The Agriculturists 11(1): 33-38 (2013) ISSN 2304-7321 (Online), ISSN 1729-5211 (Print)
A Scientific Journal of Krishi Foundation ***Indexed Journal***

Effect of Row Spacing and Cultivar on the Growth and Seed Yield of Soybean (*Glycine max* [L.] Merrill) in *Kharif-II* Season

M. M. Rahman[1*], M. M. Rahman[2] and M. M. Hossain[1]

[1]*Department of Agronomy, Bangladesh Agricultural University, Mymensingh*
[2]*Willes Little Flower School and College, Dhaka, Bangladesh*

**Corresponding author and Email: rahmanag63@yahoo.com*

Received: 2 September 2012 Accepted: 18 May 2013

Abstract

An experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh during *Kharif-II* season 2005 to investigate the effect of row spacing and cultivars on the growth and yield of soybean. Three soybean cultivars: (1) Bangladesh Soybean -4 (G-2), (2) BARI soybean -5 (BS-5) and (3) Shohag (PB-1) and four row spacings, (1) 20 cm, (2) 30 cm, (3) 40 cm and (4) 50 cm were used in the experiment in a split-plot design with row spacing in the main plot and cultivars in the sub-plot. Seeds were sown on 26 July 2005 at specified rows maintaining 5 cm plant to plant distance. The highest seed yield was obtained from 20 cm spacing and yield decreased with increased spacing irrespective of cultivars. Among cultivars the highest yield was given by cultivar BS-5 which was followed by PB-1. It was concluded that the soybean cultivars BS-5 and PB-1 could be selected for sowing in *Kharif-II* season and should be planted at 20 cm apart rows for achieving higher yield.

***Keywords*: Soybean, cultivar, row spacing, growth, seed yield, *kharif-II* season**

1. Introduction

Soybean (*Glycine max* [L.] Merrill) is the world's most important grain legume crop in terms of total production and international trade. Despite suitable climatic and edaphic conditions, the yield of soybean is very low in Bangladesh. The lower yield at farmer's level is attributed to the poor agronomic management practices and also due to use of low quality seed (Rahman and Islam, 2006). Planting of low quality seeds results in poor seedling emergence and non-uniform plant establishment. Moreover, unavailability of quality seeds is also a cause of limited adoption of the crop.

Soybean is mainly cultivated in *rabi* season. Unavailability of quality seeds for sowing in *rabi* season is a major problem in soybean cultivation. Soybean seed losses viability in storage and thus, farmers cannot store seed for their own. They have to use seeds harvested from *kharif-II* crops. The planting geometry and plant population have not yet been established for *kharif-II* seed crop. Planting density is an important determinant of seed yield and it plays an important role in modulating the environmental factors related to growth and development of the crop. Planting soybean in rows ensures easy intercultural operations and helps to attain in higher yield. The row spacing recommended for soybean in *kharif-II* season is 40 cm (BARI, 2005). However, the relevant research finding in this line for different cultivars is highly scarce. The effect of different row spacing on yield performance of soybean cultivars might help determining variety specific row spacing to obtain high yield. Considering these views, the present experiment was undertaken to determine the response of several soybean cultivars grown under varying row spacings.

2. Materials and Methods

The experiment was conducted in *Kharif-II* season during July to November 2005 at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh. The experiment comprised four row spacings viz. 20, 30, 40 and 50 cm and three cultivars namely, Bangladesh Soybean-4 (G-2), BARI soybean -5 (BS-5) and Shohag (PB-1). The trial was conducted in a split-plot design with row spacings in the main plots and cultivars in the sub-plots. The treatments were replicated three times. The unit plot size was 4 m x 3 m.

The seeds of each variety were inoculated with *Rizhobium* inoculum and then were sown on 26 July 2005 in rows following treatments. Three manual weedings were done at 21, 35 and 45 days after sowing (DAS). During first and second weeding, thinning was done to maintain a plant to plant spacing of 5 cm. No irrigation was given because heavy rainfall occurred during the whole period of the cropping season. The crop was infested by hairy caterpillar at vegetative, flowering and seed filling stages, which were successfully controlled by application of Dimethion 40 EC @ 1.5 L ha^{-1} immediately after infestations. No disease incidence occurred in the crop field.

