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EFFECT OF BIO-FERTILIZER ON GROWTH AND PRODUCTIVITY OF SOYBEAN VARIETIES

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ABSTRACT

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from December 2018 to March, 2019 to find out the effect of bio-fertilizer on growth and productivity of soybean varieties. Two factors were used in the experiment, *viz*. Factor A: varieties 4 (V_1 = Shohag (PB-1), V_2 = BARI Soybean-6, V_3 = Binasoybean-1, V_4 = Binasoybean-5) and Factor B: Biofertilizer level 3 (F_0 = No biofertilizer (control), F_1 = *Rizobium* (Soybean Ishwardi) and F_2 = *Rizobium* (Soybean Laxmipur)). The experiment was laid out in a Randomized Complete Block Design (RCBD) with two factors and three replications. Variety, biofertilizers and their interaction had significant effect on plant height, number of branch, number of leaf at different DAS, pods plant^{-1}, pod length, seeds pod^{-1}, 100 seeds weight, grain yield, straw yield, biological yield and harvest index (%).The highest plant height (18.19, 27.20, 44.45, 54.96 and 57.42 cm, respectively), number of branch plant^{-1}(2.29, 3.08, 3.58, 4.08 and 4.27, respectively) and number of leaves (16.98, 27.71, 37.92, 43.35 and 45.30 cm) were recorded in Binasoybean-5 with the application of Soybean Laxmipur ($V_4 \times F_2$) where the lowest plant height (11.54, 17.26, 28.21, 34.88 and 36.44 cm, respectively), number of branch plant^{-1} (1.60, 2.16, 2.51, 2.86 and 3.00, respectively) and number of leaves plant^{-1} **(**16.00, 24.03, 32.10, 37.41 and 39.09, respectively) were found in no biofertilizer (control) application with the variety Shohag (PB-1) ($V_1 \times F_0$) at 25, 35, 45, 55 DAS and at harvest. The highest days to 1st flowering (49.28 days), number of pods plant^{-1} (16.98), pod length (5.53 cm), number of seeds pod^{-1} (3.31) and weight of 100 seeds (14.05 g) was observed in the variety Binasoybean-5 with the application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest days to 1st flowering (34.57 days), number of pods plant^{-1} (16.00), pod length (3.88 cm), number of seeds pod^{-1} (2.33) and weight of 100 seeds (9.86 g) were observed in control with the variety Shohag (PB-1) ($V_1 \times F_0$). The

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highest stover yield (16.98), stover yield (4.55 t ha^{-1}), biological yield (6.55 t ha^{-1}) and harvest index (30.49 %) was observed in variety Binasoybean-5 with the application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest stover yield (16.00), stover yield (3.96 t ha^{-1}), biological yield (5.53 t ha^{-1}) and harvest index (25.34 %) was observed in control with the variety Shohag (PB-1) ($V_1 \times F_0$). It has been appeared that Binasoybean-5 with the application of Soybean Laxmipur ($V_4 \times F_2$) produces greater yield over treatments still requires further verification under different soybean.

Keywords: Bio-Fertilizer, *Glycine max*, Growth, Soybean, Varieties, Yield.

