Influence of Nitrogen Sources and Application Methods on Growth and Yield of Soybean [*Glycine max* (L.) Merrill]

**I. Bala Manikanta*, Jamkhogin Lhungdim, K. Nandini Devi,
N. Surbala Devi and N. Gopimohan Singh**

College of Agriculture, Central Agricultural University, Imphal 795004, India

*Corresponding author

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A field experiment was conducted during the kharif season of 2019 in the research farm of college of Agriculture, Central Agricultural University, Imphal to study the Influence of Nitrogen Sources and Application Methods on Growth and Yield of soybean {*Glycine max* (L.) Merrill}. The treatments comprised of four Nitrogen sources [N1(75%N Urea+25%N FYM), N2(75%N Urea+25%N poultry manure), N3(75%N Urea+25%N Vermi compost), and N4(100%N Urea)] and two Application methods[M1(Soil incorporation), M2(Band placement)] Which were laid out in Factorial Randomized Design (FRBD) with eight treatment combinations and replicated thrice. Among Nitrogen sources all growth parameters, yield attributes and yield were performed well under N2 (75%N Urea+25%N Poultry manure) followed by N3(75%N Urea+25%N Vermi compost). While lowest values were found under N1 (75%N Urea+25%N FYM). Between two application methods M2 (Band placement) performed better. Among various growth parameters plant height, number of branches/plant, dry matter accumulation/plant were noticed maximum with the 75%N Urea+25%N Poultry manure applied in band placement method (N_2M_2). Similarly, Number of pods/plant, grain yield (q/ha), straw yield (q/ha) and harvest index(%) were noticed maximum with same treatment combination N_2M_2. Similarly gross returns and net returns was found best in N_2M_2.

Introduction

Soybean [*Glycine max* (L) Merrill] is known as the "GOLDEN BEAN" of the 20th Century. It can be treated as oilseed as well as pulse crop with the highest percentage (40-45%) of protein among all pulses. It is the only pulse crop that contains 20% of oil in the seed. That's why soybean is also regarded as potential oil yielding crop. It contributes 1/3rd of total oil produced in the world. Soybean posses a high nutritional quality protein,

which is rich in valuable amino acid lycine (5%). Soybean being the richest, cheapest and easiest source of best quality proteins and fats and having a vast multiplicity of uses as food and industrial products is sometimes called a Wonderer.

At present soybean yields are realised below its potential yielding capacity. The main reasons for not realising its full yielding potentiality, are lack of use of proper nutrition mainly nitrogen and its application methods.

For getting higher yield, it is necessary to optimize the nutrients inputs. Soybean, being a leguminous crop, is capable to fix atmospheric nitrogen through symbiosis. However, several studies have shown that the symbiotic N-fixation is not able to meet high N-requirement of this crop particularly under N-deficient conditions. The nitrogen requirement of soybean is high because of high yield potential and high protein content in grain (40-45%). Initial application of nitrogen doses stimulates root development, nodulation, good growth and yield. Starter-nitrogen application is directed at providing soybean with readily available soil nitrogen during seedling development and has been shown to increase soybean grain yields (Touchton and Rickerl, 1986). Atmospheric nitrogen fixed by *Bradyrhizobium japonicum* in nodules and mineral nitrogen are both sources of nitrogen for developing soybean plant with fixation capacity of 70% of the total nitrogen uptake. Amount of nitrogen fixed by soybean varies from 70 to 120 kg/ha (Tisdale and Nelson, 1975). Nitrogen application also improves the growth of the soybean plants. It has been reported that leaf area index (LAI) has been reported to increase with increase in nitrogen application (Grewal *et al.,* 1994).

