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Yield and Yield Components of Soybean Varieties as Affected by Different Sowing Dates

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Abstract: To observe the effect of different sowing dates and variety on the performance of soybean crop an experiment was carried out with. 5 sowing dates viz. 7 November, 27 November, 16 December, 7 January and 27 January; and 3 soybean varieties viz. Bangladesh soybean-4 (G-2), Shohag (PB-1) and BARI soybean-5 (BS-5). The experiment was conducted in split-plot design with three replications. In aspects of yield attributing characters viz. pods plant^{-1}, seeds pod^{-1}, seed yield (g m^{-2}), Stover yield (g m^{-2}) Biological yield (g m^{-2}) and harvest index were significantly affected by sowing date. The highest pods plant^{-1} (39.85), fertile pods plant^{-1} (36.00), seed yield (170.36g m^{-2}), stover yield (402.69 g m^{-2}), Biological yield (573.05 g m^{-2}) and harvest index (29.70%) were found on 16 December sowing. The effect of variety was also significant. The highest pods plant^{-1} (35.94), seeds pod^{-1} (2.09), seed yield (159.71g m^{-2}), biological yield (454.37 g m^{-2}) and harvest index (35.48%) were found in the variety G-2 and the highest non fertile pods plant^{-1} (4.47), 100-seed weight (9.33 g) and stover yield (322.01g m^{-2}) were found in the variety BS-5. The highest seed yield (207.40g m^{-2}) were found with the interaction of G-2 with 16 December sowing.

Key words:

INTRODUCTION

Soybean (*Glycine max* L. Merril) has a tremendous value in agriculture as a good source of high quality plant protein and vegetable oils in one hand and nitrogen fixation ability on the other hand. It is quite wide spread in different region of the world and grows well from the tropics to the temperate zones. The crop is grown through out the world with the largest production in United States, China, Brazil, Indonesia, Japan, Korea and Argentina. The world production of soybean as estimated in 2003 was 189. 23 million MT from an area of 83.70 million hectares [1].

Soybean has a great role in agriculture as food, feed, national income etc. soybean seed contains about 40-45% protein, 20-22% oil, 20-26% Carbohydrate and a high amount of Ca, P and vitamins [2]. Soybean oil is cholesterol free and easily acceptable in diet.

Soybean is new prospective crop in Bangladesh. It can be cultivated throughout the year. The world average yield of soybean is about 3 t ha^{-1} while that in Bangladesh 1.2 t ha^{-1} [3] compared to other soybean producing countries. This is mainly due to use of low yield potential varieties and poor agronomic management practices. Among the agronomic practice sowing date have remarkable influence on soybean yield. The yield is largely affected by yield contributing characters which are influenced by environment during the growth and development of the crop in different sowing date.

The research in this line is highly scarce in Bangladesh. Therefore, the present study was undertaken to find out the effect of sowing date, variety and their interaction on the yield attributes and yield of soybean plant.

MATERIALS AND METHODS

The experimental site is situated at 24°75' N latitude and 90° 50' E longitudes at an attitude of 18 m. The experimental field was a high land having sandy loam soil with pH 6.9. The initial soil (0-15 cm depth) contained 0.058% total N, 0.463% organic matter, 23 ppm available P,

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5.0 ppm available S and 0.13 ppm exchangeable K. During the period from November 2006 to May 2007 the maximum temperature ranged from 17.0°C to 37.0°C and the minimum temperature ranged from 6.0°C to 26.4°C and the average temperature ranged from 14.3°C to 31.6°C.

Five sowing dates viz. 7 November (S1), 27 November (S2), 16 December 06 (S3), 7 January (S4) 27 January (S5). Three soybean varieties viz. Bangladesh soybean-4 (G-2) (V1), Shohag (PB-1) (V2) and BARI soybean-5 (BS-5) (V3) were included in the experiment as treatment. The experiment was laid out in a split-plot design with three replications. The sowing dates were allocated in the main plot and varieties in the sub-plots. The unit plot size was 4.0 m×2.5 m. The spaces between tow main plots and that between tow sub-plots were 1 m and 0.50 m, respectively.