1. INTRODUCTION

Soybean (*Glycine max*) is one of the world's most important legumes in terms of production and trade and has been a dominant oilseed since the 1960s (Smith and Huyser, 1987). Soybean is becoming a major source of vegetable protein (40%), oil (20%), Carbohydrates (21%) and Iron (11.5%) and it fixes 60- 100 kg/ha about atmospheric nitrogen in soil (Purohit and Kumar, 1998).In soybean nodulation can be induced by different rhizobia distributed in six species belonging to three different genera. Most of these bacterial species belongs to the Rhizobiacae family in the alpha-proteobacteria, which are either *Rhizobium*, *Mesorhizobium*, *Ensifer*, or *Bradyrhizobium* genera (Weir, 2011). Recently several workers have attempted to study the role of rhizobial inoculation on improvement in growth and yield of soybean (Appuna *et al*. 2008; Dhami and Prasad, 2009). Soybean being one of the legumes has been shown to meet up to 80 % of its nitrogen (N) budget through Biological Nitrogen Fixation (BNF) (Hungria *et al*. 2006). Biological nitrogen fixation is the process whereby atmospheric nitrogen (N_2) is reduced to ammonia in the presence of the enzyme nitrogenase. Nitrogenase is a biological catalyst found naturally in certain prokaryotes such as rhizobia. Biological nitrogen fixation is due to the association of plants, with both free-living (for example. *Azoarcus, Azospirillum*, and *Azotobacter*) and symbiosis (for example. *Rhizobia* and *Frankia*) with higher plants (Herridge *et al*. 2008). Soybean production in Bangladesh has remained low, partly due to soil nutrient depletion and degradation which have been considered serious threats to agricultural productivity. Intensification of land use especially by small-scale farmers with minimal nutrient inputs has led to declining crops yields and increased nutrients removal. Despite this, responses of soybean to inoculation with *Bradyrhizobium* spp have been studied and documented and found to increase soybean yields (Njira *et al*. 2013; Thuita *et al*. 2012). A well-established fact is that when legumes are grown in low and high available nitrogen, the nitrogen fixation rate is reduced (Solomon *et al*. 2012). In soils with low nitrogen, a moderate amount of 'starter nitrogen' would be required by the legume plants for nodule development, root and shoot growth before the onset of BNF (Herridge *et al*. 1984) which currently is not known in soybean production areas in Bangladesh. Capability of fixing N is recognized as a process of great

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agronomic importance and a variety of leguminous crop plants and non-leguminous plants can obtain their nitrogen from the air by symbiotic association with various bacteria present in soil at adequate densities. The objectives of the study to evaluate the effect variety and bio-fertilizer on growth, yield attributes and yield of soybean.

2. MATERIALS AND METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from December 2018 to March, 2019 to find out the effect of bio-fertilizer on growth and productivity of soybean varieties. Two factors were used in the experiment, *viz*. Factor A: varieties 4 (V_1 = Shohag (PB-1), V_2 = BARI Soybean-6, V_3 = Binasoybean-1, V_4 = Binasoybean-5) and Factor B: Biofertilizer level 3 (F_0 = No biofertilizer (control), F_1 = *Rizobium* (Soybean Ishwardi) and F_2 = *Rizobium* (Soybean Laxmipur)). The experiment was laid out in a Randomized Complete Block Design (RCBD) with two factors and three replications. There were 12 treatment combinations and 3 replications with a total 36 unit plots. The unit plot size was 2.25 m^2 (2.5 m x 0.9 m). There was a gap of 0.9 m between the blocks and that between each plot was 0.6m.

Seeds were sown at the rate of 40 kg ha^{-1} in the distain maintain furrow on 6th December, 2018 and the furrows were covered with the soils soon after seeding. The fertilizers were applied as basal dose @ P, K as 20, 17.60 kg ha^{-1} and compost 30ton ha^{-1} at final land preparation respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil. Biofertilizers applied dose 30 g for kg^{-1} seeds. Biofertilizers were mixed with the seed before sowing. Variety, biofertilizers and their interaction had significant effect on plant height, number of branch, number of leaf at different DAS (at 25, 35, 45, 55 DAS and harvest), pods $plant^{-1}$, pod length, seeds pod^{-1}, 100 seeds weight, grain yield, straw yield, biological yield and harvest index (%). The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT- C and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Vegetative characters

Plant height (cm)

At 25, 35, 45, 55 DAS and at harvest, significantly the tallest plant (16.92, 25.29, 41.34, 51.11 and 53.40 cm, respectively) was recorded from variety V_4 (Binasoybean-5) (Figure 1). In case of biofertilizer treatments, the highest plant height (16.37, 24.48, 40.01, 49.46 and 51.68 respectively) was recorded in F_2 (Soybean Laxmipur) (Figure 2). Interaction effect exerted

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significant and best result was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) (Table 1). This is probably due to sufficient supply of required nutrients to the plant, which finally caused the photosynthesis and soybean growth to be improved. These results are in agreement with the results of Darzi *et al.* (2007) that they performed their study on the fennel plant. Dileep Kumar *et al.* (2001) also reported that combined inoculation of pea seeds with rhizobial and phosphate solubilizing bacteria increased plant height.

