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EFFECT OF RATE AND TIMING OF NITROGEN APPLICATION ON YIELD OF SOYBEAN

R. Nasrin[1*], M. K. Nilu[2], M. A. Islam[3] and M. M. Rahman[3]
[1]DAE, Nakla, Sherpur, Bangladesh
[2] DAE, Purbadhola, Netrokona, Bangladesh
[3]Dept. of Agronomy, BAU, Mymensingh-2202, Bangladesh
[*]Corresponding author's email: agri.roksana@yahoo.com

ABSTRACT

An experiment was conducted at the Agronomy Filed Laboratory, Bangladesh Agricultural University, Mymensingh from 5 January to 20 April, 2008 to investigate the effect of rate and timing of nitrogen application on the yield of soybean var. shohag. There were five levels of nitrogen viz. 0, 25, 40, 55 and 70 kg N ha^{-1} and three application timing viz. basal, $^2/_3$ at basal + $^1/_3$ at 25 DAS and $^1/_3$ at basal + $^1/_3$ at 25 DAS +$^1/_3$ at 35 DAS. The experiment was laid out in a randomized complete block design with three replications having unit plot size of 4 m×2.5m. Both the rate and timing of nitrogen application had significant influence on all the characters except stover yield $plant^{-1}$. The performance of 25 kg N ha^{-1} and two timing of nitrogen application at $^2/_3$ basal + $^1/_3$ 25 DAS was found to be the best. Interaction effect of rate and timing of N application significantly influenced all the characters except, number of filled pods $plant^{-1}$, stover yield $plant^{-1}$ and stover yield. The highest seed yield (2.08 t ha^{-1}) and stover yield (2.82 t ha^{-1}) were produced in plots applied with 25 kg N ha^{-1} in two splits as $^2/_3$ basal + $^1/_3$ 25 DAS. However, the application of 25 kg N ha^{-1} at $^2/_3$ basal + $^1/_3$ 25 DAS could give high yield of soybean var. Shohag.

Key words: Rate, timing, nitrogen application, yield, soybean.

Introduction

Soybean (*Glycine max* [L.] Merril) is one of the leading oil seed and grain legume crops of the world belonging to the family leguminosae, sub-family papilionaceae. It grows well in different regions of the world, particularly in the tropics to the mid temperate zones. According to FAO (2003) the area, production and average yield under soybean of the world in 2003 are 83,695 thousand hectares, 189234 thousand tons and 2.26 tons ha^{-1}, respectively. In Bangladesh the area under soybean is about 5 thousand hectare with a production of 4 thousand tons and the yield ranges from 1.50 to 2.30 tons ha^{-1} (BARI, 2005). It is a new and prospective crop in Bangladesh. Soybean may be called the "Golden bean" or "Miracle bean" or the "Nugget of nutrition" or the "Protein hope of future" because of its high nutritive value containing about 42-45% protein, 18-20% edible oil and 42-46% carbohydarde (Gowda and Kaul, 1982). It also contains essential amino acids. It is a source of Calcium, Phosphorus and Iron including vitamin A, B, C, D and can meet up different nutritional needs of human beings (Rahman, 1982). On an average about 8-10% of the protein intake in Bangladesh diet originates from animal sources (Begum, 1989) and the rest can be met from plant sources by increasing the consumption of vegetables and pulses including soybean. Now a days, a variety of saya product such as "soya dal", "soya chatni", soya-khichuri", " soya-milk", "soya-curd", soya-flour" and roasted soybean snacks becoming familiar to the people of Bangladesh (Smith, 1975). The lower yield of soybean at farmer's level is mainly attributed to the lack of improved agronomic management practices of which judicious fertilizer application is an important determinant for better performance of soybean. Among the nutrients, nitrogen is a major essential plant nutrient element and has favorable effect on yield and yield contributing character of soybean (Lahoria *et al*. 2004). It has the quickest and most pronounced effect on plant growth and yield of crops. It tends primarily to encourage above ground vegetative growth and to impart deep green colour to the leaves. Improper use of nitrogen fertilizer instead of giving increased yield may even reduce the same. Plants receiving insufficient nitrogen are stunted in growth with restricted root system; the leaves turn yellow or yellowish green and tend to drop off. Proper timing of nitrogen application reduces the loss of nitrogen in the soybean field and gives higher

yield. The present works was therefore, under taken with the following objectives: i) To study the effect of different rate of nitrogen on yield of soybean, ii) To evaluate the effect of time of nitrogen application on the yield of soybean and iii) To find out the effect of interaction between rate and timing of nitrogen application on yield of soybean.