The land was fertilized with N, P_2O_5, K_2O and S @ 50, 150, 100 and 100 kg ha^{-1} respectively were applied in the form of Urea, Triple Super Phosphate, Muriate of Potash and Gypsum during final land preparation at each sowing date. Seeds of soybean varieties were sown at 25 cm apart rows using of 50 kg seeds for G-2, 60 kg for PB-1 and 60 kg for BS-5, ha^{-1}. Intercultural operations such as weeding, thinning, spraying of insecticide and fungicide were done uniformly, in all plots. Weeding were done tow times at 15 and 35 days after sowing (DAS) and thinning at final weeding. Finally plant to plant distance in each row was kept 5 cm. No irrigation was required in the field. Soybean plants were infested by hairy caterpillar and cutworm at the early growth stage which were controlled by spraying Dimethion 50 EC @ 35 ml a.i. with 10 li. water for 5 decimal land. Powdery mildew, root rot of soybean and rust disease were found which were controlled by the spraying tilt @ of 5 ml in 10 litter water for one acre of land.

The crop was harvested from the central 4.5 m^2 area with sickle at full maturity (i.e. when 95% pods become brown). PB-1 and BS-5 were shown early maturity than G-2. within 110-120 DAS all plants became mature. The harvested crops were then brought to the threshing floor and dried for four consecutive days. After threshing the seeds were separated, cleaned dried in the sun for four consecutive days and their weights were recorded plot wise. Seeds obtain from the harvest area in each unit plot were dried in sun. Then a small portion of it was oven dried to a constant weight. The seed yield was expressed in g m^{-2} on dry weight basis. Stover obtained from the harvest area of each unit plot including sample plants were dried in the sun. A small portion of it was taken and this sample was dried in the oven at 80°C for 72 hours to constant weight. Then the Stover yield was expressed in dry weight basis. Biological yield was calculated as the sum of seed yield and stover yield.

This is the ratio of economic yield to biological yield and was calculated by the following formula [4]:

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Data were analyzed using analysis of variance (ANOVA) technique and the mean differences were adjudged by Duncan's Multiple Range Test [5] with the help of a computer based statistical package programme M-STAT-C. In case of Abnormal Seedlings%, the data were transformed by squire root transformation technique.

RESULTS AND DISCUSSION

Number of Pods per Plant: Due to the effect of sowing date the number of pods $plant^{-1}$ was significantly affected (Table 1). The highest number of pods $plant^{-1}$ (39.85) was found 16 December sowing which was statistically identical with 27 January. The lowest number of pods $Plant^{-1}$ (9.68) with 7 November sowing (Table 2). The result shows that the number of pods $plant^{-1}$ was increased with each successive delay in sowing after 7 November up to 16 December and further delay in sowing after 16 December the number of pods $plant^{-1}$ again started to decreased. Ehsanullah *et al.* [6] observed that number of pods $plant^{-1}$ was significantly affected by sowing date and was highest of the 19 May sowing.

Due to the effect of variety the number of pods $plant^{-1}$ was affected significantly (Table 1). The highest number of pods $plant^{-1}$ (35.94) was found in variety G-2 and the lowest number of $plant^{-1}$ (23.95) was found in variety PB-1 which was statistically identical with BS-5 (Table 2). The result shows that G-2 produce 33 and 32% higher pods $plant^{-1}$ than PB-1 and BS-5 respectively.

Due to the interaction effect of sowing date and variety the number of pods $plant^{-1}$ was significantly affected (Table 1). The highest number of pods $plant^{-1}$ (42.83) was found in variety G-2 sown 16 December and the lowest number (4.30) was found in BS-5 on 7 November sowing which was statistically identical with PB-1 at same sowing date (Table 3).

Table 1: Summary of analysis of variance (mean square value) on yield and yield attributes of soybean

Source of variance	Degree of freedom	Pods Plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	seed yield (gm^{-2})	Stover yield (gm^{-2})	Biological yield (gm^{-2})	Harvest index (%)
Replication	2	8.762	0.020	1.099	403.058	1188.038	2305.411	9.678
Sowing date	3	1675.864**	0.275*	0.242NS	20794.224**	78442.408**	176522.784**	184.194**
Error	6	2.275	0.042	0.507	203.512	1131.467	1548.589	5.666
Variety	2	553.272**	0.813**	13.227**	23312.014**	2694.829*	14206.333**	1125.543**
Sowing date × Variety	6	67.116**	0.071*	0.245NS	1104.799**	2319.180*	6033.772**	110.639**
Error	16	12.053	0.020	0.297	27.713	695.517	945.841	6.665

NS = Non significant

*= Significant at 5% level of probability **= Significant at 1% level of probability

Factor A = Sowing date Factor B = Variety

Table 2: Effect of sowing date and variety on the yield attributes and yields of soybean

