of about 54.01 lakh hectare with annual production of about 55.07 lakh tonnes (Anonymous, 2016). Soybean like most legumes performs nitrogen fixation by symbiotic relationship with bacteria (*Rhizobium japonicum*). It contains 40-42 protein along with calcium iron, and glycine (Mere *et al*., 2013).

The productivity is low due to imbalanced fertilization or improper use of chemical fertilizers has caused nutritional in the soil, instability in productivity and hidden hunger, besides depletion of nutritional quality of the pulses. Use of organic manures with optimum rate of fertilizers turn-over of nutrients in the soil system. The organic manures along with biofertilizers helps in reducing the doses of inorganic fertilizers, which turn reduces the cost of cultivation and itsalso helps in improving productivity of soil (Gharpinde *et al*., 2014). Farmyard manure (FYM) and vermicompost are the important component of integrated nutrient management for maintain the soil health and improving the yields. The decomposition and mineralization of organic manures is the slow process, match the nutrient requirement of a crop and reduced the loss of plant nutrients (Chaturvedi *et al*., 2010). Nitrogen required as a starter dose along with organic manures and seed inoculation with effective strain of biofertilizers for its cultivation. From this background information, the present investigation was undertaken to study the effect of organic and inorganic sources of plant nutrients on yields, economics and nutrient content of soybean grown in sandy loam of Jhabuahills.

MATERIALS AND METHODS

Field experiments were conducted during *kharif* season of 2013, 2014 and 2015 at Research Farm, Zonal Agricultural Research Station, Jhabua (MP) ($21^0$30' – $22^0$55' N and $73^0$30' - 75^0 01' E; altitude 428 m above sea level). The experimental soil was sandy with shallow to medium depth with gravel developed over stony uplands with pH of 7.5, low in organic carbon (0.41%), available N, P and K of 215, 12.3 and 116.5 kg/ha, respectively. The experiment laid out in randomized block design with nine nutrient levels *viz*., T_1 - control, T_2-

[1]Krishi Vigyan Kendra, Jhabua (MP), India
[2]Zonal Agricultural Research Station, Jhabua (MP), India
*Corresponding Author Email : kumawatandy@gmail.com

vermicompost (5t/ha), T_3-FYM (10 t/ha), T_4-Recommended Dose of Fertilizer (RDF=20 N, 60 P and 40K kg/ha), T_5-50% RDF + *Rhizobium* + PSB, T_6- 50% RDF + 50% vermicompost, T_7-50% RDF + 25% vermicompost + *Rhizobium* + PSB, T_8- *Rhizobium* culture + PSB and T_9-50% vermicompost + *Rhizobium* + PSB. Recommended dose of fertilizers (RDF) i.e. nitrogen, phosphorous and potash were applied as basal in the form of urea, single superphosphate and murate of potash (MOP), respectively. *Rhizobium* and PSB was used as seed treatment (5 g/kg seed). Organic manures (FYM and vermicompost) was applied 15 days prior of sowing of the respective plots as per treatment. The nitrogen, phosphorus and potassium content in the applied FYM and vermicompost were 0.62, 0.41, 0.83% and 1.71, 1.18, and 1.95%, respectively. The seed and straw yield per net plot was recorded after drying. The plot yield was later on converted into kg/ha by multiplying it by conversion factor. Harvest index was calculated by using the following formula of Donald (1962) and expressed in per cent. The protein content was calculated by the multiplying the percentage value of nitrogen content of seed with the factor 6.25 (AOAC, 1970).

The seed and straw samples were subjected to analysis of N through auto nitrogen analyser, P calorimetrically using vanadomolybdo-phosphoric acid yellow colour method and K flam photometrically (Jackson, 1973). Nutrient uptake in seed and straw were calculated in kg/ha in relation to dry matter production/ha by using the formula. Fisher's method of analysis of variance was applied for the analysis and interpretation of data was made as per method of Panse and Sukhatme (1967). The level of significance used in 'F' and 't' tests was calculated at 5% probability. Critical difference values were calculated wherever 'F' test was found significant. Production efficiency and economic efficiency was calculated by following given formula below

$$\text{Production efficiency (kg/ha/day)} = \frac{\text{Seed yield (kg/ha)}}{\text{Total duration taken crop (days)}}$$

$$\text{Economic efficiency (Rs./ha/day)} = \frac{\text{Seed yield (kg/ha)}}{\text{Net return (Rs./ha)}}$$