The crop was harvested from central 6 m^2 (2.4 m × 2.5 m) area of each plot at full maturity (when about 80% pods turned into brown) on 27 October for cultivar G-2 and 13 November for cultivars BS-5 and PB-1. The post harvest processing such as threshing, cleaning and drying were done properly. Prior to harvesting, 10 randomly selected sample plants were uprooted and data on different growth characters and yield components were recorded. Crop growth rate, leaf area index and leaf area duration were recorded by destructive sampling of plants from 0.20 m^{-2} area at 15 day intervals starting from 30 days after sowing following Gardner *et al.* (1985). Dry matters of plant samples were also recorded at R5 stage (beginning pod stage) after drying in oven at 80 ^{o}C for 72 hours. The collected data were analysed following ANOVA and mean comparison was done by DMRT with the help of MSTAT-C.

3. Results and Discussion

Growth attributes

Leaf area index (LAI), leaf area duration (LAD), total dry matter (TDM) and crop growth rate were varied significantly due to row spacing, cultivars and their interactions. LAI, LAD and TDM were the highest when crops were grown at 20 cm row spacing (Table 1). The highest values of LAI, LAD, TDM and CGR were 2.14, 96.05 days, 381.91 g m^{-2} and 6.65 g m^{-2} d^{-1} respectively at 20 cm row spacing which decreased with increased row spacing. The lowest values were 1.16, 45.41days, 257.18 g m^{-2} and 3.39 g m^{-2} d^{-1}, respectively at 50 cm row spacing (Table 1). These growth parameters were the highest for cultivar BS-5 and the lowest for G-2. The interaction of row spacing to cultivar showed the highest values for LAI, LAD, TDM and CGR for cultivar BS-5 at 20 cm row spacing which were 2.64, 128.41 days, 479.35 g m^{-2} and 8.41 g m^{-2} d^{-1}, respectively and the lowest values were for cultivar G-2 at 50 cm row spacing (Table 1). The result showed that narrowest rows attributed to the highest growth of the crop because of high plant density while widest rows gave the lowest because of low plant density. The results of the present study are in agreement with those reported by Rahman *et al*. (2005) who found that LAI, LAD, CGR and TDM production increased in soybean with increases in densities for all the cultivars.

Table 1. Effect of row spacing and cultivar on leaf area index (LAI), leaf area duration (LAD), total dry matter (TDM) at R5 stage and crop growth rate (CGR) of soybean in *Kharif-II* season

Treatments		**LAI**	**LAD (days)**	**TDM (g m^{-2})**	**CGR (g m^{-2} d^{-1})**
Row spacing (cm)					
	20	2.14a	96.05a	380.91a	6.65a
	30	1.71b	69.51b	323.32b	4.82b
	40	1.37bc	55.33c	294.52b	4.47b
	50	1.16c	45.41d	257.18c	3.39c
	CV (%)	12.86	9.93	9.35	7.16
	SE	0.0093	9.7119	191.52	0.0266
Cultivar					
	G-2	1.03c	37.42c	204.72c	3.66c
	BS-5	2.09a	90.78a	395.65a	5.85a
	PB-1	1.66b	71.52b	341.58b	4.99b
	CV (%)	5.51	8.64	7.11	13.37
	SE (±)	0.0013	5.5141	83.0617	0.0696
Cultivar	× Row spacing (cm)				
	20	1.53d	55.59d	233.29e	4.72cd
G-2	30	1.16e	39.54e	212.08ef	3.68de
	40	0.79f	29.07f	194.13ef	3.49de
	50	0.63g	25.47f	178.36f	2.73e
	20	2.64a	128.41a	479.35a	8.41a
BS-5	30	2.24b	94.47b	440.15b	6.59b
	40	1.74c	72.51c	350.42c	4.61cd
	50	1.77c	67.73c	312.69cd	3.79de
	20	2.25b	104.13b	430.10b	6.83b
PB-1	30	1.73c	74.51c	317.74cd	4.19cd
	40	1.57d	64.43cd	338.00f	5.32c
	50	1.08e	43.02e	280.50d	3.65de
	CV (%)	5.51	8.64	7.11	13.37
	SE (±)	0.0051	22.0565	332.07	0.2784

