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EFFECT OF PLANT DENSITIES ON SEED OF TWO SOYBEAN VARIETIES

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Abstract: A field experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during the period from December 2005 to April 2006 to study the effect of plant density on seed yield of soybean. Two soybean varieties namely PB-1 (Shohag) and G-2 (Bangladesh soybean-4), and six plant densities namely 20, 40, 60, 80, 100 and 120 plants m^{-2} were included in the study. An equidistant (square) planting pattern having spacing 22.4 cm × 22.4 cm; 15.8 cm × 15.8 cm; 12.9 cm × 12.9 cm; 11.2 cm × 11.2 cm; 10 cm × 10 cm; and 9.1 cm × 9.1 cm, respectively were used to create required plant densities. The experiment was laid out in a split-plot design with varieties in the main plot and plant densities in sub plots. The treatments were replicated three times. Variety showed significant influence in all characters except harvest index. Plant density had significant variation in all characters except number of nodes $plant^{-1}$. Again, the interaction of variety and plant density significantly influenced all characters except plant height, number of nodes $plant^{-1}$ and number of seeds pod^{-1}. Plant density of 20 plants m^{-2} gave the highest number of nodes $plant^{-1}$, number of branches $plant^{-1}$, number of total pods $plant^{-1}$, number of fertile pods plant, number of seeds $plant^{-1}$, seed yield $plant^{-1}$, while the highest total dry matter, seed yield m^{-2}(150.95 g) and stover yield m^{-2} were found at 80 plants m^{-2}. The highest plant highest was recorded at 120 plants m^{-2}. Therefore, higher yield of soybean could be obtained from variety G-2 by planting the crop at a density of 80 plants m^{-2}.

Key word: Plant density, Soybean, Interaction.

Introduction

Soybean (*Glycine max* L.) has high potential both as a pulse and oil crop in Bangladesh (Annon, 1985). Soybean seed contains over 40 percent protein and it can play a vital role in balancing the protein deficiency of our diet. Soybean plant can fix atmospheric nitrogen with the help of *Rhizobium* bacteria forming root nodules that helps improving growth and yield as well as the fertility of the soil (Biswas *et al.*, 1991). The growth, yield and yield components of soybean are greatly influenced by the maintenance of optimum planting density per unit area which in turn is regulated by the optimum plant spacing. It also leads to lodging and reduce fruit bearing capacity. Nimje (1996) reported that dry matter weight $plant^{-1}$ and yield attributes (Pods $plant^{-1}$, yield $plant^{-1}$ and 1000-grain weight) were highest in proper spacing. Therefore, the present study was undertaken to observe the effect of plant densities on the seed yield of soybean.

