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Yield performance of soybean as influenced by phosphorus

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Abstract: An experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during January to April 2012 to find out the effect of level of phosphorus on the yield performance of different varieties of soybean. The experiment comprised of four varieties viz. BARI soybean 5, BARI soybean 6, BINA soybean 1 and BINA soybean 2 and four levels of phosphorus viz. 0, 40, 80, and 120 kg P_2O_5 ha^{-1}. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Both variety and phosphorus level had significant influence on all the plant characters except number of plants m^{-2} and straw yield. The application of 80 kg P_2O_5 ha^{-1} produced the highest number of filled pods(50.43), number of seeds pod^{-1} (2.93), 100-seed weight (10.66 g), seed yield (1.95 t ha^{-1}) and stover yield (4.10 t ha^{-1}). The highest number of nodes $plant^{-1}$ (13.17), number of branches $plant^{-1}$ (5.10), number of filled pods (51.16), number of seeds pod^{-1} (3.00), seed yield (1.96 t ha^{-1})and stover yield (4.08 t ha^{-1}) were found in the variety BARI soybean 5. BARI soybean 5 with 80 kg P_2O_5 ha^{-1} gave the highest grain yield. From the present study it is concluded that BARI soybean 5 with 80 kg P_2O_5 ha^{-1} may be used for getting better yield of soybean.

Key words: Phosphorus, yield performance, soybean.

Introduction

Soybean occupies the second position as oil source in the world. In Bangladesh, about 100527 acres of land is under soybean cultivation and annual production is approximately 69522 metric tons (BBS, 2010). Phosphorus plays an important role in the development of strong root system, nodulation, seed formation and growth of soybean plant. Phosphorus is one of the limiting plant nutrients for soybean production (Rao *et al*., 1995). Phosphorus application is necessary for high protein and oil yields from soybean seeds as well as for high forage yield from soybean planted for the purpose (Shah *et al.*, 2001). The world average yield of soybean is about 3 t ha^{-1} while that in Bangladesh 1.2 t ha^{-1} is only (Woodruff, 1998) 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 use of high yielding variety 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 at different phosphorus levels.

The research in this line is highly scarce in Bangladesh. Therefore, the present study was undertaken to find out the effect of phosphorus level on the yield performance of soybean.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from January to April 2012 to study effect of level of phosphorus on the yield performance of different varieties of soybean. The site belongs to the Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). The soil was sandy loam having 0.0585% total N, 0.463% organic matter, 23 ppm available P, 5.0 ppm available S & 0.13 ppm exchangeable K. The experiment comprised of four varieties viz. BARI soybean 5 (V_1), BARI soybean 6 (V_2), BINA soybean 1(V_3) and BINA soybean 2 (V_4) and four levels of phosphorus viz. 0 (P_0), 40 (P_1), 80 (P_2), and 120 (P_3) kg P_2O_5 ha^{-1}. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The entire experimental area was divided into three blocks representing the replications and each was sub-divided into 16 plots. The unit plot size was (2.5m x 2 m). The experimental field was first opened with a power tiller on 27 December, 2011. Each unit plot was fertilized with N, K_2O and gypsum at the rate of 50, 50 and 90 kg ha^{-1}, respectively in form of urea, muriate of potash and gypsum at the time of final land preparation. Phosphorus was applied in the form of TSP at the time of final land preparation as per experimental specifications. The seeds were then treated with 20g of inoculums kg^{-1} seed to develop proper coating as a general dose for the seeds of all varieties as per instruction of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The seeds were sown on 3 January immediately after inoculation. Crop management practices such as weeding, thinning, irrigation, insect and pest control were done as per requirements. At physiological maturity ten plants $plot^{-1}$ were collected randomly, sun dried and plant height (cm), number of nodes $plant^{-1}$, number of branches $plant^{-1}$, number of filled pods $plant^{-1}$, number of unfilled pods $plant^{-1}$, number of seeds pod^{-1}, Number of plants m^{-2}, 100- seed weight (g), seed yield (t ha^{-1}) and stover yield (t ha^{-1}). Data were analyzed using analysis of variance (ANOVA) technique with the help of computer package program and differences were adjudged by Duncan Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

The ultimate objective in a crop production is its economic yield. For soybean, seed yield is the major concern. The effect of variety and phosphorus on vegetative and yield contributing characters of soybean and interaction effect of variety and phosphorus on vegetative and yield contributing characters of soybean are presented in Tables 1- 3 .