RESULTS AND DISCUSSION

Effect on yields

The seed, straw and biological yield of soybeansignificantly differed due various integrated nutrient treatments (Table 1). The application of 50% RDF and 50% vermicompost (T_6) produced higher seed yield (22.62q/ha) but was statistically on par with 100% RDF (T_4) and 50% RDF + 25% vermicompost + biofetilizers (*Rhizobium*+PSB) (T_7) and superior to rest of the treatments. Further mean data showed that highest straw yield (23.86 q/ha)was also recorded in the treatment of 50% RDF and 50% vermicompost) but it was comparable with the 100% RDF.Similarly, highest biological yield (46.48 q/ha) was noted under application of 50% RDF and 50% vermicompost. The harvest index did not influenced by the different integrated nutrient management treatments. This might be due to beneficial effect of vermicompost was exhibited only when it was applied in conjunction of inorganic fertilizers which improve increase the nutrient availability and sustaining it over a period of time as compared to their alone application. Organic and inorganic sources of nutrients create the favourable soil condition resulting enhanced the availability of nutrients and final reflection on yield attributes of crop. The results in conformity with the findings of Chaturdevi*et al.* (2010), Mere*et al.* (2013),Devi *et al.* (2014) andMorya*et al.*(2018).

Table 1: Yields and harvest index of soybean as influenced by different nutrient management practices (mean data of 3 years)

Treatment	Seed yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
T_1=control	10.99	12.70	23.69	46.39
T_2= vermicompost (5 t/ha)	18.36	20.10	38.46	47.74
T_3=FYM (10 t/ha)	17.97	19.87	3784	47.49
T_4=100% RDF (20 N:60 P:40 K kg/ha)	21.43	23.30	44.73	47.92
T_5=50% RDF + *Rhizobium* + PSB	16.84	18.68	35.52	47.41
T_6=50% RDF + 50% vermicompost	22.62	23.86	46.48	48.65
T_7=50% RDF + 25% vermicompost + *Rhizobium*+ PSB	20.13	21.91	42.04	47.89
T_8=*Rhizobium* + PSB	13.29	14.85	28.14	46.83
T_9=50% vermicompost + *Rhizobium* + PSB	10.99	1.660	31.44	46.90
SEm±	9.91	5.42	12.70	1.44
CD (P=0.05)	29.83	16.20	38.11	NS

Effect on economics

Mean data of three years presented in table 2 showed that maximum gross returns (Rs. 69,230/ha), net returns (Rs. 49,571/ha) was recorded with the application of 50% RDF + 50% vermicompost followed by 100% RDF (Rs. 65727/ha and Rs. 48,623/ha, respectively).This was due toproduced higher seed and straw yield resulting gave maximum gross returns and net returns. Whereas, the higher B:C ratio (3.84) was obtained with the application of 100% RDF but it was at par with 50% RDF + 50% vermicompost and 50% RDF + 25% vermicompost + biofertilizers (*Rhizobium*+PSB). This might be due to relatively lower cost of chemical fertilizers produced higher B:Cratio and organic manures having higher cost than the chemical fertilizers therefore increase the cost of cultivation. The highest production efficiency (20.56 kg/ha/day) and economic efficiency (450.64 Rs./ha/day) were recorded with the application of 50% RDF + 50% vermicompost followed by 100% RDF and 50% RDF + 25% vermicompost + biofertilizers (*Rhizobium*+PSB). The results are conformity with the Awasarmal*et al.* (2013),Devi *et al.* (2014) and Jain (2015).

Table 2: Economics and production efficiency and economic efficiency of soybean as influenced by different nutrient management practices (mean data of 3 years)

Treatment	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio	Production efficiency (kg/ha/day)	Economic efficiency (kg/ha/day)
T_1=control	33862	20398	2.51	9.99	185.43
T_2= vermicompost (5 t/ha)	56346	34132	2.54	16.69	310.29
T_3=FYM (10 t/ha)	55198	26734	1.94	17.25	243.04
T_4=100% RDF (20 N:60 P:40 K kg/ha)	65727	48623	3.84	19.48	442.03
T_5=50% RDF + *Rhizobium* + PSB	51740	36376	3.37	15.31	330.69
T_6=50% RDF + 50% vermicompost	69230	49571	3.52	20.56	450.64
T_7=50% RDF + 25% vermicompost + *Rhizobium* + PSB	61762	44210	3.52	18.30	401.91
T_8=*Rhizobium* + PSB	40837	27293	3.02	12.08	248.12
T_9=50% vermicompost + *Rhizobium* + PSB	45605	27686	2.55	13.49	251.69
SEm±	2865	2865	0.18	1.19	26.05
CD (P=0.05)	8590	8590	0.55	3.58	78.09

Effect on nutrient content and uptake

The nutrient content (NPK) in seed as well as strawwas significantly influenced by various nutrient management levels (Table 3). Among the different treatments, application of 50% RDF and 50% vermicompost significantly improve N, P and K content in seed and as well as straw followed by 100% RDF. Similarly, highest uptake of N, P and K by the crop was also recorded with the application of 50% RDF and 50% vermicompost but it was at with 100% RDF and 50% RDF + 25% vermicompost + biofertilizers (*Rhizobium*+PSB). This might be due to beneficial effect of combined use of organic and inorganic sources of nutrients supply the nutrients for a longer period and improve the physical, chemical and biological properties of soil. As nitrogen increased, the protein content also increased because due to application of RDF and organic manures along with biofertilizers accelerated the availability of nitrogen which increase the protein content in seed. Similar findings were also made by Mere *et al*. (2013).