Treatment	Pods plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	Seed yield (g m^{-2})	Stover yield (g m^{-2})	Biological yield (g m^{-2})	Harvest index (%)
Sowing date							
7 Nov. 06	9.68c	1.61c	8.91	53.75c	178.260c	232.011c	19.04d
27 Nov. 06	26.0b	2.03a	8.55	99.37b	323.640b	423.018b	23.06c
16 Dec. 06	39.85a	1.77b	8.80	170.36a	402.693a	573.059a	29.70a
27 Jan. 07	36.87a	1.75b	8.89	113.57b	319.009b	432.584b	26.08b
S$\bar{x}$	0.5028	0.0684	0.237	4.7553	11.2124	13.1174	0.7893
Level of significance	**	*	NS	**	**	**	**
CV (%)	5.366	11.423	8.098	13.055	10.996	9.478	9.674
Variety							
G-2	35.94a	2.09a	7.58b	159.71a	294.65b	454.37a	35.48a
PB-1	23.95b	1.68b	9.46a	89.84b	300.13ab	389.98b	20.68b
BS-5	24.41b	1.60b	9.33a	78.23b	322.91a	401.14b	17.25c
S$\bar{x}$	1.0022	0.0408	0.1573	4.1605	7.6131	8.8781	0.7453
Level of significant	**	**	**	**	*	**	**
CV (%)	12.35	7.87	6.20	13.19	8.62	7.41	10.55

In a column, figures with similar letter (s) without letter do not differ significantly as per DMRT.

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

Table 3: Interaction effect of sowing date and variety on the yield attributes and yield of soybean

Treatment	Pods Plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	seed yield (g m^{-2})	Stover yield (gm^{-2})	Biological yield (gm^{-2})	Harvest index (%)
7 Nov. × G-2	19.46d	1.76bc	7.54	131.48bc	195.76d	327.24f	40.09a
7 Nov. × PB-1	5.30e	1.59cd	9.83	16.81e	142.05e	158.87g	10.75e
7 Nov. × BS-5	4.30e	1.48d	9.36	12.96e	196.96d	209.92g	6.29e
27 Nov. × G-2	40.03ab	2.30a	7.38	151.84b	311.34c	463.19c	32.88b
27 Nov. × PB-1	16.26d	1.88b	8.89	75.92d	333.91bc	409.83cde	18.53d
27 Nov. × BS-5	21.70d	1.91b	9.39	70.36d	325.66c	396.02e	17.76d
16 Dec. × G-2	42.83a	2.31a	7.81	207.40a	378.49b	585.89ab	35.29b
16 Dec. × PB-1	38.16abc	1.53cd	9.57	151.84b	382.34b	534.19b	28.41c
16 Dec. × BS-5	38.56abc	1.47d	9.01	151.84b	447.24a	599.09a	25.41c
27 Jan. × G-2	41.43ab	1.99b	7.58	148.14b	293.01c	441.16cde	33.65b
27 Jan. × PB-1	36.10bc	1.73bcd	9.54	114.81c	342.23bc	457.04cd	25.04c
27 Jan. × BS-5	33.10c	1.55cd	9.56	77.77d	321.78c	399.55de	19.55d
S$\bar{x}$	2.0044	0.0816	0.3147	8.3209	15.2263	17.7561	1.4905
Level of significance	**	*	NS	**	*	**	**
CV (%)	12.35	7.87	6.20	13.19	8.62	7.41	10.55

In a column, figures with similar letter (s) without letter do not differ significantly as per DMRT.

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

Number of Seeds per Pod: There was significant influence on seeds pod^{-1} by sowing date (Table 1). The highest seeds pod^{-1} (2.03) was found in 27 November sowing and the lowest number (1.61) in 7 November sowing (Table 2).

The significant result was found on seeds pod^{-1} due to the effect of variety (Table 1). The highest seeds pod^{-1} (2.09) was found in G-2 and the lowest number (1.60) in PB-1, which was statistically identical with BS-5 (Table 2).

The interaction effect of sowing date and variety on seeds pod^{-1} was found significant (Table 1). The highest seeds pod^{-1} (2.31) was found in the variety G-2 with 16 December sowing. Also the 27 November sowing of same variety was statistically identical. The lowest seeds pod^{-1} (1.47) was found in the variety BS-5 with 16 December sowing which was also statistically identical with 7 November sowing (Table 3).

100- Seed Weight: The result was non significant. There was no variation due to the effect of sowing date on 100-seed weight (Table 1).