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh agricultural University, Mymensingh during 5 January to 20 April 2009 to study the effect of rate and timing of nitrogen application on the performance of soybean var. Shohag. The experimental site is located at 24° 75′ N latitude and 90°5′ E longitudes and at an elevation of 18 m above the mean sea level. The land belongs to the Sonatola Soil Series of Non-calcareous Dark Grey Flood plain soil under the Old Brahmaputra Flood plain Agro-ecological zone (AFZ 9) (UNDP and FAO 1988). The experimental field is a high land having sandy loam soil with pH 6.9. The initial soil (0-15 cm depth) test result showed that the soil contained 0.058% total nitrogen, 0.463% organic matter, 23 ppm available phosphorus 5.0 ppm available sulphur and 0.13 ppm exchangeable potassium. The experiment site was located under the sub-tropical climate which is characterized by moderately low temperature, scanty rainfall and high humidity. The maximum air temperature was found in April (28.29°C) and minimum air temperature showing in January 19.19°C. The experiment was laid out in a randomized complete block design with three replications. The experiment included (a) five levels of nitrogen such as 0, 25, 40, 55 and 70 kg N ha^{-1} and (b) three application timing (i) Basal (T_1), (ii) $^2/_3$ basal + $^1/_3$ 25DAS (T_2) and (iii) $^1/_3$ basal + $^1/_3$ 25DAS+ $^1/_3$ 35DAS (T_3). The treatment combinations were randomly distributed in each block. The size of each plot was 4.0 m× 2.5m.The spacing between the blocks and unit plots were 1.0 m and 0.25m respectively. A dose of 175 kg ha^{-1} triple super phosphate, 120 kg ha^{-1} murate of potash and 115 kg ha^{-1} of gypsum was applied. The seed were sown in 25 cm apart lines continuously on 5 January, 2009. The seeds were inoculated with Bradyrhizobium at the rate of 30 g kg^{-1} seed prior to sowing. The crop was harvested with sickle on 20 April at full maturity when the colour of leaf turned yellow and dropped off and dried in the sun for 3-4 days. Threshing was done with stick. The seeds were dried in sun for 3-4 days and the weight were recorded plot wise. The collected data were analyzed statistically following the ANOVA technique and the mean differences were adjusted as per Duncan's Mulitple Range Test (Gomez and Gomez, 1984)

Results and Discussion

Different level of nitrogen influenced all yield contributing characters significantly except stover yield $plant^{-1}$ (Table 1). The highest plant height, number of branches $plant^{-1}$, number of nodes $plant^{-1}$, number of filled pods $plant^{-1}$, number of seeds $plant^{-1}$, number of seeds pod^{-1}, seed yield $plant^{-1}$, dry weight $plant^{-1}$, 1000 seed weight and seed yield were obtained from the treatment 25 kg N ha^{-1}. The highest stover yield $plant^{-1}$ and stover yield (t ha^{-1}) were obtained with application of 40 kg N ha^{-1} and empty pods $plant^{-1}$ from 0 kg N ha^{-1} (controlled). Rathod *et al.* (2006) found that plant height was significantly increased with increased rate of nitrogen. Zhiete *et al.* (2007) observed that highest number of pods $plant^{-1}$ obtained with the application of 45 kg N ha^{-1}. Lee *et al.* (2006) also found that seed yield increased with increased rate of nitrogen application. On the other hand, Hamed (2003) also found that maximum stover yield obtained with application of 45 kg N ha^{-1}.