Nitrogen is mainly applied to soil as broad casting method. Soil application of nitrogen as broadcasting often results in lower efficiency of concerned nutrients. The broad casted nitrogen undergoes several changes and losses which occur through leaching and

Materials and Methods

The investigation was carried out at research farm of College of Agriculture, Central Agricultural University, Imphal during kharif season of 2019. The experimental site was located at 24º46' N latitude and 93º54'E longitude at an altitude of 775m above, the mean sea level. It comes under the Eastern

Himalayan Region (II) and subtropical zone (NEH-4) of Manipur. The climatic condition of Imphal valley is sub-tropical. The rainy season usually begins by May and extends up to September. The average annual rainfall of Imphal valley is 1212 mm and the winter normally begins from mid November and extends up to the end of February. The amount of rainfall received during the crop period was 738mm. The soil of the experimental site was clay in texture with medium fertility status and acidic in reaction with a soil pH of 5.39. The chemical composition of the soil indicated that the soil was low in available nitrogen (181.8 kg/ha), medium in available phosphorus (22.3 kg/ha), medium in available potassium (227.4 kg/ha) and high in organic carbon content (1.2 %).

The experiment consist of treatment combination of four types of Nitrogen sources (75%N Urea+25%N FYM, 75%N Urea+25%N Poultry manure, 75%N Urea+25%N Vermi compost, 100% N Urea) and two types of application methods(Soil incorporation, Band placement) Which were laid out in Factorial Randomized Block Design(FRBD) with eight treatment combinations and replicated thrice. Soybean variety Dsb-19 was sown @80 kg seed ha^{-1} in rows 45 cm. The recommended dose of fertilizer N:P_2O_5:K_2O was applied @ 20:40:30 kg ha^{-1} for soybean crop. phosphorus and potassium was applied as basal through chemical fertilizers SSP and muriate of potash but Nitrogen was applied through inorganic (Urea) and organic (FYM, Poultry manure and Vermincompost) based on treatments. The nitrogen composition in organic manures is FYM (0.42%), Poultry manure (1.83%), vermin compost (1.55%).

The biometric observations were recorded on growth characters like plant height and number of branches per plant on five sample plants selected randomly from each net plot. For dry matter studies three plant samples

were uprooted from each gross plot. Post-harvest studies include the seed yield (kg/ha), stover yield (kg/ha) and harvest index (%) were also recorded from each net plot at the time of harvest. All the data obtained were statistically analysed by the method of analysis of variance to test the significance of the treatment effects as well as result interpretation as given by Gomez and Gomez (1984). F-test at 5% level of probability was used to test the significance of treatment effect and wherever the "F" test was significant critical difference (CD) values were given at 5 % level of significance.

Results and Discussion

Effect of nitrogen sources and application methods on growth characters of soybean

Data concerning the plant height, number of branches per plant and dry matter accumulation per plant as influenced by Nitrogen sources and application methods are presented in table 1.

The data on plant height of soybean recorded at harvest stage reveals that nitrogen sources and application methods bring significant difference among different treatments among nitrogen sources N2(75%N Urea+25%N Poultry manure) produced tallest plant (87.06cm), which was followed by N4 (85.55cm). It might be due to higher amount of Nitrogen availability resulted into more activities of meristematic tissues of the plant, increase in number and size of cell, which results into increased plant height. The results are in conformity with the findings of Shaheen *et al.,* (2017). Among application methods M_2 (Band placement) produced maximum plant height (88cm). It might be due to improved nutrient use efficiency. The results are conformity with findings of Nettles (l940), Harmoney and Thompson (2005). Among different treatment combinations, maximum plant height was noted with the

treatment combination N2M2 (91.56cm) which might be due to best combination of nitrogen source with application method followed by N4M2(87.6cm). While the least plant height was found in treatment combination N_1M_1 (82.8cm). The observation on number of branches/plant reveals that the maximum number of branches/plan t(17.49) was observed in N2 (75%N Urea+25%N Poultry manure) and it was par with N_3(16.82) & N_4(17.19) treatments. Where as lowest number of branches/plant (16.18) was observed in N_1 (75%N Urea+25%N FYM).Among application methods M_2 (17.8) gave more number of branches/plant than M1(16.04). Among treatment combination, the maximum number of branches/plant was observed in N_2M_2 (18.92) and it was par with N_3M_2 (17.24) & N_4M_2 (18.47) and least one was found in N_1M_1.

