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Effect of Method of Sowing and Seed Rate on the Growth and Yield of Soybean

M.A. Hamid, M.Z. Islam, [1]M. Biswas, [1]A.A. Begum, [1]M. Saifullah and [1]M. Asaduzzaman
Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh
[1]Regional Agricultural Research Station, Jamalpur, Bangladesh

Abstract: The growth and yield of soybean was determined using two factors viz., methods of sowing (line sowing and broadcasting) and seed rates (40, 60 80 and 100 kg ha^{-1}). Results revealed that leaf area index (LAI) and shoot dry matter weight were higher in line sowing than broadcasting throughout the entire course of development. Significantly highest number of plant population/plot, branches/plant, filled pods/plant, seed and stover yield were obtained in line sowing method. Seed rate significantly influenced all the studied characters except 100-seeds weight. It was observed that LAI, shoot dry matter weight, plant population/plot, plant height, number of unfilled pods/plant and seed yield increased with increased seed rate while number of branches/plant, filled pods/plant and seeds/plant decreased with increased seed rate. Interaction between line sowing and 100 kg seeds/ha gave the highest seed yield (2.76 t ha^{-1}) which was statistically similar to line sowing and 80 kg seeds/ha (2.67 t ha^{-1}).

Key words: Soybean, sowing method, seed rate, growth, yield

Introduction

Soybean (*Glycine max* (L.) Merrill) is the most important oilseed and grain legume crop of the world. It has occupied the top position in terms of oil source in the world. Besides, soybean oil is cholesterol free and easily acceptable diet. On an average, about 8-10% of the protein intake in Bangladesh diet originates from animal sources (Begum, 1989), the rest can be met from plant sources by increasing the consumption of pulses, specially soybean. In Bangladesh the use of soybean is gradually increased. The most common method of soybean consumption in home is soya-dhal, soya-chatni, soya-khichuri, soy-milk, soya-curd, soya-flour and roasted soybean snacks. Besides, soybean is used for making chanachur, biscuit and baby food. Its milk is comparable to cow's milk (Smith, 1975).

Though soybean is cultivated throughout the year in Bangladesh but its production is not satisfactory due to improper management practices. Information on optimum seed rate, suitable sowing method, improved varieties, judicious application of fertilizer and water management is also limited for soybean cultivation. Among the various factors of production, use of improved cultural practices and adequate management is important aspect for increased production. Within the cultural practices, suitable method of sowing and optimum seed rate may increase the yield of soybean. In line sowing method, optimum number of plants per unit area can be maintained easily. In broadcasting, seeds are sown haphazardly. As a result, it is difficult to maintain desired plant population per unit area which is important to obtain the high yield. For higher yield, a suitable method of sowing of soybean is to be found out. Seed rate influences yield and yield contributing characters of soybean (Kolarik and Marek, 1980). Grain yield increased with increasing seed rate up to a certain limit, beyond which yield tended to decrease (Svoboda, 1984; Chen *et al*., 1992). Leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) decreased significantly due to reduced seed rate whereas relative growth rate (RGR) increased at a lower seed rate (Jain *et al*., 1996). Keeping in mind the serious inter-plant competition for optimum plant nutrients, sunlight, moisture and aeration it is essential to find a fair combination of sowing method and seed rate to achieve maximum yield of soybean.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from January 1999 to April 1999. The treatments included in the experiment were the methods of sowing (line and broadcast) and seed rates (40, 60, 80 and 100 kg ha^{-1}). The experiment was laid out in a split-plot design with four replications. Methods of sowing were allocated in the main plots and seed rates in the sub plots. Each unit plot size was 3 x 4 m^2. The land was uniformly fertilized @ 10-11-25-10-1 NPKS and Zn kg ha^{-1} in the form of urea, tipple super phosphate, muriate of potash, gypsum and zinc sulfate, respectively. Entire amount of NPKS and Zn fertilizers were applied at the time of final land preparation. The variety of soybean used in the experiment was PB-1 (Sohag). Seeds were sown on 5 January 1999 as per treatment in 30 cm apart lines by making continuous furrow with an iron tine. Intercultural operations such as weeding, irrigation, spraying of insecticide etc. were done uniformly in all plots. One weeding was done at 25 days after sowing (DAS) and the second weeding was done at 40 DAS. Irrigation was done twice. One irrigation was done at 30 DAS and another at 50 DAS. Soybean plants were infested by mole cricket (*Gryllotalpa gryllotalpa*) and cutworm (*Agrotis ipsilon*) at the early period of growing. These insects were controlled by irrigation and insecticides (Sevin). At the later stage of growth the plants were infested by soybean leaf roller (*Lamprosema indicata*) insects. These insects were controlled by spraying Nogos. The crop was harvested at full maturity on 24 April 1999. Sampled plants from 0.25 m^2 area (excluding border) were collected from each unit plot to record growth parameters like leaf area index, shoot dry matter etc. Leaf area index and shoot dry matter weight were determined at every 15 days interval beginning at 45 DAS up to 90 DAS. All leaves were separated from the sampled plants. Five leaves were selected randomly and they were punched. Other leaves and stem were dried in an electric oven at 85± 5ºC for 72 h until constant weight. Area of punched leaves was calculated using formula πr^2. Dry weight of punched and other leaves was recorded separately. Then on the basis of the area of punched leaves the total area was calculated (Islam, 1988). LAI was calculated following the standard formula (Radford, 1967; Hunt, 1978):