Timing of nitrogen application significantly influenced all of the characters except stover yield $plant^{-1}$. The highest plant height, number of branches $plant^{-1}$, number of nodes $plant^{-1}$, number of filled pods $plant^{-1}$, number of seeds $plant^{-1}$, number of seeds pod^{-1}, seed yield $plant^{-1}$, stover yield $plant^{-1}$, dry weight $plant^{-1}$, 1000 seed weight ,seed yield and stover yield was found when nitrogen was applied in two splits i.e. $^2/_3$ basal + $^1/_3$ 25 DAS. On the other hand the highest number of empty pods $plant^{-1}$ was found when nitrogen was applied as basal (Table 2). Takahashi *et al.* (1991) found that two time application of nitrogen gives higher yield than basal application. Singh *et al.* (2001) also revealed that three time application of nitrogen give significantly higher stover yield than all basal application.

The interaction of rate and timing of nitrogen application has significant effect on plant height, number of branches plant^{-1}, number of nodes plant^{-1}, number of empty pods plant^{-1}, number of seeds plant^{-1}, number of seed pod^{-1}, seed yield plant^{-1}, dry weight plant^{-1}, 1000 seed weight and seed yield (Table 3).

Table 1. Effect of different rates of nitrogen on yield and yield contributing characters of soybean

Rates of nitrogen (kg ha^{-1})	Plant height (cm)	No. of branches plant^{-1}	No. of nodes plant^{-1}	No. of filled pods plant^{-1}	No. of empty pods plant^{-1}	No. of seeds plant^{-1}
0 (N_0)	36.31c	2.87bc	10.48b	44.09c	5.04a	63.97c
25 (N_1)	38.72a	3.64a	12.27a	51.10a	3.96c	116.72a
40 (N_2)	38.25ab	3.04b	12.15a	48.47ab	4.25b	115.88a
55 (N_3)	38.14abc	3.02b	11.67a	47.86b	4.30b	112.97a
70 (N_4)	36.76bc	2.79c	11.58a	47.30b	4.36b	92.64b
S X	0.60	0.06	0.25	0.93	0.10	1.26
Level of significance	*	**	**	**	**	**

Table 1 (Contd.)

Rates of nitrogen (kg ha^{-1})	No. of seeds pod^{-1}	Seed yield plant^{-1}	Stover yield plant^{-1}	Dry weight plant^{-1}	1000 seed weight (gm)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
0 (N_0)	2.11b	2.507b	4.59	9.299c	113.64b	1.39b	1.74c
25 (N_1)	2.56a	4.091a	4.99	12.404a	117.07a	1.64a	2.38b
40 (N_2)	2.41a	3.753ab	5.96	10.76b	112.26bc	1.45b	2.61a
55 (N_3)	2.21b	3.627b	5.47	10.52b	110.96c	1.41b	2.49ab
70 (N_4)	2.06b	3.416b	5.24	10.36b	106.21d	1.37b	2.29b
S X	0.06	0.25	0.34	0.41	1.30	0.03	0.07
Level of significance	**	**	NS	**	**	**	**

Table 2. Effect of timing of nitrogen application on yield and yield contributing characters of soybean

Timing of nitrogen application	Plant Height (cm)	No. of branches plant^{-1}	No. of nodes plant^{-1}	No. of filled pods plant^{-1}	No. of empty pods plant^{-1}	No. of seeds plant^{-1}
T_1	35.85b	2.58c	11.91a	45.50b	4.61a	88.69b
T_2	38.70a	3.50a	12.00a	51.01a	4.14c	106.86a
T_3	38.35a	3.14b	10.98b	46.79b	4.39b	105.75a
S X	0.47	0.05	0.19	0.72	0.08	0.98
Level of significance	**	**	**	**	**	**

Table 2 (Contd.)

Timing of nitrogen application	No. of seeds pod $^{-1}$	Seed yield plant^{-1}	Stover yield plant^{-1}	Dry weight plant^{-1}	1000 seed weight (gm)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	2.22ab	3.158c	5.12	8.05c	108.54c	1.37b	2.22b
T_2	2.30a	4.023a	5.39	12.93a	117.61a	1.64a	2.42a
T_3	2.29a	3.255b	5.23	11.02b	109.94b	1.35b	2.26ab
S X	0.05	0.20	0.27	0.32	1.00	0.02	0.06
Level of significance	**	**	NS	**	**	*	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

*= Significant at 5% level of probability, **= Significant at 1% level of probability, NS= Not significant

Table 3. Interaction effect of rate and timing of nitrogen application on yield and yield contributing characters of soybean