Table 3: Nutrient content and their uptake by soybean as influenced by different nutrient management practices (mean data of 3 years)

Treatment	Nutrient content in seed (%)			Nutrient content in straw(%)			Nutrient uptake by seed (kg/ha)			Nutrient uptake by straw (kg/ha)		
	N	P	K	N	P	K	N	P	K	N	P	K
T1=control	5.83	0.670	1.21	1.35	0.198	2.93	64.23	7.38	13.33	17.13	2.51	37.28
T2= vermicompost (5 t/ha)	6.44	0.736	1.35	1.52	0.227	3.59	118.32	13.51	24.81	30.59	4.56	72.24
T3=FYM (10 t/ha)	6.41	0.732	1.33	1.50	0.225	3.54	115.22	13.14	23.91	29.88	4.48	70.27
T4=100% RDF (20 N:60 P:40 K kg/ha)	6.47	0.785	1.40	1.58	0.235	3.70	137.73	16.78	29.82	36.99	5.51	86.73
T5=50% RDF + *Rhizobium* + PSB	6.26	0.720	1.30	1.44	0.211	3.51	105.63	12.15	21.94	26.82	3.96	65.70
T6=50% RDF + 50% vermicompost	6.72	0.780	1.42	1.61	0.242	3.73	151.78	17.67	32.01	38.43	5.77	89.04
T7=50% RDF + 25% vermicompost + *Rhizobium* + PSB	6.35	0.747	1.40	1.56	0.232	3.65	128.03	15.06	28.12	34.21	5.09	80.08
T8=*Rhizobium* + PSB	5.89	0.700	1.24	1.41	0.206	3.11	78.49	9.35	16.55	20.85	3.04	46.39
T9=50% vermicompost + *Rhizobium* + PSB	6.24	0.712	1.27	1.40	0.203	3.19	92.32	10.56	18.85	23.29	3.37	53.02
SEm ±	0.16	0.024	0.04	0.04	0.009	0.17	7.23	0.93	1.56	1.44	0.25	4.57
CD (P=0.05)	0.47	0.072	0.11	0.13	0.026	0.50	21.66	2.80	4.68	4.33	0.73	13.69

Table 4: Protein content and protein yield of soybean as influenced by different nutrient management practices (mean data of 3 years)

Treatment	Protein content in seed (%)	Protein yield (kg/ha)
T_1=control	36.44	40143
T_2= vermicompost (5 t/ha)	40.23	73953
T_3=FYM (10 t/ha)	40.05	72009
T_4=100% RDF (20 N:60 P:40 K kg /ha)	40.41	86084
T_5=50% RDF + *Rhizobium* + PSB	39.13	66021
T_6=50% RDF + 50% vermicompost	41.99	94864
T_7=50% RDF + 25% vermicompost + *Rhizobium*+ PSB	39.69	80016
T_8=*Rhizobium* + PSB	36.83	49057
T_9=50% vermicompost + *Rhizobium* + PSB	39.00	57702
SEm±	0.98	4516
CD (P=0.05)	2.92	13540

Effect on protein content and protein yield

Mean data of three years presented intable 4 showed that higher protein content (41.99%) was obtained with the application of 50% RDF and 50% vermicompost followed 100% RDF and 50% RDF + 25% vermicompost + biofertilizers (*Rhizobium*+PSB). Highest protein yield (99864 kg/ha) was produced by the application of 50% RDF and 50% vermicompost but it was statistically at par with 100% RDF. This might be due to nitrogen increased in grain, the protein content also increased. Application of organic manures in the form of vermicompostwith inorganic fertilizers along with biofertilizer accelerated availability of nitrogen which increased the protein content in grain of soybean. Similar findings were also reported byKhaim*et al*. (2013) and Morya*et al.*(2018).

CONCLUSION

The present study clearly suggests that integrated nutrient management affect the yields and economics of the soybean. Therefore, crop fertilized with organic and inorganic sources of nutrient (50% RDF @ 20 N: 30P_2O_5: 20 K_2O kg/ha and 50% vermicompost @ 2.5t/ha) was most productive and remunerative and sustainable for Jhabua Hill.

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Citation:

Tomar IS, Yadav RK, Tripathi RK, Singh M, Morya J and Kumawat N. 2018. Effect of nutrient management on yields, economics and nutrient content and their uptake of soybean (*Glyscine max* L.) under rainfed conditions. *Journal of AgriSearch* **5** (2): 96-99