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from 3 December 2005 to 28 April 2006 including two varieties PB-1 (Shohag) and G-2 (Bangladesh Soybean-4) having six plant densities viz. 20 plants m^{-2} (22.4 cm × 22.4 cm), 40 plants m^{-2} (15.8 cm × 15.8 cm), 60 plants m^{-2} (12.9 cm × 12.9 cm), 80 plants m^{-2} (11.2 cm × 11.2 cm), 100 plants m^{-2} (10 cm × 10 cm) and 120 plants m^{-2} (9.1 cm × 9.1 cm). The experiment was laid out in a split-plot design with variety in the main plot and density in the sub-plot having treatments being replicated three times. The total numbers of plots were 36 and size of each plot was (4.4 m × 2.5 m). The distances kept between replications and also between main plots were 1.0 meter and 0.5 meter, respectively. The soil was first opened with a power tiller on 22 November 2005. Four times ploughing and cross ploughing followed by laddering prepared the experimental field. The weeds and stubbles were removed to clean the field and then it was leveled properly by hand. Each unit plot was uniformly fertilized with N, P_2O_5, K_2O, Zn and Gypsum at the rate of 50, 150, 100, 3 and 90 kg ha^{-1} respectively in the form of Urea, TSP, Murate of potash, Zinc sulphate and Gypsum at the time of final land preparation. The seeds were treated with 50 g of inoculum (*Rhizobium sp.*) per 1 kg seed to develop proper coating as per instruction of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The seeds were sown on 3 December 2005 immediately after inoculation as per experimental specification. Four to five seeds were used in each hill and finally one plant was kept after final thinning. Two irrigations were given at 35 and 65 DAS to the plots. The irrigation was given when the soil moisture went down about 50% of the field capacity. Soon after emergence the soybean seedling were infested by cutworms and hairy caterpillars (*Diasrisia oblique*). Cutworm larvae was controlled through hand picking and hairy caterpillar was controlled by spraying Sumithion 50 EC @ 1 L ha^{-1} at 65 days after sowing (DAS). The crop was harvested by hand on 8 April 2006 at full maturity (when about 95% pods become brown in color). Just before harvest the plots, ten sample plants (excluding border rows) were selected randomly from the central 3.60m^2 area of each unit plot and were uprooted for recording necessary data on vegetative characters and yield attributing characters. After harvest the crop was then brought to the threshing floor and dried for three consecutive days in the sun. Then the crop was threshed by beating with sticks. The seeds were then cleaned and dried in the sun for 3-4 consecutive days. The seed yield was recorded at about 10 % moisture level basis. Plant height (cm), number of nodes $plant^{-1}$, number of branches $plant^{-1}$, total dry matter , number of total pods $plant^{-1}$, number of fertile pods $plant^{-1}$, number of

seeds plant^{-1} , number of seeds pod^{-1},100-seed weight (g), seed yield plant^{-1} (g), seed yield m^{-2} (g), stover yield m $^{-2}$ (g), and harvest index (%) were recorded. The harvest index (%) was calculated following the formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Grain yield} + \text{Stover yield}}$$

The data were analyzed using analysis of variance (ANOVA) techniques and the mean difference among the treatments was adjudged with Duncan's Multiple Range Test.

Result and Discussion

The experiment was carried out to study the effect of plant density on seed yield of two soybean varieties. The variety PB-1 gave higher 100 seed weight and harvest index than variety G-2. Plant height number of nodes plant^{-1}, number of branches plant^{-1}, total dry matter m^{-2}, number of total pods plant^{-1}, number of total fertile pods plant^{-1}, number of seeds plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1}, seed yield (m^{-2}) and Stover yield (m^{-2}) were greater in variety G-2 than variety PB-1. 100-seed weight and was near about double in variety PB-1 than variety G-2. Plant height increased with increasing plant density in varieties. The highest total dry matter (m^{-2}) was obtained from 80 plants m^{-2} in both varieties. Seeds plant^{-1} decreases with increasing plant densities in both varieties. Seed yield plant^{-1} was higher at 20 plants m^{-2} in both varieties PB-1 and G-2. The highest 100-seed weight was also observed at 60 plants m^{-2} and the lowest was at 100 plants m^{-2}. Variety G-2 gave the highest seed yield and Stover yield from 80 plants m^{-2}. PB-1 gave the highest seed yield and Stover yields both at 100 plants m^{-2}. The highest Stover yield both at 100 plants m^{-2}. The highest seed yield was 185.22 g m^{-2} and 126.67 g m^{-2} at 80 plants m^{-2} and 100 plants m^{-2} in varieties G-2 and PB-1, respectively. The study revealed that the variety G-2 gives more yield at lower plant density than variety PB-1. Plant height, number of nodes plant^{-1}, number of branches plant^{-1}, total dry matter m^{-2}, number of total pods plant^{-1}, number of total fertile pods plant^{-1}, number of seeds plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1}, seed yield m^{-2} and Stover yield m^{-2} were greater in variety G-2 than variety PB-1. Further study is needed to find out the suitable plant density for better yield of soybean varieties.