Rate x timing of N application	Plant Height (cm)	No. of branches plant^{-1}	No. of nodes plant^{-1}	No. of filled pods plant^{-1}	No. of empty pods plant^{-1}	No. of seeds plant^{-1}
N_0T_1	35.69c	2.03f	9.90d	42.07	5.46a	57.19g
N_0T_2	37.33abc	3.32bc	11.65bc	47.27	4.20bcd	65.04f
N_0T_3	35.92bc	3.27bc	9.90d	42.94	5.47a	69.66f
N_1T_1	39.33ab	3.59b	11.82bc	48.78	4.11cd	98.96d
N_1T_2	37.04abc	4.05a	13.31a	56.28	4.45bc	120.90bc
N_1T_3	39.90a	3.28bc	12.12abc	48.22	3.32e	130.28a
N_2T_1	37.20abc	2.38e	12.64abc	46.95	4.50bc	99.10d
N_2T_2	38.59abc	3.33bc	11.92abc	50.28	3.80de	127.33ab
N_2T_3	38.97abc	3.35bc	11.88bc	48.19	4.45bc	121.20bc
N_3T_1	37.49abc	2.44de	11.87bc	45.85	4.27bcd	100.63d
N_3T_2	39.27ab	3.60b	11.87bc	52.13	4.20bcd	122.00bc
N_3T_3	37.65abc	3.10c	11.27c	45.60	4.43bc	116.28c
N_4T_1	31.85d	2.47de	112.88ab	43.83	4.72b	87.57e
N_4T_2	38.52abc	3.19c	11.70bc	49.07	4.07cd	99.05d
N_4T_3	39.81a	2.71d	9.74d	49.00	4.29bcd	91.30e
SX	1.05	0.10	0.43	1.61	0.17	2.19
Level of significance	*	**	**	NS	**	**

Table 3 (Contd.)

Rate x timing of N application	No. of seeds pod $^{-1}$	Seed yield plant^{-1}	Stover yield plant^{-1}	Dry weight plant^{-1}	1000 seed weight (gm)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
N_0T_1	2.08cd	2.11e	4.37	6.51f	104.83ef	1.36efg	1.67
N_0T_2	2.18bc	2.95cd	5.06	12.22bc	121.50a	1.36efg	1.63
N_0T_3	2.08cd	2.46de	4.33	9.17de	114.60bc	1.46cde	1.91
N_1T_1	2.43abc	3.38bc	4.80	8.51e	114.70bc	1.45cdef	2.17
N_1T_2	2.47ab	5.84a	5.01	13.47b	123.33a	2.08a	2.82
N_1T_3	2.77a	3.06cd	5.17	15.23a	113.17cd	1.39defg	2.15
N_2T_1	2.17bc	3.45bc	5.67	8.47e	112.90cd	1.42defg	2.52
N_2T_2	2.44abc	3.74bc	6.73	13.20b	116.43b	1.62b	2.72
N_2T_3	2.63a	4.07b	5.47	10.61cd	107.43e	1.31efg	2.57
N_3T_1	2.26bc	3.76bc	5.57	8.93e	103.37f	1.35efg	2.42
N_3T_2	2.17bc	3.80bc	5.07	10.73cd	115.47bc	1.6bc	2.62
N_3T_3	2.19bc	3.32bc	5.77	11.93bc	114.03bcd	1.28fg	2.41
N_4T_1	2.15bc	3.09cd	5.22	7.88ef	106.90e	1.27g	2.33
N_4T_2	2.26bc	3.78bc	5.07	15.08a	111.29d	1.55bcd	2.29
N_4T_3	1.77d	3.37bc	5.42	8.14e	100.45g	1.29efg	2.24
SX	0.11	0.44	0.60	0.71	2.24	0.05	0.13
Level of significance	*	**	NS	**	**	**	NS

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

*= Significant at 5% level of probability, **= Significant at 1% level of probability, NS= Not significant