Figures having similar letter (s) do not differ significantly at 5% level as per DMRT

Yield and yield attributes

Seed yield was significantly influenced by row spacing, cultivar and their interaction (Table 2). The highest seed yield of 133.75 g m^{-2} was produced at 20 cm rows, while the lowest (105.33 g m^{-2}) was found at 50 cm rows. The result showed that seed yield decreased with increase in row spacing. The cultivar BS-5 gave the highest seed yield (151.24 g m^{-2}). The highest seed yield (166.57 g m^{-2}) was produced by the cultivar BS-5 at 20 cm rows while the lowest seed yield (62.40 g m^{-2}) was found in cultivar G-2 at 50 cm rows. In all the three cultivars, seed yield decreased with increase in row spacing (Table 3). Stover yield, total dry matter and harvest index were influenced significantly by row spacing, cultivar and interactions.

The crop sown at 20 cm rows produced the highest stover yield (179.58 g m^{-2}) while the 50 cm rows produced the lowest (118.40 g). Cultivar BS-5 produced the highest stover yield (169.23 g m^{-2}) and cultivar G-2 produced the lowest (104.64 g m^{-2}). The highest stover yield (233.75 g m^{-2}) was produced by cultivar BS-5 at 20 cm rows, but the lowest (94.80 g m^{-2}) was produced by cultivar G-2 at 50 cm rows. Stover yield decreased with increase in row spacing in all the three cultivars (Table 3). The highest TDM (313.33 g m^{-2}) was produced at 20 cm rows but the lowest (223.73 g m^{-2}) was at 50 cm rows. The cultivar BS-5 produced the highest TDM (320.46 g m^{-2}) while the lowest was found with G-2 (175.39 g m^{-2}). The interaction showed that the highest (400.32 g m^{-2}) dry matter was attained in cultivar BS-5 at 20 cm rows while the lowest (157.20 g m^{-2}) was obtained in cultivar G-2 at 50 cm rows (Table 3). The highest harvest index (46.34%) was at 40 cm row spacing and values were similar to that at 30 and 50 cm row spacing (Table 2). The lowest value (42.51%) was observed at 20 cm row spacing. The highest (47.72%) harvest index was found in cultivar BS-5 and the lowest in cultivar G-2. Cultivar and row spacing interaction showed that cultivar PB-1 sown at 40 cm rows resulted in the highest harvest index (50.92%), while the lowest (38.57%) was found in cultivar G-2 at 40 cm rows (Table 3).

Plant height, number of branches $plant^{-1}$, number of fertile and non-fertile pods $plant^{-1}$, number of seeds pod^{-1}, and number of seeds $plant^{-1}$ varied significantly with row spacing (Table 2). The tallest plant (43.74 cm) was found at 20 cm row spacing while the highest number of branches (2.51) and pods $plant^{-1}$ (19.86) were found at 50 cm row spacing. The result showed that plant height increased with decreased row spacing but other yield related attributes in individual plants were reduced with increase of row spacing (Table 2). The interaction of cultivar and plant spacing was significant for number of fertile pods $plant^{-1}$, non-fertile pods $plant^{-1}$ and number of seeds $plant^{-1}$ (Table 3) while plant height, number of nodes $plant^{-1}$, number of branches $plant^{-1}$, number of seed pod^{-1} and weight of 100 seed remained unaffected. The result indicated that seed yield of all the soybean varieties increased with decrease of row spacing and the highest was attained at the lowest row spacing of 20 cm.

The present study showed that plant height increased in soybean with decrease of row spacing. The plant density at row spacing of 20 cm was 100 plants m^{-2} while that at 40 cm was only 50 plants m^{-2}. Therefore, the increase in plant height at closer spacing might have been caused due to increased plant population density. The higher population density caused mutual shading in plants that contributed to stem elongation and ultimately plant height increased (Pendersen and Lauer, 2003; Rahman *et al*., 2004).