$$LAI = \frac{LA}{P}$$

Where, LA= Leaf area and P= Ground area. Dry weight of leaves and stems altogether was regarded as shoot dry matter weight (without pod) of plants. An area of 6 m^2 in the middle portion of each plot was used to collect data on other crop characters. Seed yield was adjusted at 12% moisture level. The collected data were analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program M-STATC and mean differences were adjudged by Duncan's multiple range test (DMRT).

Results and Discussion

Leaf area index:

Effect of method of sowing: Leaf area index was not significantly influenced at 45, 75 and 90 DAS but significantly influenced at 60 DAS due to the method of sowing. Line sowing showed maximum LAI values at all stages except at 75 DAS (Fig. 1). Line sowing produced significantly the highest LAI (8.62) at 60 DAS. LAI increased linearly and the highest LAI was obtained at 75 DAS and then it decreased that might be due to the senescence of older leaves. Jain *et al.* (1996) also stated that LAI of soybean increased with age and decreased at ripening.

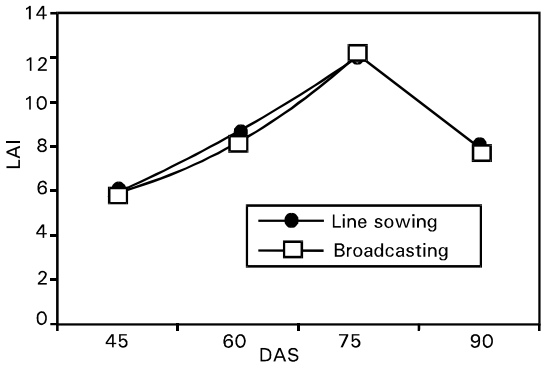

Fig. 1: Leaf area index (LAI) of soybean at different days after sowing (DAS) as influenced by mathod of sowing

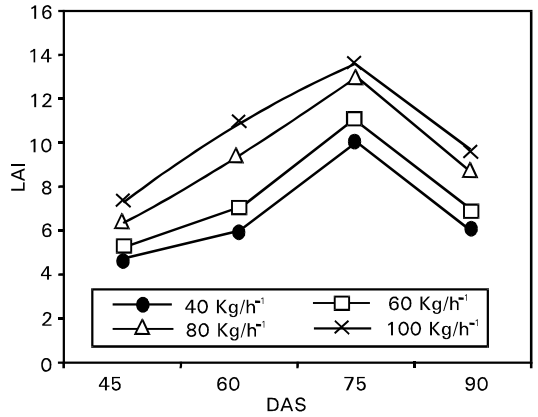

Fig. 2: Leaf area index (LAI) of soybean at different days after sowing (DAS) as influenced by seed rate

Effect of seed rate: Seed rate had significant effect on LAI at all dates of observation (Fig. 2). The highest LAI was observed in 100 kg ha^{-1} seed rate and the lowest was found in 40 kg ha^{-1} for all dates of observation. Jain *et al.* (1996) also stated that LAI decreased with a lower seed rate. At 75 and 90 DAS seed rates of 100 and 80 kg ha^{-1} recorded statistically similar LAI. LAI of all seed rates showed the highest values at 75 DAS. The results revealed that LAI increased linearly up to 75 DAS and then it decreased due to senescence of older leaves.