Effect of variety: Variety exerted significant effect on the number of filled pods $plant^{-1}$ (Table 1). Mean value of data indicated that the highest number (51.16) of filled pods were produced by BARI soybean 5 which is identical to BARI soybean 6 (50.74). The lowest number (27.70) of filled pods were produced by BINA soybean 2.

Due to effect of variety the number of unfilled pods $plant^{-1}$ was affected significantly (Table 1). The highest (9.00) number of unfilled pods were produced by BARI soybean 6 which is identical to BINA soybean 1 (8.60). The lowest number (1.91) of unfilled pods were produced by BINA soybean 2.

Variation in number of seeds pod^{-1} were found in different variety (Table 1). The highest number (3.00) of seeds pod^{-1}

were produced by BARI soybean 5. The lowest number (2.76) of seeds pod^{-1} were produced by BINA soybean 1.

Table 1. Effect of variety on vegetative and yield contributing characters of table

Variety	No. of filled pods plant^{-1}	No. of unfilled pods plant^{-1}	No. of seeds pod^{-1}	Plants m^{-2}	100- seed wt. (g)	Stover yield (t ha^{-1})
V_1	51.16a	8.24b	3.00a	43.75b	9.77b	4.08
V_2	50.74a	9.00a	2.81c	47.50b	9.31c	4.04
V_3	48.10b	8.60ab	2.76d	54.25a	9.71b	4.00
V_4	27.70c	1.91c	2.90b	57.75a	12.33a	3.94
Level of sig.	**	**	**	**	**	ns
CV (%)	6.11	6.96	1.79	9.11	1.57	11.47

In a column, figures with common letter(s) or without letter do not differ significantly, whereas figures with dissimilar letters differ significantly as per DMRT, ** = Significant at 1% level of probability, * = Significant at 5% level of probability, ns= Not significant, V_1=BARI soybean 5 V_3= BINA soybean 1, V_2= BARI soybean 6 V_4= BINA soybean 2

Table 2. Effect of phosphorus on vegetative and yield contributing characters of soybean

Treatment	No. of filled pods plant^{-1}	No. of unfilled pods plant^{-1}	No. of seeds pod^{-1}	Plants m^{-2}	100- seed wt. (g)	Stover yield (t ha^{-1})
P_0	43.43b	7.81a	2.84b	51.25	10.07c	3.49
P_1	43.74b	6.63bc	2.90a	51.33	10.33b	3.79
P_2	50.43a	6.88b	2.93a	49.16	10.66a	4.10
P_3	40.10c	6.42c	2.81b	51.50	10.06c	3.39
Level of sig.	**	**	**	ns	**	ns
CV (%)	6.11	6.96	1.79	9.11	1.57	11.47

In a column, figures with common letter(s) or without letter do not differ significantly, whereas figures with dissimilar letters differ significantly as per DMRT., ** = Significant at 1% level of probability P_0 = 0 kg P_2O_5 ha^{-1}, * = Significant at 5% level of probability, ns= Not significant , P_1= 40 kg P_2O_5 ha^{-1}, P_2= 80 kg P_2O_5 ha^{-1}, P_3= 120 kg P_2O_5 ha^{-1}

Seed yield (t ha^{-1}) under different variety was found significant. The highest seed yield (1.96 t ha^{-1}) was recorded in the variety BARI soybean 5 followed by BARI soybean 6 (1.84 t ha^{-1}) and the lowest seed yield (1.71 t ha^{-1}) was recorded from BINA soybean 2 (Fig.1). The highest seed yield of BARI soybean 5 was due to the highest number of filled pods and the highest number of seeds. Seed yield differences might be due to genetic characteristics of the varieties. The lowest seed yield of BINA soybean 2 was due to the lowest number of filled pods.