The highest seed yield in the lowest spacing could have been achieved by early canopy closure in the narrowest rows that facilitated high TDM production. The leaf area development with closer spacing contributed to high TDM production due to higher solar radiation interception that contributed to higher yield production (Ball *et al*., 2000). Rahman *et al.* (2011) also reported the highest seed yield of soybean in *kharif-II* season at a population density of 80-100 plants m^{-2} which commensurate the result of the present study. The recommended row spacing for soybean is 40 cm in *kharif –II* season, which is equivalent to a plant population density of 50 plants m^{-2} (BARI, 2005). The present study, therefore, indicated that the higher seed yield of soybean could be achieved in kharif-II season by planting the crop at a narrower spacing. Similar result was found by Rahman and Hanif (2006) who reported that soybean cv. Shohag gave the highest yield at 15 cm row spacing in rabi season. Therefore, a row spacing of 20 cm could be used for these three soybean varieties in *kharif-II* season to obtain high yield.

Table 2. Effect of row spacing and cultivar on growth, yield attributes and yield of soybean in *Kharif-II* season

Treatments	Plant height (cm)	Nodes plant^{-1} (no.)	Branches plant^{-1} (no.)	Fertile pods plant^{-1} (no.)	Non fertile pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	Seed plant^{-1} (no.)	Weight of 100 seeds (g)	Seed yield (g m^{-2})	Stover yield (g m^{-2})	Total dry mater (g m^{-2})	Harvest index (%)
Row spacing (cm)												
20	43.74a	12.63	2.03b	15.23c	2.00a	1.74b	26.42d	8.30	133.75a	179.58a	313.33a	42.51b
30	40.46b	12.99	2.16b	16.67bc	1.29b	1.73b	28.87c	8.35	119.02b	137.08b	256.10b	45.82a
40	38.61bc	13.12	2.21ab	19.86a	1.31b	1.93a	38.20a	8.40	117.37b	129.58c	246.96b	46.34a
50	37.61c	12.99	2.51a	17.39b	1.20b	1.89a	32.83b	8.46	105.33c	118.40d	223.73c	46.10a
CV (%)	5.14	5.74	1.19	8.34	10.68	6.94	3.03	1.19	3.34	4.39	3.27	2.00
SE(±)	0.944	0.1224	0.0002	0.462	0.0053	0.0036	0.2034	0.0022	3.503	8.534	16.067	0.1815
Cultivar												
G-2	37.47c	11.59b	1.80c	13.08c	0.83c	1.80	23.33c	5.42c	70.75c	104.64c	175.39c	40.28b
BS-5	42.96a	13.79a	2.80a	20.44a	1.82a	1.84	37.79a	10.11a	151.24a	169.23a	320.46a	47.72a
PB-1	39.89b	13.42a	2.08b	18.34b	1.71b	1.83	33.62b	9.50b	134.62b	149.63b	284.24b	47.57a
CV (%)	5.24	4.36	8.55	5.80	6.94	6.19	4.04	1.01	3.26	3.90	2.46	2.76
SE(±)	0.7361	0.0529	0.0060	0.1675	0.0017	0.0021	0.2713	0.0012	2.503	5.052	6.819	0.259

Figures having similar letter (s) do not differ significantly at 5% level as per DMRT

Table 3. Interaction effect of cultivar and row spacing on growth, yield attributes and yield of soybean in *Kharif-II* season