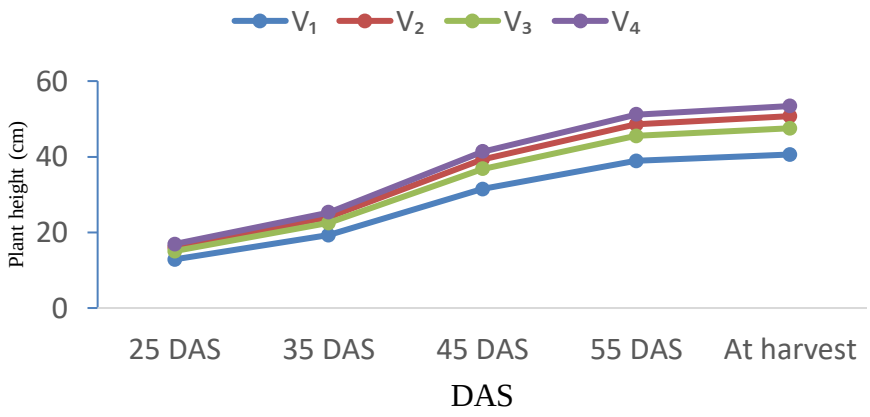

Figure 1: Effect of variety on plant height of soybean at different days after sowing (LSD $_{(0.05)}$ = 0.758, 1.135, 1.854, 2.001 and 2.315 at 25, 35, 45, 55 DAS and a harvest, respectively)

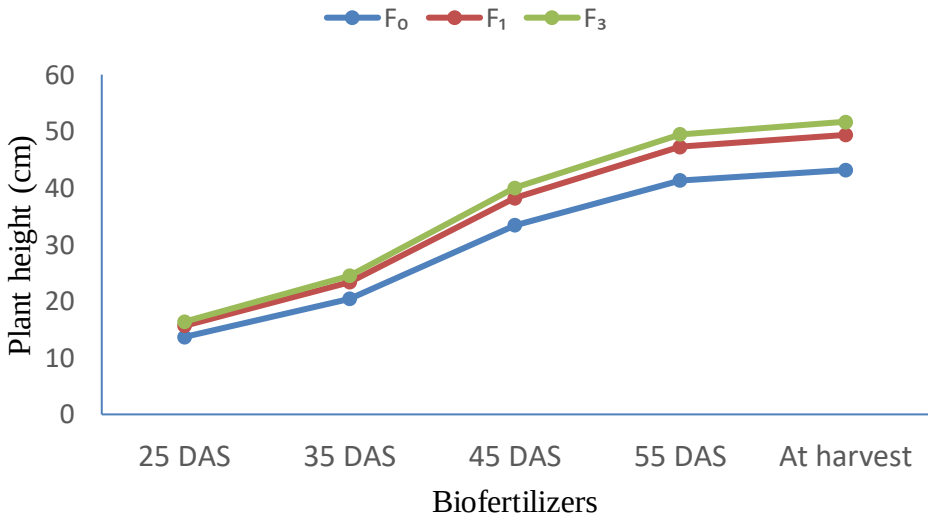

Figure 2: Effect of biofertilizer variety on plant height of soybean at different days after sowing (LSD $_{(0.05)}$ 0.631, 0.944, 1.543, 1.665 and 1.991 at 25, 35, 45, 55 DAS and at harvest, respectively)

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Table 1: Interaction effect variety and bio-fertilizer on plant height of soybean at different days