Effect of interaction between method of sowing and seed rate: Leaf area index was not significantly influenced at 45, 75 and 90 DAS but significantly influenced at 60 DAS due to interaction between method of sowing and seed rate (Table 1). The highest LAI (11.78) was observed in the combination of line sowing x 100 kg seeds/ha and the lowest (5.80) was observed in the combination of broadcast sowing 40 kg seeds/ha at 60 DAS (Table 1).

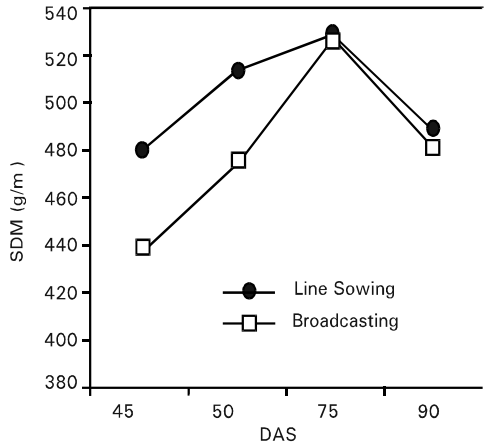

Fig. 3: Shoot dry matter (SMD) weight (withou pod) of soybean at different at different days after sowing (DAS) as influenced by method of sowing

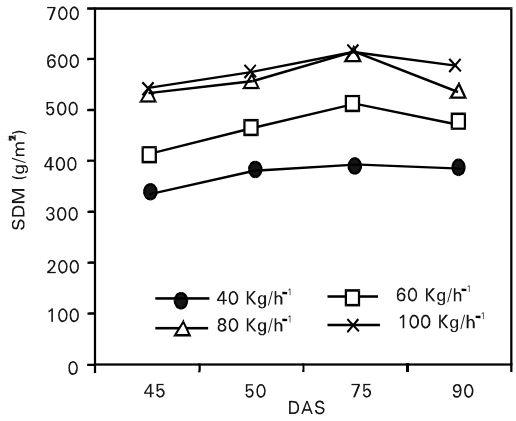

Fig. 4: Shoot dry matter (SDM) weight (without pod) of soybean at different days after sowing (DAS) as influenced by seed rate

Shoot dry matter (SDM) weight:

Effect of method of sowing: Shoot dry matter weight was significantly influenced at 45 and 60 DAS but non significantly influenced at 75 and 90 DAS due to sowing method. The highest shoot dry weight was produced in line sowing then broadcast sowing at all dates of observation (Fig. 3). At 45 and 60 DAS, the highest SDM (480.24 & 513.22 g/m^2, respectively) was found in line sowing which was significantly different from those of broadcast sowing.

Effect of seed rate: Seed rates exerted significant effect on SDM weight at all dates of observation. The highest SDM weight was found in 100 kg seeds/ha which was statistically similar to that of 80 kg seeds/ha at all dates of observations. The lowest SDM weight (without pod) was found in 40 kg seeds/ha at all dates of observation (Fig. 4).

From the results it was found that SDM weight increased up to 75 DAS and then decrease might be due to the shading of older leaves and formation of pods.

Effect of interaction between method of sowing and seed rate: Shoot dry matter weight was significantly influenced by the interaction between methods of sowing and seed rates at 45, 75 and 90 DAS while it was non significantly influenced at 60 DAS

(Table 2). The highest SDM weight was observed in line sowing where seed rate was 100 kg ha^{-1} at 45, 60, 75 and 90 DAS. However, at 45 and 75 DAS similar result was found in line sowing where seed rate was 80 kg ha^{-1}. At 45 and 75 DAS the lowest SDM weight were observed in broadcast sowing with seed rate 40 kg ha^{-1}. The lowest SDM weight at 90 DAS was found in line sowing with seed rate 40 kg ha^{-1}.