Cultivar	× Row spacing (cm)	Plant height (cm)	Nodes plant^{-1} (no.)	Branches plant^{-1} (no.)	Fertile pods plant^{-1} (no.)	Non fertile pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	Seed plant^{-1} (no.)	Weight of 100 seeds (g)	Seed yield (g m^{-2})	Stover yield (g m^{-2})	Total dry mater (g m^{-2})	Harvest index (%)
G-2	20	40.57	10.97	1.60	11.27j	1.37e	1.79	20.00i	5.28	77.94f	111.25f	189.19g	41.22e
	30	39.50	12.20	1.80	15.10gh	0.83f	1.59	24.00h	5.35	77.51f	108.75f	186.26c	41.62e
	40	35.43	12.03	1.77	12.43ij	0.53g	1.96	24.30h	5.44	65.15g	103.75gh	168.90h	38.57f
	50	34.17	11.17	2.03	13.50hi	0.57g	1.86	25.03h	5.61	62.40g	94.80g	157.20i	39.73ef
BS-5	20	46.30	13.70	2.63	17.73def	2.57a	1.72	30.50fg	10.11	166.57a	233.75a	400.32a	41.61e
	30	43.13	13.70	2.83	18.70bcd	1.60d	1.74	32.53ef	10.14	154.73bc	157.50c	312.23c	49.57ab
	40	41.80	13.73	2.87	27.17a	1.60d	1.95	52.73a	10.12	148.24c	151.25cd	299.49d	49.52ab
	50	40.60	14.03	2.87	18.17cde	1.50dc	1.95	35.40cd	10.10	135.42d	134.40e	269.82e	50.19ab
PB-1	20	44.37	13.23	1.87	16.70efg	2.07b	1.72	28.77g	9.51	156.74b	193.75b	350.59b	44.72d
	30	38.53	13.07	1.83	16.20fg	1.43de	1.86	30.07de	9.56	124.83e	145.00d	269.83e	46.26cd
	40	38.60	13.60	2.00	19.97bc	1.80c	1.89	37.57bc	9.65	138.73d	133.75e	272.48e	50.92a
	50	38.07	13.77	2.63	20.50b	1.53de	1.86	38.07b	9.67	118.18e	126.00e	244.18f	48.39bc
	CV (%)	5.24	4.36	8.55	5.80	4.04	6.19	4.04	1.01	3.26	3.90	2.46	2.76
	SE (±)	2.924	0.212	0.0242	0.6701	0.0023	0.009	1.0852	0.0048	10.0113	20.206	27.281	1.0372

Figures having similar letter (s) do not differ significantly at 5% level as per DMRT

4. Conclusions

It may be concluded that soybean cultivar BARI soybean -5 (BS-5) could be sown at 20 cm apart rows to obtain higher yield in *kharif II* season.

References

Ball, R. A., Purcell, L. C. and Vories, E. D. 2000. Optimizing soybean plant population for a short season production system in the Southern USA. *Crop Science*. 40 : 757-764.

BARI, 2005. Krishi Prozukti Haat Boi (Handbook of Agrotechnology). Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. 155-160 pp.

Gardner, F. P., Pearce, R. B. and Mitchell, R. L. 1985. Physiology of Crop Plants. Iowa State University Press, pp. 1-327.

Pendersen, P. and Lauer, J. G. 2003. Corn and soybean response to rotation sequence, row spacing and tillage system. *Agronomy Journal*, 95 : 965-997.

Rahman, M. M. and Hanif, M. A. 2006. Effect of row spacing and phosphorus level on soybean seed yield and quality. *Bangladesh Journal of Seed Science and Technology*, 11(1&2) : 69-75.

Rahman, M. M. and Islam, M. A. 2006. Effects of sowing date on seed yield and yield attributes of soybean. *Journal of the Bangladesh Agricultural University*, 4(1) : 23-31.

Rahman, M. M., Hampton, J. G. and Hill, M. J. 2005. Growth response of cool tolerant soybean to variation in sowing date. *Agronomy New Zealand*, 35 : 81-96.

Rahman, M. M., Mwakangwale, M. G., Hampton, J. G. and Hill, M. J. 2004. The effect of plant density on seed yield of two cool tolerant soybean cultivars in Canterbury. *Agronomy New Zealand*, 34 : 149-159.

Rahman, M., Hossain, M. and Bell, R. W. 2011. Plant density effects on growth, yield and yield components of two soybean varieties under equidistant planting arrangement. *Asian Journal of Plant Sciences*, 10(5): 278-286.