Interaction effect	Plant height (cm)				
	25 DAS	35 DAS	45 DAS	55 DAS	At harvest
$V_1 \times F_0$	11.54f	17.26f	28.21f	34.88i	36.44g
$V_1 \times F_1$	13.20e	19.74e	32.26e	39.89h	41.68f
$V_1 \times F_2$	13.82e	20.67e	33.79e	41.77gh	43.64f
$V_2 \times F_0$	14.43de	21.57de	35.26de	43.59fg	45.55ef
$V_2 \times F_1$	16.50bc	24.67bc	40.33bc	49.86b-d	52.10bc
$V_2 \times F_2$	17.28ab	25.83ab	42.23ab	52.21a-c	54.55ab
$V_3 \times F_0$	13.52e	20.21e	33.03e	40.84gh	42.67f
$V_3 \times F_1$	15.46cd	23.12cd	37.78cd	46.71d-f	48.81c-e
$V_3 \times F_2$	16.19bc	24.20bc	39.56bc	48.91c-e	51.11b-d
$V_4 \times F_0$	15.19cd	22.71cd	37.12cd	45.89ef	4de7.95
$V_4 \times F_1$	17.37ab	25.97ab	42.45ab	52.48ab	54.ab84
$V_4 \times F_2$	18.19a	27.20a	44.45a	54.96a	57.42a
LSD (0.05)	1.314	1.965	3.211	3.466	4.144
CV (%)	6.43	5.43	5.62	8.49	6.45

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

(V_1 = Shohag (PB-1), V_2 = BARI soyabean-6, V_3 = Binasoybean-1, V4= Binasoybean-5 and F_0 = control, F_1 = Soybean Ishwardi, F_2 = Soybean Laxmipur)

Number of branch plant^{-1}

Effect of variety, biofertilizer and their interaction on number of branch plant^{-1} showed statistically significant variation due to different varieties at 25, 35, 45, 55 DAS and at harvest. The highest number of branch plant^{-1} (2.29, 3.08, 3.58, 4.08 and 4.27 at 25, 35, 45, 55 DAS and at harvest, respectively) was observed in variety Binasoybean-5 with application of (Soybean Laxmipur) ($V_4 \times F_2$) and the lowest was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 2). Sundara *et al.* (2002) during their research in sugarcane plant reported that

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application of phosphate solubilizing bacteria (*Bacillus megaterium*) increased the number of stems per plant.

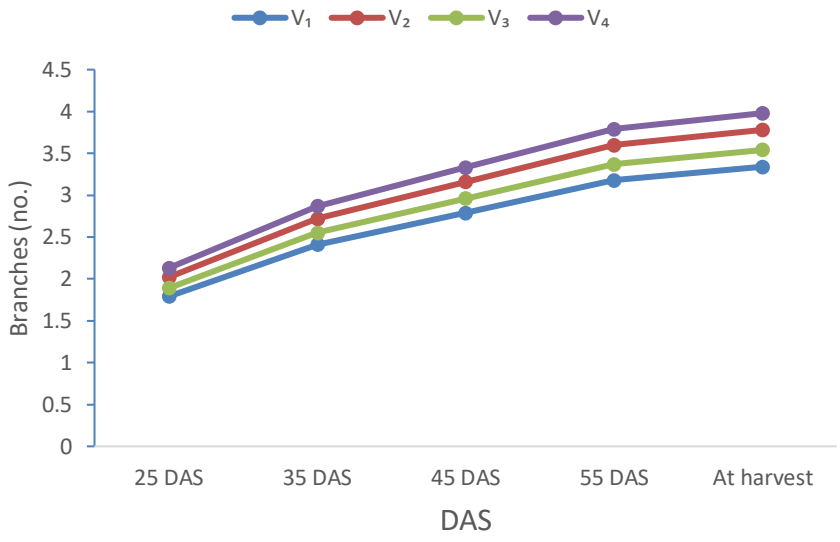

Figure 3: Effect of variety on number of branch plant^{-1} of soybean at different days after sowing (LSD $_{(0.05)}$ 0.069, 0.087, 0.061, 0.053 and 0.061 at 25, 35, 45, 55 DAS and at harvest, respectively)

