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Effect of organic nutrient sources on productivity of soybean[*Glycine max* (L.) Merril]

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ABSTRACT

The experiment was laid out in a randomized block design (RBD) with six treatments and replicated thrice Growth and yield significantly increased by the application of different nutrient sources. Application of Poultry manure @ 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) enhanced both the growth and yield of crop. Maximum number of pods $plant^{-1}$ (67.73), seeds pod^{-1} (2.83), grain yield (1513 kg ha^{-1}) and Harvest index(45.62 %) were observed with Poultry manure @ 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6).

Key words: Organic nutrient sources, Productivity, Soybean.

INTRODUCTION

Soybean [*Glycine max (*L.)Merril] called as a 'miracle bean', and also known as gold of 21st century is a leguminous crop and belongs to family fabaceae with sub family papiliionaceae. It is basically a pulse crop but gained the importance as an oilseed crop as it contains 20 per cent cholesterol free oil. It is now the world's leading oilseed crop, cultivated in an estimated global area of 108.75 million ha with a production reaching 268 million tonnes and productivity 2.5 tonnes ha^{-1} in 2012-13 (Source - All India Co-ordinated Research Project on Soybean Report, 2012-13). In India, it is grown in a projected area of 10.69 million ha with estimated production and productivity of 12.67 million tonnes and 1185 kg ha^{-1}(AICRP Report, 2012-13). But the average production of soybean per unit area in our country is still low as compared to other developed and developing countries. The leading soybean producing states are Madhya Pradesh, Maharashtra and Rajasthan. The leading state producer of soybean in India is Madhya Pradesh with a production of 6.68 million tonnes (AICRP Report 2012-13).

Soybean has a very good adaptability towards a wide range of soils and climate. The north-eastern region is one of the major soybean growing belts and is grown in slopes, jhumland, terraces and plains. In Nagaland, the estimated area under soybean production is 2,424 ha with a total production of 2501 metric tonne with a productivity of 1032 kg ha^{-1} (Report, Department of Agriculture, Nagaland 2010). It is one of the most popular food items of majority of the people of Nagaland and is utilized as a fermented product as well as a pulse crop. In spite of its popularity in the state, the farmers give very little priority for its cultivation in large scale as a sole crop because the productivity is lesser as compared to other adjoining states.

Organic nutrient sources form a very important source of plant nutrients. They supply both macro and micro nutrients to crop plant. Use of organic sources improves the physical, chemical and biological conditions of the soil and helps to maintain and sustain soil fertility and enhance crop productivity in a framework of an ecologically compatible, socially acceptable and economically viable situation. There is a substantial increase in command area of soybean in last two decades and thereby intensive cropping. It has resulted in increase in cost of fertilizers. Low purchasing power of farmers has restricted the use of fertilizer for increasing crop production. Under such conditions it is essential to use all the available sources of plant nutrients in a judicious way to minimize fertilizer use and at the same time to sustain soil fertility and productivity on a long term basis. Therefore, efficient management of organic nutrient sources is a prerequisite for achieving continuous productivity of crops in an economically and ecologically sustainable manner. Hence, the present investigation was undertaken to study the 'Effect of organic nutrient sources on productivity of soybean (*Glycine max* L. Merril)".

MATERIALS AND METHODS

The present field experiment was conducted during *kharif* season of 2012 at the Experimental Farm, Department of Agronomy, School of Agricultural Sciences and Rural Development, Medziphema to study the "Effect of organic nutrient sources on productivity of soybean (*Glycine max* L.Merril)". The experiment was laid out in Randomised Block Design (RBD) with six treatments *viz., Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_1), FYM @

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7.5 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_2), Vermicompost @ 1.5 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_3), Neem seed kernel @ 1.5 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_4), Pig manure @ 7 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_5), Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) and Control (T_7) with three replications. The soil of experimental field was sandy loam and well drained. The topography of field was uniform with the experimental soils having low available N (250 kg ha^{-1}), low available P (12.31 kg ha^{-1}), and medium available K (251.21 kg ha^{-1}). Soil organic carbon content was high (1.44 %). Soil pH was found to be 4.5. During the experiment, the minimum temperature was 21°C and maximum temperature was 32°C. Soybean variety PS-1042 was sown at 40 cm × 20 cm spacing 16th of July, 2012, during *kharif* with a seed rate of 50 kg ha^{-1}. The seeds were treated with biofertilizers Rhizobium and Phosphatica to enhance the root nodule formation and seed establishment.