Yield and yield attributes

Effect of sowing methods: There was a significant difference between line and broadcast methods of sowing in respect of plant population/plot at harvest, number of branches/plant, number of filled and unfilled pods/plant, seed and straw yield (Table 3). However, the highest plant population/plot (391.5) was found in line sowing method. Caldwell *et al.* (1973) reported that for high and uniform germination of soybean, the depth of planting should be 2.5 cm in most soils and should not be greater than 5 cm. The placement of seed at improper depth could inhibit the germination of seed which resulted in lower plant population in broadcasting. Similar results were found for number of branches/plant and number of filled pods/plant. The highest number of unfilled pods/plant was found in broadcast method. Line sowing method produced the highest seed and stover yield (2.24 and 2.52 t ha^{-1}, respectively). Similar results were observed by Bhuiyan (1976) who stated that higher yield of stover was found in line sowing. The highest seed yield in line sowing method might be attributed to the higher plant population per unit area, number of branches/plant and filled pods/plant.

Effect of seed rate: Seed rates exerted significant influence on all the studied characters except 100-seeds weight. The highest plant population/plot (518.5) was found in 100 kg ha^{-1} seed rate while the lowest (209.5) was found in 40 kg ha^{-1}. Plant population increased with increasing seed rate. The tallest plant (60.92 cm) was also recorded from the maximum seed rate (100 kg ha^{-1}). Seed rate of 40 kg ha^{-1} recorded the shortest plant stature (44.18 cm). The interplant competition in higher plant density could induce the plant growth and produced the highest plant. Number of branches/plant was found highest (5.0) in 40 kg ha^{-1} of seed rate. Number of branches/plant decreased gradually as the seed rate increased and the lowest number of branches/plant (3.19) was recorded in 100 kg ha^{-1} of seed rate. Similar trend was observed for number of filled pods/plant. The lower plant population per unit area might enjoy more space to produce more branches while the higher population per unit area did not enjoy those facilities. Number of unfilled pods/plant was recorded the lowest (2.49) in 40 kg ha^{-1} while the highest (3.86) was found in 100 kg ha^{-1} of seed rate. Number of unfilled pods

Table 1: Effect of interaction between method of sowing and seed rate on the leaf area index (LAI) of soybean at different days after sowing (DAS)

Method of sowing x Seed rate	LAI			
	45 DAS	60 DAS	75 DAS	90 DAS
Line x 40	4.84	6.08e	9.58	6.12
Line x 60	5.13	7.23d	11.27	6.90
Line x 80	6.52	9.36c	13.26	8.62
Line x 100	7.42	11.78a	13.96	9.78
Broadcast x 40	4.58	5.80e	10.63	6.02
Broadcast x 60	5.28	6.96d	11.05	6.86
Broadcast x 80	6.40	9.27c	12.98	8.59
Broadcast x 100	7.04	10.32b	13.54	9.52
Level of significance	NS	0.05	NS	NS

Table 2: Effect of interaction between method of sowing and seed rate on the shoot dry matter (SDM) weight (without pod) of soybean at different days after sowing (DAS)

Method of sowing x Seed rate	SDM weight (g/m^2)			
	45 DAS	60 DAS	75 DAS	90 DAS
Line x 40	360.00d	415.40	423.80c	366.50d
Line x 60	415.90c	460.20	470.00b	420.60cd
Line x 80	559.60a	585.00	628.80a	541.60b
Line x 100	585.45a	592.30	637.60a	620.00a
Broadcast x 40	327.00d	367.55	398.80d	390.80e
Broadcast x 60	414.90c	449.20	541.80b	460.00d
Broadcast x 80	486.20b	520.10	578.50a	523.50bc
Broadcast x 100	536.10a	564.40	594.10a	545.30b
Level of significance	0.05	NS	0.01	0.01