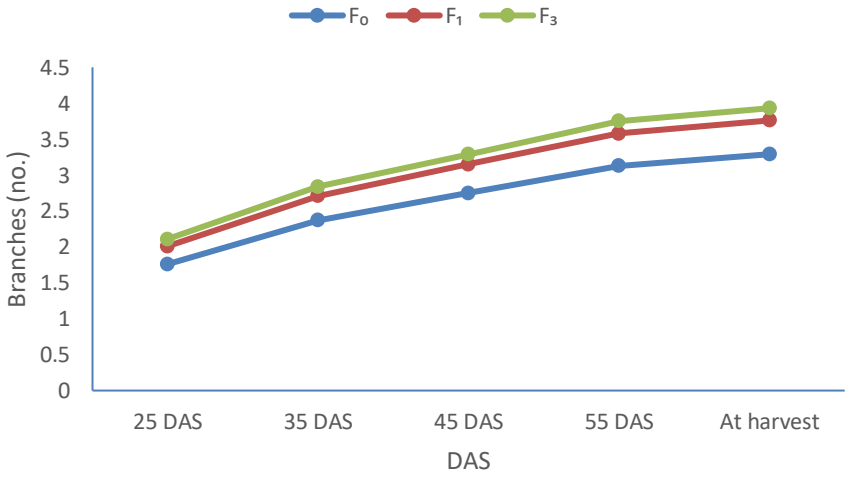

Figure 4: Effect of biofertilizer on number of branch plant^{-1} of soybean at different days after sowing (LSD $_{(0.05)}$ 0.0572, 0.073, 0.051, 0.044 and 0.051 at 25, 35, 45, 55 DAS and at harvest, respectively)

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Table 2: Interaction effect variety and biofertilizer on number of branch plant^{-1} of soybean at different days

Interaction effect	Branch plant^{-1} (no.)				
	25 DAS	35 DAS	45 DAS	55 DAS	At harvest
$V_1 \times F_0$	1.60h	2.16g	2.51g	2.86g	3.00h
$V_1 \times F_1$	1.83ef	2.47ef	2.87e	3.27e	3.43ef
$V_1 \times F_2$	1.92d-f	2.59ef	3.00d	3.42d	3.59d-f
$V_2 \times F_0$	1.81fg	2.44f	2.84e	3.23e	3.39fg
$V_2 \times F_1$	2.08bc	2.79bc	3.25c	3.70c	3.88bc
$V_2 \times F_2$	2.17ab	2.93ab	3.40b	3.87b	4.06ab
$V_3 \times F_0$	1.70gh	2.29g	2.66f	3.03f	3.18gh
$V_3 \times F_1$	1.94de	2.62de	3.04d	3.46d	3.63de
$V_3 \times F_2$	2.04cd	2.74cd	3.18c	3.63c	3.81cd
$V_4 \times F_0$	1.91ef	2.57ef	2.99d	3.40d	3.57ef
$V_4 \times F_1$	2.18ab	2.94ab	3.42b	3.89b	4.08ab
$V_4 \times F_2$	2.29a	3.08a	3.58a	4.08a	4.27a
LSD (0.05)	0.119	0.151	0.107	0.092	0.201
CV (%)	5.43	5.19	4.65	5.63	5.30

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Number of leaves plant^{-1}

Effect of variety, biofertilizer and their interaction on number of leaves plant^{-1} showed statistically significant variation. At 25, 35, 45, 55 and at harvest, the highest number of leaves plant^{-1} (4.81, 7.85, 13.30, 20.90 and 19.65, respectively) was recorded from variety V_4 (Binasoybean-5), whereas the lowest was found from the variety V_1 (Shohag (PB-1) (Fig.5). In case of biofetilizer, at 25, 35, 45, 55 DAS and at harvest, the highest number of leaves plant^{-1} (4.76, 7.77, 13.15, 20.67 and 19.45, respectively) was recorded in F_2 (Soybean Laxmipur) where the lowest in F_0 (control) (Fig.6). The highest number of leaves plant^{-1} (5.17, 8.44, 14.30, 22.47

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and 21.13 at 25, 35, 45, 55 DAS and at harvest, respectively) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) (Table 3).