The maximum dry matter accumulation/plant (65.33gm) was observed in N_2 (75%N Urea+25%N Poultry manure) and it was par with N_3(61.26gm). It might be result of increase in photosynthetic activity and accumulation of more photosynthates which might be due to more nutrient availability. whereas lowest drymatter accumulation/plant (58.73gm) in N1(75%N Urea+25%N FYM). The results are conformity with the findings of Shaheen *et al.,* (2017). Among application methods maximum dry matter accumulation/plant (66.81gm) was in M_2 (Band placement) than M_1 (55.88gm). Among treatment combination, the maximum drymatter accumulation/plant was observed in N_2M_2 (73.86gm) followed by N_3M_2 (64.4gm) and the least one was observed in N1M1 (52.20gm). Effect of Nitrogen sources and Application methods on yield and yield attributes of soybean: Data concerning the number of pods/plant, grain yield, stover yield and harvest index as influenced by Nitrogen sources and application methods are presented in table 2.

Treatment details

Nitrogen sources	Notation
1. 75%N Urea+25%N FYM	N_1
2. 75%N Urea+25%N Poultry manure	N_2
3. 75%N Urea+25%N Vermicompost	N_3
4. 100% N Urea	N_4
Application methods	
1. Soil incorporation	M_1
2. Band placement	M_2

Table.1 Effect of nitrogen sources and application methods on growth characters of soybean

Treatment	Plant height (cm)	Number of branches per plant	Dry matter accumulation per plant (gm)
Nitrogen sources			
N_1(75%N Urea+25%N FYM)	85.00	16.18	58.73
N_2(75%N urea+25%N poultry manure)	87.06	17.49	65.33
N_3(75%N urea+25%N vermi compost)	84.80	16.82	61.26
N_4(100%N urea)	85.55	17.19	60.06
S.E. ±	0.718	0.425	1.955
CD at 5%	1.544	0.914	4.204
Application methods			
M_1(Soil incorporation)	83.20	16.04	55.88
M_2(Band placement)	88.00	17.80	66.81
S.E. ±	0.507	0.300	1.382
CD at 5%	1.091	0.646	2.973
Interaction effect			
N_1M_1	82.80	15.79	52.20
N_1M_2	87.20	16.57	65.26
N_2M_1	82.56	16.06	56.80
N_2M_2	91.56	18.92	73.86
N_3M_1	83.96	16.40	58.13
N_3M_2	85.63	17.24	64.40
N_4M_1	83.50	15.92	56.40
N_4M_2	87.60	18.47	63.73
S.E. ±	1.015	0.601	2.765
CD at 5%	2.183	1.293	5.946

Table.2 Effect of nitrogen sources and application methods on yield and yield attributes of soybean

Treatment	No. of pods/plant			Grain Yield (Q/ha)	Straw Yield (Q/ha)	Harvest Index (%)
Nitrogen sources						
N1(75%N Urea+25%N FYM)	106.71			23.51	32.10	42.33
N2(75%N urea+25%N poultry manure)	115.57			25.60	32.13	44.30
N3(75%N urea+25%N vermi compost)	113.75			24.87	31.25	44.28
N4(100%N urea)	107.57			24.20	31.29	43.55
S.E. ±	1.616			0.335	0.332	0.295
CD at 5%	3.475			0.721	0.714	0.636
Application methods						
M1(Soil incorporation)	106.16			23.42	30.65	43.31
M2(Band placement)	115.64			25.67	32.73	43.92
S.E. ±	1.143			0.237	0.234	0.209
CD at 5%	2.457			0.509	0.505	0.449
Interaction effect						
N_1M_1	103.65			23.00	31.55	42.25
N_1M_2	109.77			24.03	32.65	42.40
N_2M_1	110.79			24.10	31.29	43.50
N_2M_2	120.36			27.10	32.97	45.10
N_3M_1	106.00			23.50	30.05	43.87
N_3M_2	121.50			26.24	32.45	44.70
N_4M_1	104.21			23.09	29.72	43.61
N_4M_2	110.93			25.31	32.85	43.50
S.E. ±	2.286			0.474	0.461	0.418
CD at 5%	4.915			1.019	1.102	0.899