The highest plant height (39.90 cm) was found from 25 kg N ha^{-1} applied into three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS + $^1/_3$ 35 DAS and the lowest plant height (31.85 cm) obtained from 70 kg N ha^{-1} applied as basal. Table 3 shows that the highest number of branches plant^{-1} (4.05) was observed from 25 kg N ha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. The lowest number of branches plant^{-1} (2.03) was obtained from 0 kg N ha^{-1}(control treatment). The highest number of nodes plant^{-1} was observed at 25 kg N ha^{-1} applied into two equal splits at $^2/_3$ basal + $^1/_3$ 25 DAS , and the lowest number of nodes plant^{-1} was found

from 70 kg N ha^{-1} (9.74) applied into three equal splits at $^1/_3$ basal + $^1/_3$ 25 DAS + $^1/_3$ 35 DAS. It was found that higher number of filled pods $plant^{-1}$ (56.28) was produced from 25 kg N ha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. The lowest one (42.07) was found when 0 kg N ha^{-1} applied as basal which was significantly lower than those of the other treatment. It was found that the highest number of empty pods $plant^{-1}$ (5.47) was produced when 0 kg N ha^{-1} was applied. The lowest number of empty pods $plant^{-1}$ (3.32) was found in 25 kg N ha^{-1} applied in three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS +$^1/_3$ 35 DAS. The highest number of seeds $plant^{-1}$ (130.28) was produced from 25 kg N ha^{-1} applied into three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS +$^1/_3$ 35 DAS. The lowest number of seeds $plant^{-1}$ was produced when 0 kg N ha^{-1} applied as basal. The highest number of seeds pod^{-1} (2.77) was produced from 25 kg N ha^{-1} applied into three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS +$^1/_3$ 35 DAS. The lowest number of seeds pod^{-1} produced in 70 kg N ha^{-1} applied in three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS +$^1/_3$ 35 DAS. The highest seed yield $plant^{-1}$ (5.84) was recorded from 25 kg N ha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. The lowest seed yield $plant^{-1}$ was found when 0 kg N ha^{-1} applied as basal. It was found that highest stover yield $plant^{-1}$ was produced (6.73) from 40 kg N ha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. The lowest stover yield $plant^{-1}$ was found when 0 kg N ha^{-1} applied as basal. The highest dry weight $plant^{-1}$ was observed in 25 kg N ha^{-1} applied into three equal splits at $^1/_3$ basal +$^1/_3$ 25 DAS +$^1/_3$ 35 DAS. The lowest dry weight $plant^{-1}$ (6.51) was found when 0 kg N ha^{-1} applied as basal. The highest 1000 seed weight was observed from 25 kg Nha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. Whereas, 70 kg N ha^{-1} applied into three splits at $^1/_3$ basal +$^1/_3$ 25 DAS+ $^1/_3$ 35 DAS produced the lowest 1000 seed weight. The highest seed yield (2.08 t ha^{-1}) was observed in 25 kg N ha^{-1} applied into two splits at $^2/_3$ basal +$^1/_3$ 25 DAS. The lowest seed yield (1.27 t ha^{-1}) was observed from N_4T_1. Stover yield was not significantly affected by the interaction between rate and timing of nitrogen application. Numerically the highest straw yield was produced from 25 kg N ha^{-1} applied into two splits s at $^2/_3$ basal +$^1/_3$ 25 DAS and lowest straw yield (1.63 tha^{-1}) was found in when 0 kg N ha^{-1} was applied.

However, a high yield of soybean requires a large amount of N, and soybean plants should continue to assimilate nitrogen during both vegetative and reproductive stages. Begum *et al* (2015) also agreed the findings of this present study, where they explored that significant variations were observed in number of branches and seeds $plant^{-1}$, plant height, number of filled pods $plant^{-1}$, weight of seeds $plant^{-1}$, dry weight of plant, stover weight $plant^{-1}$, 1000-seed weight, seed and stover yield by the combined application of 25 kg N with 54 kg P ha^{-1}. Suryantini and Kuntyastuti (2015) also stated that the cultivation of soybean after rice required higher amount of N fertilizer (30 kg Nha^{-1}) to increase the grain yield from 0.5 t ha^{-1} to 3.4 t ha^{-1}.

Conclusion

Form the present study it may be concluded that application of 25 kg N ha^{-1} in two splits as $^2/_3$ basal and at $^1/_3$ 25 DAS could give high yield of soybean var. shohag.

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