Table 3: Effects sowing method seed rate on the crop characters of soybean

Treatments	Crop characters								
	Plant population at harvest	Plant height at harvest (cm)	Number of branches/plant	Number of filled pods/plant	Number of unfilled pods/plant	Number of seeds/plant	100 seeds weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Methods of sowing									
Line	391.45a	52.88	4.12a	36.61a	2.93b	57.14	13.40	2.24a	2.52a
Broadcasting	330.06b	51.15	3.68b	31.61b	3.26a	51.06	13.20	1.76b	2.22b
Level of significance	0.01	NS	0.01	0.01	0.01	NS	NS	0.01	0.01
Seed rate (kg ha^{-1})									
40	209.50d	44.18c	5.00a	48.36a	2.46d	62.12a	13.45	1.46c	1.74c
60	325.12c	49.20b	3.90b	37.23b	2.78c	55.05b	13.36	1.62b	2.01c
80	389.86b	53.70b	3.50c	29.56c	3.26b	54.02b	13.28	2.40a	2.70b
100	518.50a	60.92a	3.19c	21.30d	3.86a	45.21c	13.18	2.51a	3.01a
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01
Method of sowing x seed rate									
Line x 40	250.50	45.14	5.68a	52.91a	2.35	64.28	13.51	1.63e	1.89
Line x 60	348.50	50.92	3.93bc	38.44c	2.54	58.43	13.45	1.80d	2.20
Line x 80	399.75	54.32	3.68cd	30.40d	3.15	56.33	13.35	2.67a	2.85
Line x 100	567.00	61.12	3.20d	24.70e	3.68	49.51	13.30	2.76a	3.10
Broadcast x 40	168.50	43.22	4.33b	43.82b	2.56	59.94	13.39	1.26g	1.59
Broadcast x 60	301.75	48.48	3.86bc	36.02c	3.02	52.66	13.27	1.44f	1.75
Broadcast x 80	380.00	52.08	3.32d	28.72d	3.38	52.00	13.22	2.11c	2.61
Broadcast x 100	470.00	60.72	3.19d	17.90f	4.06	40.42	12.92	2.25b	2.90
Level of significance	NS	NS	0.01	0.01	NS	NS	NS	0.01	NS

NS= Non-significant

increased with increasing seed rate. This might be due to higher competition for space, light, water, etc. in densely populated plants. The seed rate 100 kg ha^{-1} produced the highest stover yield (3.01 t ha^{-1}) while the lowest stover yield (1.74 t ha^{-1}) was recorded from 40 kg ha^{-1} seed rate. However, the results in terms of stover yield indicated that stover yield increased gradually with the increase in seed rate. The higher plant population with higher seed rate might enhance the stover yield. Probably the micro environment of the higher population was not so favorable for seed development. Number of seeds/plant was also recorded the highest (62.12) from 40 kg ha^{-1} and the lowest (45.21) was recorded from the seed rate 100 kg ha^{-1}. The highest seed yield (2.51 t ha^{-1}) was found in 100 kg ha^{-1} which was statistically similar to that of 80 kg ha^{-1} (2.40 t ha^{-1}). The results revealed that seed yield of soybean increased significantly up to 80 kg seeds/ha. Chen (1992) reported that seed yields increased with high plant densities. Malik and Singh (1996) also found the similar results.

Combine effect: Seed yield of soybean was significantly influenced by the interaction between method of sowing and seed rate. The highest seed yield (2.76 t ha^{-1}) was obtained by the interaction of line sowing and 100 kg seeds ha^{-1} which was statistically similar to that of interaction between line sowing and 80 kg seeds ha^{-1} (2.67 t ha^{-1}). The lowest seed yield (1.26 t ha^{-1}) was obtained from the interaction of broadcast and 40 kg seeds ha^{-1}. Results revealed that every interaction of line sowing and different seed rates gave more yield than their corresponding interaction of broadcast and different seed rates. Number of branches/plant and number of filled pods/plant were recorded the highest from the combination of line sowing x 40 kg seeds ha^{-1}. In general, lower seed rates in both sowing methods showed better performance pertaining to yield attributes in comparison with higher seed rates.

Overall the results of this study indicated that line sowing was better than broadcasting. In case of seed rate, sowing of 80 kg seeds ha^{-1} appeared as the economically best seed rate. For the confirmation of the results further study is necessary.

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