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 24°46’ N latitude and 93°54’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:P₂O₅:K₂O 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 Vermin compost) 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 M2 (Band placement) produced maximum plant height (88cm). It might be due to improved nutrient use efficiency. The results are conformity with findings of Nettles (1940), 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 N1M1 (82.8cm). The observation on number of branches/plant reveals that the maximum number of branches/plant t(17.49) was observed in N2 (75%N Urea+25%N Poultry manure) and it was par with N3(16.82) & N4(17.19) treatments. Where as lowest number of branches/plant (16.18) was observed in N1 (75%N Urea+25%N FYM).Among application methods M2 (17.8) gave more number of branches/plant than M1(16.04). Among treatment combination, the maximum number of branches/plant was observed in N2M2 (18.92) and it was par with N3M2 (17.24) & N4M2 (18.47) and least one was found in N1M1.

The maximum dry matter accumulation/plant (65.33gm) was observed in N2 (75%N Urea+25%N Poultry manure) and it was par with N3(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 M2 (Band placement) than M1 (55.88gm). Among treatment combination, the maximum drymatter accumulation/plant was observed in N2M2 (73.86gm) followed by N3M2 (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<sub>1</sub> |
| 2. 75% N Urea+25% N Poultry manure | N<sub>2</sub> |
| 3. 75% N Urea+25% N Vermicompost | N<sub>3</sub> |
| 4. 100% N Urea | N<sub>4</sub> |

Application methods

| Application methods | |
|---------------------|--|
| 1. Soil incorporation | M<sub>1</sub> |
| 2. Band placement | M<sub>2</sub> |

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) |
|-----------|------------------|-----------------------------|----------------------------------------|
| N<sub>1</sub>(75% N Urea+25% N FYM) | 85.00 | 16.18 | 58.73 |
| N<sub>2</sub>(75% N urea+25% N poultry manure) | 87.06 | 17.49 | 65.33 |
| N<sub>3</sub>(75% N urea+25% N vermi compost) | 84.80 | 16.82 | 61.26 |
| N<sub>4</sub>(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<sub>1</sub>(Soil incorporation) | 83.20 | 16.04 | 55.88 |
| M<sub>2</sub>(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

| Interaction effect | |
|-------------------|--|
| N<sub>1</sub>M<sub>1</sub> | 82.80 | 15.79 | 52.20 |
| N<sub>1</sub>M<sub>2</sub> | 87.20 | 16.57 | 65.26 |
| N<sub>2</sub>M<sub>1</sub> | 82.56 | 16.06 | 56.80 |
| N<sub>2</sub>M<sub>2</sub> | 91.56 | 18.92 | 73.86 |
| N<sub>3</sub>M<sub>1</sub> | 83.96 | 16.40 | 58.13 |
| N<sub>3</sub>M<sub>2</sub> | 85.63 | 17.24 | 64.40 |
| N<sub>4</sub>M<sub>1</sub> | 83.50 | 15.92 | 56.40 |
| N<sub>4</sub>M<sub>2</sub> | 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**  |                   |                    |                    |                   |
| N1M1                    | 103.65            | 23.00              | 31.55              | 42.25             |
| N1M2                    | 109.77            | 24.03              | 32.65              | 42.40             |
| N2M1                    | 110.79            | 24.10              | 31.29              | 43.50             |
| N2M2                    | 120.36            | 27.10              | 32.97              | 45.10             |
| N3M1                    | 106.00            | 23.50              | 30.05              | 43.87             |
| N3M2                    | 121.50            | 26.24              | 32.45              | 44.70             |
| N4M1                    | 104.21            | 23.09              | 29.72              | 43.61             |
| N4M2                    | 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 |
|-------------|---------------------|-------------------|-----|
| N1M1        | 103500.8            | 55797.8           | 1.16|
| N1M2        | 108165.2            | 59802.2           | 1.23|
| N2M1        | 108450.1            | 63544.1           | 1.41|
| N2M2        | 121950.6            | 76384.6           | 1.67|
| N3M1        | 105750.7            | 59286.7           | 1.27|
| N3M2        | 118080.5            | 70956.5           | 1.50|
| N4M1        | 103920.4            | 60620.4           | 1.40|
| N4M2        | 113895.7            | 69935.7           | 1.59|
The number of pods/plant was significantly affected by different treatments of nitrogen sources. Among nitrogen sources N2 (115.57) gave more number of pods per plant and it was par with N3 (113.75) and least was observed in N1 (106.71). The results are in conformity with Azam Shah et al., (2012). Again application methods M2 (115.64) produced more number of pods per plant than M1 (106.16) the results is in conformity with Timmons et al. (1973). Among treatment combination N2M2 (120.36) produced significantly maximum number of pods per plant and it was par with N3M2 (121.50). The less number of pods per plant was observed in N1M1 (103.65).