Effect of level of phosphorus: Phosphorus has a significant influence on the number of filled pods plant^{-1} (Table 2). The results showed that the number of filled pods plant^{-1} at harvest ranged from 40.10 to 50.43. The highest number (50.43) of fertile pods plant^{-1} was produced by 80 kg P_2O_5 ha^{-1} and the lowest number (40.10) of filled pods plant^{-1} was produced with 120 kg P_2O_5 ha^{-1}. The present results supports the reports of Singh and Bajpai (1990) who observed that increasing phosphorus rate increased the number of filled pods plant^{-1} up to a certain limit and then decreased.

Level of phosphorus exerted significant effect on the number of unfilled pods plant^{-1} (Table 2). The number of unfilled pods plant^{-1} at harvest ranged from 6.42 to 7.81. The highest number (6.42) of unfilled pods plant^{-1} was produced by 0 kg P_2O_5 ha^{-1}. The lowest number (40.10) of unfilled pods plant^{-1} was produced with 120 kg P_2O_5 ha^{-1}. Islam *et al.* (2004) reported that increasing phosphorus reduced the number of unfilled pods plant^{-1}.

Among the treatment 80 kg P_2O_5 ha^{-1} produced maximum number (2.93) of seeds pod^{-1} and the minimum number (2.81) was obtained from 120 kg P_2O_5 ha^{-1}. Tomar *et al.* (2004) observed that the number of seeds pod^{-1} increased with the increase of phosphorus level.

The effect of level of phosphorus on seed yield was significant at 1% level of probability. The highest seed yield (1.95 t ha^{-1}) was produced when the crop was fertilized with 80 kg P_2O_5 ha^{-1}**.** The lowest seed yield (1.52 t ha^{-1}) was recorded in the treatment of 0 kg P_2O_5 ha^{-1} (Fig.2). Improvement of yield component such as number of filled pods and number of seeds per pod in this treatment ultimately resulted in the highest yield of seeds. Many researchers reported that application of phosphorus increased the yield of soybean.

Effect of interaction between variety and phosphorus: The interaction effect of variety and phosphorus had significant effect on yield of soybean. The highest of number of nodes plant^{-1} (13.66), number of filled pods (60.73), number of seeds pod^{-1} (3.00), seed yield (1.95 t ha^{-1}) and straw yield (4.09 t ha^{-1}) were found in treatment combination of BARI soybean 5 with 80 kg P_2O_5 ha^{-1}.

The lowest yield was found from treatment combination of BINA soybean 1 with 0 kg P_2O_5 ha^{-1}. Other treatment combination viz. BARI soybean 6 with 0 kg P_2O_5 ha^{-1}, BINA soybean 2 with 0 kg P_2O_5 ha^{-1}, BARI soybean 6 with 120 kg P_2O_5 ha^{-1}, BINA soybean 1 with 120 kg P_2O_5 ha^{-1}, BINA soybean 2 with 120 kg P_2O_5 ha^{-1} also gave lower yield of soybean.

Table 3. Interaction effect of variety and phosphorus on vegetative and yield contributing characters of soybean

	No. of filled pods plant^{-1}	No. of unfilled pods plant^{-1}	No. of seeds pod^{-1}	Plants m^{-2} (No.)	100- seed wt. (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
$P_0 \times V_1$	58.83ab	12.56a	2.73b	41.00	9.54ghi	1.62fgh	3.74
$P_0 \times V_2$	47.23ef	9.83b	2.93a	49.00	9.24j	1.53ghi	3.52
$P_0 \times V_3$	41.23g	6.83f	2.70b	56.00	9.70efgh	1.49 j	3.44
$P_0 \times V_4$	26.43hi	2.03g	3.00a	59.00	11.80c	1.52ghi	3.51
$P_1 \times V_1$	41.30g	8.90c	3.00a	45.00	9.85def	1.71de	3.77
$P_1 \times V_2$	50.03de	7.33ef	3.00a	49.00	9.38ij	1.61gh	3.54
$P_1 \times V_3$	53.60cd	9.46bc	2.73b	55.33	9.75efg	1.57ghi	3.45
$P_1 \times V_4$	30.03h	0.83h	3.00a	56.00	12.35b	1.61gh	3.54
$P_2 \times V_1$	60.73a	7.93de	3.00a	45.00	10.11d	1.95a	4.09
$P_2 \times V_2$	56.10abc	9.50bc	2.63b	43.00	9.70efgh	1.85b	3.89
$P_2 \times V_3$	54.56bcd	8.00de	2.96a	51.66	9.97de	1.81c	3.81
$P_2 \times V_4$	30.33h	2.10g	3.00a	57.00	12.86a	1.71de	3.60
$P_3 \times V_1$	46.73ef	6.60f	2.90a	44.00	9.58fghi	1.73d	3.81
P3× V_2	46.66ef	7.73e	2.70b	49.00	8.92k	1.65fg	3.63
$P_3 \times V_3$	43.03fg	8.66cd	2.66b	54.00	9.45hij	1.66f	3.67
$P_3 \times V_4$	24.00i	2.70g	3.00a	59.00	12.31b	1.64fgh	3.61
Level of sig.	**	**	**	ns	*	**	ns
CV(%)	6.11	6.96	1.79	9.11	1.57	5.39	11.47