The significant variation was found on the 100-seed weight due to the effect of variety (Table 1). The highest 100-seed weight (9.46 g) was found in the variety PB-1, which was also statistically identical with BS-5 and the lowest 100-seed weight (7.58 g) was found in G-2 (Table 2).

The interaction effect of sowing date and variety on 100-seed weight was non significant (Table 3).

Seed Yield: The significant variation was found on seed yield due to the effect of sowing date (Table 1). The highest seed yield (170.36 g m^{-2}) was found with 16 December sowing and the lowest seed yield (53.75 g m^{-2}) from 7 November sowing (Table 2). The result shows that the seed yield was increased with each successive delay in sowing after 7 November up to 16 December and further delay in sowing after 16 December the seed yield again started to decreased. Singh *et al.* [7] found highest mean seed yield (2.21 t ha^{-1}) with 10 June sowing in India.

The significant difference was found among the varieties by seed yield (Table 1). The highest seed yield (159.71 g m^{-2}) was found in the variety G-2 and the lowest seed yield (78.23 g m^{-2}) was found in the variety BS-5 which was statistically identical with PB-1 (Table 3). The result shows that G-2 produce 43 and 51% higher seed yield than PB-1 and BS-5 respectively (Table 2). BARI [8] reported that variety G-2 gave the higher seed yield than variety PB-1.

The interaction effect of sowing date and variety on seed yield was significant (Table 1). The highest seed yield (207.40 g m^{-2}) was found in the variety G-2 with 16 December sowing and the lowest seed yield (12.960) was found in the variety BS-5 with 7 November sowing. PB-1 was also statistically identical with BS-5 at 7 November sowing (Table 3).

Stover Yield: Stover yield was significantly affected by sowing date (Table 1). The highest stover yield (402.69 g m^{-2}) was found with 16 December sowing and the lowest (178.26 g m^{-2}) was found with 7 November sowing (Table 2). The result shows that the stover yield was increased with each successive delay in sowing after 7 November up to 16 December and further delay in sowing after 16 December the stover yield again started to decreased.

Variety had a significant influence on stover yield (Table 1). The highest stover yield (322.91 g m^{-2}) was found in variety BS-5 and the lowest stover yield (294.65 g m^{-2}) observed in variety G-2. PB-1 was statistically identical with G-2 and BS-5 (Table 2). The result shows that BS-5 produce 7 and 8% higher stover than PB-1 and G-2 respectively.

The significant result was observed due to the interaction effect of sowing date and variety on stover yield (Table 1). The highest stover yield (447.24 g m^{-2}) was found in the variety BS-5 with 16 December sowing and the lowest (142.05 g m^{-2}) was found in PB-1 with 7 November sowing (Table 3).

Biological Yield: Biological yield was significantly affected by the sowing date (Table 1). The highest Biological yield (573.05 g m^{-2}) was obtained from 16 December sowing and the lowest biological yield (232.01 g m^{-2}) was found with 7 November sowing (Table 2). The result shows that the biological yield was increased with each successive delay in sowing after 7 November up to 16 December and further delay in sowing after 16 December the biological yield again started to decreased.

Biological yield was significantly affected by the variety (Table 1). The highest biological yield (454.37g m^{-2}) was found in the variety G-2 and the lowest biological yield (389.98 g m^{-2}) was found in PB-1. BS-5 was also statistically identical with PB-1(Table 2).

Biological yield was significantly affected by the interaction effect of sowing date and variety (Table 1). The highest biological yield (599.09 g m^{-2}) was found in the variety BS-5 with 16 December sowing. BS-5 is also statistically identical with G-2 with same sowing date and the lowest (158.87 g m^{-2}) was found in PB-1 with 7 November sowing which was also statistically identical with BS-5 at same sowing date (Table 3).

Harvest Index: The significant difference was found in harvest index due to sowing date (Table 1). The highest harvest index (29.70%) was found with 16 December sowing and the lowest (19.04%) was found in 7 November (Table 2). The result shows that the harvest index was increased with each successive delay in sowing after 7 November up to 16 December and further delay in sowing after 16 December the harvest index again started to decrease.

Harvest index was significantly affected by the effect of variety (Table 1). The highest harvest index (35.48%) was found in the variety G-2 and the lowest (17.25%) in BS-5 (Table 2).

The interaction effect of sowing date and variety on harvest index was significant (Table 1). The highest harvest index (40.09%) was found in variety G-2 with 7 November sowing and the lowest (6.29%) in BS-5 on same sowing date (Table 3).

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