Table 1 Effect of variety and plant density on vegetative characters of soybean

Treatment	Plant height (cm)	No. of nodes plant^{-1}	No. of branches plant^{-1}	Total dry matter m^{-2} (g)
Variety				
G-2	76.44a	15.76a	3.73a	416.81a
PB-1	53.83b	12.06b	2.54b	319.26b
$S\bar{x}$	0.28	0.14	0.05	3.47
Level of significance	***	**	**	**
CV (%)	1.82	4.41	6.28	4.00
Plant density				
20 plants m^{-2}	55.70d	14.35	4.67a	315.28d
40 plants m^{-2}	62.01c	14.10	3.53b	350.71c
60 plants m^{-2}	64.99b	13.92	3.03c	384.27b
80 plants m^{-2}	65.53b	13.97	3.03c	416.51a
100 plants m^{-2}	70.67a	13.50	2.63d	381.67b
120 plants m^{-2}	71.93a	13.63	2.52d	359.78c
$S\bar{x}$	0.80	0.29	0.10	3.87
Level of significance	***	NS	***	***
CV (%)	3.02	5.02	8.08	2.57

In a column, the figures having common letter(s) do not differ significantly at 5% level of probability.
NS = Not significant, ** = Significant at 1% level of probability, *** = Significant at 0.1% level of probability.

Table 2 Interaction effect of variety and plant density on vegetative characters of soybean

Variety × Plant density	Plant height (cm)	No. of nodes plant^{-1}	No. of branches plant^{-1}	Total dry matter m^{-2} (g)
G-2 × 20 plants m^{-2}	66.23	16.10	5.03a	393.65c
G-2 × 40 plants m^{-2}	74.16	15.97	4.00b	427.59b
G-2 × 60 plants m^{-2}	75.37	16.03	3.90bc	438.65b
G-2 × 80 plants m^{-2}	75.90	15.13	3.50cd	483.53a
G-2 × 100 plants m^{-2}	82.17	15.57	3.30d	393.33c
G-2 × 120 plants m^{-2}	84.83	15.77	2.67ef	364.09de
PB-1× 20 plants m^{-2}	45.16	12.60	3.10dc	236.90h
PB-1 × 40 plants m^{-2}	49.85	12.23	3.07de	273.82g
PB-1 × 60 plants m^{-2}	45.61	11.80	2.17de	329.89f
PB-1 × 80 plants m^{-2}	55.17	12.80	2.57gh	349.49e
PB-1 × 100 plants m^{-2}	59.17	11.43	1.97fh	370.00d
PB-1 × 120 plants m^{-2}	59.02	11.50	2.37h	355.46de
$S\bar{x}$	1.13	0.40	0.59	5.47
Level of significance	NS	NS	***	***
CV (%)	3.02	5.02	8.08	2.57

In a column, the figures having common letter(s) do not differ significantly at 5% level of probability.
NS = Not significant, *** = Significant at 0.1% level of probability.

Table 3 Effect of variety and plant density on yield and yield attributing characters of soybean