The observations were recorded on randomly selected 5 samples and their mean was taken for analysis at 30, 60 and 90 DAS. Observations to be recorded under growth parameters included plant height, number of primary branches $plant^{-1}$, number of root nodules $plant^{-1}$ and weight of fresh nodules $plant^{-1}$ and under yield attributes number of pods $plant^{-1}$, number of seeds pod^{-1}, Grain weight (g $plant^{-1}$), Test weight (g), Grain yield (q ha^{-1}), Stover yield (q ha^{-1}) and Harvest index (%). Crop was harvested at maturity, threshed and plot-wise yields were recorded. Grain and stover samples were taken for analysis of N, P, K, by standard procedure. The experiment data recorded during the course of investigation for each parameter were analyzed statistically by applying the technique of analysis of variance (Cochran and Cox, 1957). The significant difference was tested by "F" test. Critical difference of different groups of treatments and their interactions at 5% probability level were calculated whenever 'F' test was significant.

RESULTS AND DISCUSSION

Growth parameters: Improvement in growth characters is considered to be pre-requisite to increase yield (Table 1). Organic nutrient sources play very important role in enhancing the growth characters which results in improved crop yield. Maximum plant height (73.70 cm) was recorded with application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) at harvest. This may be due to the increase in metabolic activity, stimulation of root growth which resulted in increased uptake of N. This result was in conformity with the findings of Suppadit*et al*. (2006). The maximum number of primary branches $plant^{-1}$ (16.67) was recorded with application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). The increase in this attribute may be due to favorable uptake of nutrients under the above treatments as compared to other treatments. Ghosh *et al*. (2004) observed similar results. They reported that application of poultry manure @ 1.5 t ha^{-1}+75 % NPK significantly increased the number of primary branches and also other growth attributes (dry matter content, number and weight of root nodules $plant^{-1}$) and also yield and other yield components. The maximum number of root nodules (14.33) was obtained with the application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This may be because *Rhizobium* culture played direct role and PSB culture and poultry manure played indirect role in increasing the number of root nodules in the plant. This may be due to the fact that addition of organic manures to soil increase soil organic carbon, total nitrogen and total phosphorous content which are key determinants affecting soil microbial community. Tagoe *et al*. (2008) reported similar results. The application of poultry manure @ 5 t ha^{-1} + 50 kg ha^{-1} of N significantly increased the number of root nodule formation, and also the maximum fresh weight of the nodules (0.73 g and 2.23 g) was obtained in Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This finding was in accordance with the finding of Shroff (1994) in which it was observed that combined application of poultry manure with 100 % RDF resulted in increased fresh weight of root nodules in soybean.

Yield parameters: The number of pods $plant^{-1}$ was significantly influenced by different treatments (Table 2). The highest value (67.73) was obtained with the application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). The highest number of seeds pod^{-1} (2.83) was also observed with application of

Table 1: Effect of organic nutrient sources on plant growth attributes of soybean at harvest.

Treatment	Plant height at harvest (cm)	No. of primary branches $plant^{-1}$at harvest	No. of root nodules $plant^{-1}$ at harvest	Fresh weight of nodules (g) at harvest
T_1	67.77	13.17	13.27	1.83
T_2	69.90	13.90	13.63	1.87
T_3	69.93	14.03	12.37	1.40
T_4	71.70	12.93	12.53	1.37
T_5	72.10	15.53	14.07	2.20
T_6	73.70	16.67	14.33	2.23
T_7	64.27	12.67	12.27	1.17
SEm±	0.6	0.25	0.06	0.04
C.D. at 5%	NS	0.89	0.21	0.16

Table 2: Effect of organic nutrient sources on plant yield attributes of soybean at harvest.

Treatment	No. of pods plant^{-1}	No. of seeds pod^{-1}	Grain weight (g plant^{-1})	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T_1	54.90	2.33	10.63	127.49	1065	1363	43.86
T_2	57.77	2.40	10.80	124.63	1387	1667	45.46
T_3	52.23	2.20	10.50	126.20	1347	1623	45.34
T_4	50.77	2.27	10.47	123.40	1427	1613	45.12
T_5	63.33	2.60	11.53	126.77	1480	1757	45.57
T_6	67.73	2.83	12.07	127.53	1513	1807	45.62
T_7	47.07	2.15	10.30	122.43	670	890	42.94
SEm±	0.47	0.03	0.08	0.36	18.2	16.4	0.30
C.D. at 5%	1.72	0.12	0.3	NS	65.6	59.5	1.07

Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This might be due to more availability of nutrients from the given treatment. Suppadit*et al*. (2006) reported a similar result in which application of poultry manure with RDF resulted in significant increase in number of pods plant^{-1}, seeds pod^{-1} and pod dry matter in soybean crop. The highest value for grain weight (12.07 g plant^{-1}) was recorded with application with Poultry manure 6t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This significant increase of grain weight plant^{-1} are in accordance with the findings of Srisoomboon (1999) who reported that substitution of chemical fertilizer with that of poultry manure by 75 % significantly increased the 100 seed weight of soybean and also resulted in highest germination (51.0 and 40.0 %). However, no significant result was observed on test weight (g) plant^{-1}. This phenomenon may be ascribed to the genotypic character of the plant. The maximum grain yield (1513 kg ha^{-1}) was observed with application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This increase in yield may be due to increase in yield parameters *viz*. number of pods plant^{-1} and number of seeds pod^{-1}. Ramesh *et al*. (2006) reported similar result where application of poultry manure @ 7 t ha^{-1} resulted higher yield (1461 kg ha^{-1}) which recorded 17.5 % higher yield than chemical fertilizers (1243 kg ha^{-1}). The maximum stover yield was also obtained with application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This result is in conformity with the findings of Channabasavana *et al*. (2001) who reported that the yield and yield attribute were considerably increased with the enriched application of poultry manure. The maximum harvest index was recorded with the application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6). This result is in conformity with the findings of Ramesh *et al*. (2006) who reported that the harvest index was significantly higher (33.89 %) with the application of poultry manure and 100 % recommendations of N, P_2O and K_2O.

Nutrient uptake by the plant: The result pertaining on the influence of different organic nutrient sources on the nutrient uptake by the plant showed significant result for nitrogen uptake (Table 3). The highest N uptake (63 kg ha^{-1}) was observed in Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) (Table 4). This increase in N uptake may be due to increased availability of N in the soil owing to the application of Poultry manure together with *Rhizobium* and Phosphorous solubilizing bacteria. This result is in accordance with the findings of Kumar *et al*. (2006) who reported that application of 50 % N + 100 % N supplied through green leaf manure, poultry manure and crop residue compost (CRC) significantly resulted in higher N uptake (122.0 kg ha^{-1}) in soybean as compared to absolute control (823 kg ha^{-1}). However, P and K uptake in the plant was found to be non-significant with all the different treatments.

Economics: The data on economics of various treatments presented in Table 4 revealed maximum gross return (Rs. 90780), net return (Rs. 68830) and benefit cost ratio (3.1)

Table 3: Effect of organic nutrient sources on N, P and K (kg ha^{-1}) uptake by soybean at harvest.

Treatment	Nutrient uptake		
	N	P	K
T_1	55.76	14.83	36.20
T_2	55.03	13.57	40.29
T_3	55.54	15.00	39.33
T_4	55.41	13.27	35.90
T_5	59.57	15.13	42.07
T_6	63.00	15.27	44.60
T_7	48.80	12.70	28.10
SEm±	0.93	0.12	0.75
C.D. at 5%	3.36	NS	NS

Table 4: Effect of organic nutrient sources on economics of soybean.

Treatment	Cost of cultivation (‘)	Gross return(‘)	Net return(‘)	Benefit: cost ratio
T_1	16800	63900	47100	2.8
T_2	20300	83220	62870	3.0
T_3	31550	80820	49220	1.5
T_4	46550	85620	39070	0.84
T_5	22150	88800	66600	3.0
T_6	21900	90780	68830	3.1
T_7	16550	40200	23650	1.4

with application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) followed by Pig manure (Rs. 88800, Rs. 6660) gross return and net return respectively, and (3.0) cost benefit ratio @ 7 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_5). Hence application of Poultry manure 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed (T_6) was found to be the most profitable treatment. This result is supported by the findings of Ramesh *et al*. (2010) who reported that combined application of poultry manure @ 1 t ha^{-1} + vermicompost @ 0.7 t ha^{-1} + cowdung @ 1 t ha^{-1} recorded highest gross return (Rs. 43927), net return (Rs. 23890) and cost benefit ratio (2.19) as compared to either chemical fertilizers or control.

CONCLUSION

Application of poultry manure was found to be more beneficial as compared to other organic sources. Poultry manure @ 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1} seed produced highest grain yield (1513 kg ha^{-1}) and harvest index (45.62 %). Application of Poultry manure @ 6 t ha^{-1} + *Rhizobium* @ 20g kg^{-1} seed + Phosphatica @ 20g kg^{-1}resulted in significantly highest nitrogen uptake (63 kg ha^{-1}) and also resulted in higher B:C ratio as compared to the other treatments under experiment.

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