The grain yield was found higher in N2 (25.60 Q/ha) followed by N3 (24.87 Q/ha) and least was observed in N1 (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 M2 (25.67q/ha) produced superior grain yield than M1 (23.42q/ha) The results is in conformity with Shahzad et al. (2003), Din et al. (1999). Among treatment combination N2M2 (27.10Q/ha) produced significantly highest grain yield and it was par with N3M2 (26.24q/ha). The lowest grain yield was found in N1M1 (23.00q/ha)

Among Nitrogen sources N2 (32.13q/ha) produced significantly highest stover yield followed by N4 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 M2 (32.73q/ha) produced significantly superior stover yield than M1 (30.65q/ha). Precisely N2M2 (32.97q/ha) produced significantly highest stover yield and it was par with N3M2 (32.85q/ha) & N4M2 (32.45q/ha). The lowest straw yield was found to be produced in N1M1 (31.55q/ha). The harvest index was maximum for N2 (44.30%). It may be due to higher dry matter partitioning of photosynthates between grain and stover of plant. This is followed by N3 (44.28%) and lowest was found in N1 (42.33%). Again it can be marked that M2 (43.92%) gave higher harvest index than M1 (43.32%). Among treatment combination N2M2 (45.10%) produced significantly highest harvest index and it was par with N3M2 (44.70%). The lowest harvest index was found in N1M1 (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 N2M2 (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 N1M1 (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(N2M2) 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 N2M2 (75%N Urea+25% N Poultry manure) applied in band placement is recommended.
References

Almaz, M.G., Halim, R.A. and Martini, M.Y. (2017). Effect of Combined Application of Poultry Manure and Inorganic Fertiliser on Yield and Yield Components of Maize Intercropped with Soybean. *Pertanika J. Trop. Agric.*, 40(1).

Azam Shah, S., Mahmood Shah, S., Mohammad, W., Shafi, M. and Nawaz, H. (2012). N uptake and yield of wheat as influenced by integrated use of organic and mineral nitrogen. *Int. J. Plant Prod.*, 3(3): 45-56.

Din, J., A. Rashid and A.I. Ahmed. 1999. Diagnosis and correction of phosphorus deficiency in chickpea grown in rainfed calcareous soils of Pakistan. *J. Indian Soil Sci.* 477 (3): 504 – 509.

Gomez A A, Gomez KA (1984) Statistical Procedures for Agricultural Research, John Wiley and Sons, Inc., New York.

Grewal, Harbans Singh, Kolar, J. S. and Singh, Dalip (1994). Effect of potassium and nitrogen on growth and yield of soybean (*Glycine max* L. merr.) *J. Potassium Res.*, 10(2) : 173-174.

Harmoneny, K.R. and Thompson, C.A., (2005). Fertilizer rate and placement alters triticale forage yield and quality. *Forage and grazinglands*, 3(1).

Mamia, A., Amin, A.K.M.R., Roy, T.S. and Faruk, G.M., (2018). Influence of Inorganic and Organic Fertilizers on Growth and Yield of Soybean. *Bangladesh Agronomy Journal*, 21(1): 77-81.

Nettles, V.F., (1940). Some effective methods of applying fertilizer. In *Proceedings of the Florida State Horticultural Society* (Vol. 53, pp. 202-205).

Reddy, S., Shivaraj, B and Reddy, V.C. (2005). Effect of poultry manure, sewage sludge and urban garbage compost on yield, quality and economics of groundnut (*Arachis hypogaea* L.). *Journal of Oilseeds Research*. 22 (2): 245-248.

Shaheen, A., Tariq, R. and Khaliq, A., 2017. Comparative and interactive effects of organic and inorganic amendments on soybean growth, yield and selected soil properties. *Asian. J. Agric. & Biol.*, 5 : 60-69.

Shahzad, M.A., Shah, S.H. and Nazar, M.S., 2003. Growth and yield response of brassica cultivars to fertilizer application methods under saline field conditions. *Journal of Agricultural Research (Pakistan).*

Timmons, D.R., R.E. Burwell and R.F. Holt. 1973. Nitrogen and phosphorus losses in surface runoff from Agricultural land as influenced by placement of broad cost fertilizer. *Water Resource Res.* 9: 658-667.

Tisdale, G.L. and Nelson, W.L. (1975). Soil fertility and fertilizer. The McMillan Company Collier. McMillan Ltd., London, pp. 71-73.

Touchton, J.T. and Rickerl, D.H. (1986). Soybean Growth and Yield Responses to Starter Fertilizers. *SOIL. SCI. SOC. AM. J.*, 50(1): 234-237.

How to cite this article:

Bala Manikanta, I., Jamkhogin Lhungdim, K. Nandini Devi, N. Surbala Devi and Gopimohan Singh, N. 2020. Influence of Nitrogen Sources and Application Methods on Growth and Yield of Soybean [Glycine max (L.) Merrill]. *Int.J.Curr.Microbiol.App.Sci.* 9(10): 618-624.

doi: [https://doi.org/10.20546/ijcmas.2020.910.073](https://doi.org/10.20546/ijcmas.2020.910.073)