Treatment	No. of total pods plant^{-1}	No. of fertile pods plant^{-1}	No. of seeds plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	Seed yield plant^{-1} (g)	Seed yield m^{-2} (g)	Stover yield m^{-2} (g)	Harvest index (%)
Variety G-2	64.33a	62.47a	140.80a	2.25a	6.00b	7.88a	142.42a	274.39a	33.94
PB-1	38.78b	37.16b	69.27b	1.87b	11.70a	6.68b	110.42b	208.84b	34.85
$S\bar{x}$	0.37	0.37	0.76	0.02	0.11	0.03	0.58	2.97	0.20
Level of significance	***	***	***	**	***	**	***	**	NS
CV (%)	3.03	3.13	3.06	4.86	5.18	1.94	1.96	5.22	2.47
Plant density 20 plants m^{-2}	77.25a	74.83a	153.92a	2.01b	9.06b	11.11a	105.60e	209.68d	34.26bc
40 plants m^{-2}	49.05d	47.55b	110.50b	2.29a	8.81bc	7.44b	125.91c	224.80c	36.21a
60 plants m^{-2}	51.55c	50.13c	107.22b	2.05b	9.40a	7.75b	135.20b	249.07b	35.06ab
80 plants m^{-2}	53.68b	52.13b	110.40b	2.09b	8.66c	7.41b	150.95a	265.56a	35.85a
100 plants m^{-2}	41.43e	39.73e	80.17c	1.98b	8.52c	5.45c	126.71c	254.96b	33.22c
120 plants m^{-2}	36.37f	34.50f	86.00d	1.94b	8.67c	4.52d	114.17d	245.61b	31.75d
$S\bar{x}$	0.619	0.62	2.18	0.04	0.11	0.17	1.77	3.27	0.38
Level of significance	***	***	***	***	***	***	***	***	***
CV (%)	2.91	3.06	5.09	5.23	3.12	5.72	3.43	3.31	2.74

Table 4 Interaction effect of variety and plant density on yield and yield attributing characters of soybean

Variety ×Plant density	No. of total pods plant^{-1}	No. of fertile pods plant^{-1}	No. of seeds plant^{-1}	No. of seeds pod^{-1}	100-seed weight (g)	Seed yield Plant^{-1} (g)	Seed yield m^{-2} (g)	Stover yield m^{-2} (g)	Harvest index (%)
G-2×20 plants m^{-2}	94.47a	91.37a	204.57a	2.24	5.83fg	11.57a	122.86de	270.80b	31.23g
G-2×40 plants m^{-2}	57.77de	56.50de	141.73c	2.51	5.94efg	7.41de	148.91c	278.69b	34.84cd
G-2×60 plants m^{-2}	69.83b	68.70b	156.67b	2.28	6.42e	9.63c	157.78b	280.87b	35.99bc
G-2×80 plants m^{-2}	65.67c	64.13c	142.40c	2.22	6.16ef	8.12d	185.22a	298.31a	38.31a
G-2×100 plants m^{-2}	56.10e	54.37e	113.73d	2.09	6.22ef	6.82e	126.75d	266.59b	32.21fg
G-2×120 plants m^{-2}	42.17f	39.77f	85.70f	2.16	5.48g	2.74g	112.99f	251.10c	31.05g
PB-1×20 plants m^{-2}	60.03d	58.30d	103.27e	1.78	12.29ab	10.64b	88.33h	148.57g	37.29ab
PB-1×40 plants m^{-2}	40.33f	38.60f	79.27f	2.06	11.67c	7.47de	102.90g	170.92f	37.58ab
PB-1×60 plants m^{-2}	33.27g	31.57g	57.77g	1.83	12.38a	5.86f	112.62f	217.27e	34.13de
PB-1×80 plants m^{-2}	41.70f	40.13f	78.40f	1.95	11.17d	6.70e	116.67ef	232.82d	33.40def
PB-1×100 plants m^{-2}	26.77i	25.10h	46.60h	1.86	10.82d	4.09g	126.67d	243.33cd	34.23d
PB-1×120 plants m^{-2}	30.57h	29.23g	50.30gh	1.72	11.86bc	5.30f	115.34ef	240.11cd	32.45efg
$S\bar{x}$	0.87	0.88	3.08	0.06	0.16	0.24	2.50	4.62	0.54
Level of significance	***	***	***	NS	***	***	***	***	***
CV (%)	2.91	3.06	5.09	5.23	3.12	5.72	3.43	3.31	2.74

In a column, the figures having common letter(s) do not differ significantly at 5% level of probability.
NS = Not significant, ** = Significant at 1% level of probability, *** = Significant at 0.1% level of probability.

Conclusion

Optimum spacing ensures proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, water, lands as well as air spaces. Spacing for line sowing is recommended to maintain required number of plant population and to undertake intercultural operations for harvesting a better yield.

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