Table.3 Effect of nitrogen sources and application methods on economics of soybean

Treatment	GROSS RETURNS(₹/ha)	NET RETURNS(₹/ha)	B:C
N_1M_1	103500.8	55797.8	1.16
N_1M_2	108165.2	59802.2	1.23
N_2M_1	108450.1	63544.1	1.41
N_2M_2	121950.6	76384.6	1.67
N_3M_1	105750.7	59286.7	1.27
N_3M_2	118080.5	70956.5	1.50
N_4M_1	103920.4	60620.4	1.40
N_4M_2	113895.7	69935.7	1.59

The number of pods/plant was significantly affected by different treatments of nitrogen sources. Among nitrogen sources N_2(115.57) gave more number of pods per plant and it was par with N_3(113.75) and least was observed in N_1(106.71). The results are in conformity with Azam Shah *et al.,* (2012). Again application methods M_2(115.64) produced more number of pods per plant than M_1 (106.16) the results is in conformity with Timmons *et al.* (1973). Among treatment combination N_2M_2 (120.36) produced significantly maximum number of pods per plant and it was par with N_3M_2(121.50). The less number of pods per plant was observed in N_1M_1(103.65).

The grain yield was found higher in N_2(25.60 Q/ha) followed by N_3(24.87 Q/ha) and least was observed in N_1(23.5Q/ha). Higher grain yield may be due to effect of yield attributing characters. The results is in conformity with Azam Shah *et al.*(2012), Mamia *et al.*(2018), Almaz *et al.* (2017).Again application methods M_2 (25.67q/ha)produced superior grain yield than M_1.(23.42q/ha) The results is in conformity with Shahzad *et al.*(2003), Din *et al.* (1999). Among treatment combination N_2M_2 (27.10Q/ha) produced significantly highest grain yield and it was par with N_3M_2 (26.24q/ha). The lowest grain yield was found in N_1M_1 (23.00q/ha)

Among Nitrogen sources N_2(32.13q/ha)) produced significantly highest stover yield followed by N_4 and lowest straw yield was observed in N3. Higher stover production might be due to enhanced vegetative growth. The results is in conformity with Azam Shah *et al.*(2012), Shaheen *et al.* (2017).Among application methods M_2(32.73q/ha) produced significantly superior stover yield than M1(30.65q/ha). Precisely N_2M_2 (32.97q/ha) produced significantly highest stover yield and it was par with N_3M_2 (32.85q/ha) & N_4M_2 (32.45q/ha). The lowest straw yield was

found to be produced in N_1M_1(31.55q/ha). The harvest index was maximum for N_2(44.30%). It may be due to higher dry matter partitioning of photosynthates between grain and stover of plant. This is followed by N_3 (44.28%) and lowest was found in N_1(42.33%). Again it can be marked that M_2(43.92%) gave higher harvest index than M_1(43.32%). Among treatment combination N_2M_2 (45.10%) produced significantly highest harvest index and it was par with N_3M_2(44.70%). The lowest harvest index was found in N_1M_1(42.25%).

Economics

The influence of nitrogen sources and application methods was estimated in terms of economics is presented in Table 3. Among various treatments the highest gross returns (₹ 121950.6/ha) and net returns (₹ 76384.6) was found best in N_2M_2(75%N Urea+25%N Poultry manure applied in band placement) and benefit cost ratio(1.67) was recorded significantly higher in same treatment whereas lowest gross return (₹ 103500.8) ,net returns (₹ 55797.8) and benefit cost ratio (1.16) was observed in treatment N_1M_1(75%N Urea+25% N FYM applied in soil incorporation). The result is in conformity with Reddy *et al.* (2005).

It is clear from the results that 75%N Urea+25%N Poultry manure which applied in Band placement method(N_2M_2) achieved higher values with regards to growth characters (plant height, number of branches/plant, dry matter accumulation/plant), yield, yield attributes(pods/plant, grain yield, straw yield and harvest index) and economics(gross returns, net returns & B:C ratio). So that the treatment combination N_2M_2 (75%N Urea+25%N Poultry manure) applied in band placement is recommended.

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