In a column, figures with common letter(s) significantly or without letter do not differ In a column, figures with common letter(s) or without letter do not differ significantly, whereas figures with dissimilar letters, ** = Significant at 1% level of probability 5 P_0 = 0 kg P_2O_5 ha^{-1}, * = Significant at 5% level of probability, ns= Not significant, V_1= BARI soybean, V_2= BARI soybean, V_3= BINA soybean, V_4= BINA soybean, P_1= 40 kg P_2O_5 ha^{-1}, P_2= 80 kg P_2O_5 ha^{-1}, P_3= 120 kg P_2O_5 ha^{-1}

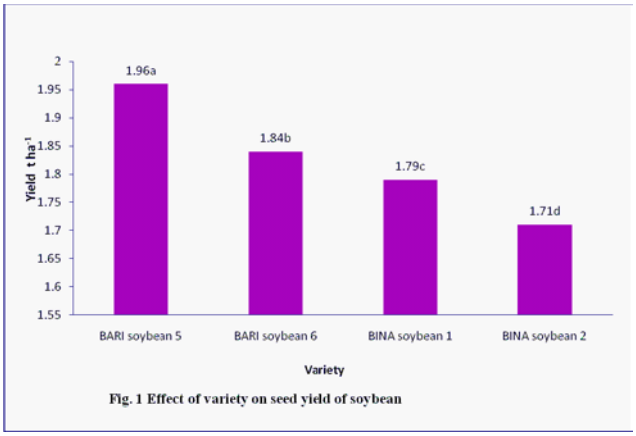

Fig. 1 Effect of variety on seed yield of soybean

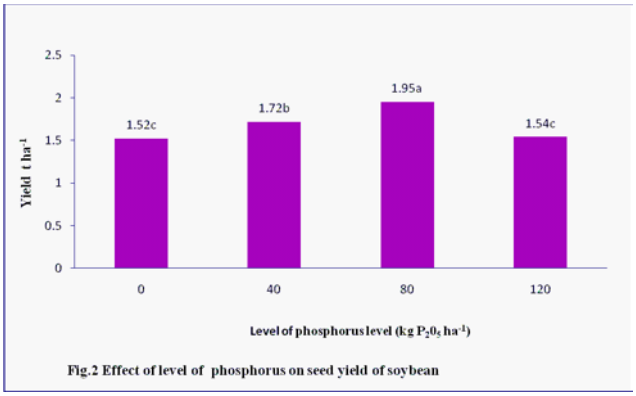

Fig.2 Effect of level of phosphorus on seed yield of soybean

The combined effect of variety and phosphorus did not show any significant effect on plants m^{-2} and stover yield. But it is found that phosphorus level (120 kg P_2O_5 ha^{-1}) combined with any variety gave low yield than previous one (80 kg P_2O_5 ha^{-1}). It means, phosphorus application above a certain limit (80 kg P_2O_5 ha^{-1}) produce a considerable yield reduction.

From the present study it is concluded that BARI soybean 5 with 80 kg P_2O_5 ha^{-1} may be used for getting better yield of soybean.

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