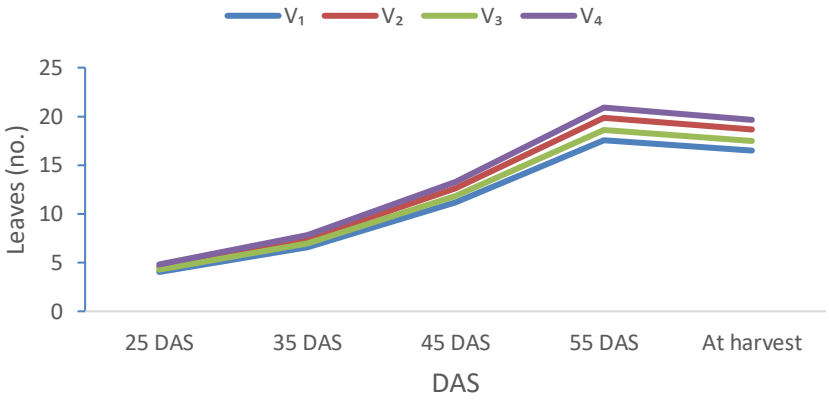

Figure 5: Effect of variety on number of leaves plant^{-1} of soybean at different days after sowing (LSD $_{(0.05)}$ 0.069, 0.111, 0.019, 0.092 and 0.765 at 25, 35, 45, 55 DAS and at harvest, respectively)

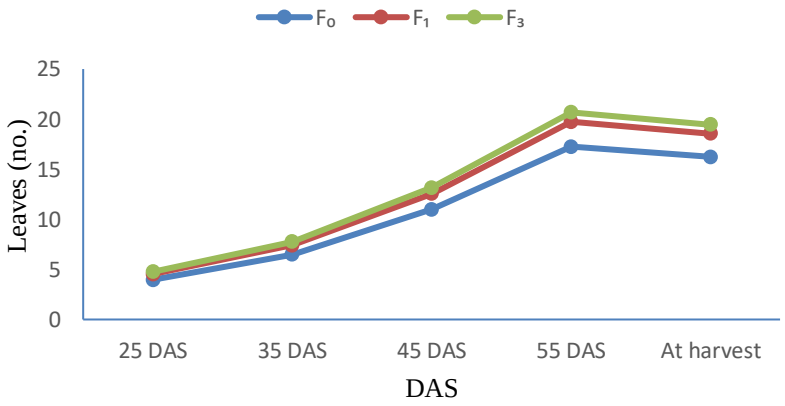

Figure 6: Effect of biofertilizer on number of leaves plant^{-1} of soybean at different days after sowing (LSD $_{(0.05)}$ 0.057, 0.092, 0.158, 0.159 and 0.244 at 25, 35, 45, 55 DAS and at harvest, respectively)

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Table 3: Interaction effect variety and biofertilizer on number of leaves plant^{-1} of s soybean at different days

Interaction effect	Leaves plant^{-1} (no.)				
	25 DAS	35 DAS	45 DAS	55 DAS	At harvest
$V_1 \times F_0$	3.63g	5.92g	10.03g	15.76j	14.82h
$V_1 \times F_1$	4.15e	6.77ef	11.47e	18.03g	16.96ef
$V_1 \times F_2$	4.35d	7.09ef	12.01d	18.87f	17.75d-f
$V_2 \times F_0$	4.10e	6.69f	11.34e	17.83h	16.77fg
$V_2 \times F_1$	4.69c	7.66bc	12.97c	20.39c	19.17bc
$V_2 \times F_2$	4.91b	8.02ab	13.58b	21.35b	20.08ab
$V_3 \times F_0$	3.84f	6.27g	10.63f	16.70i	15.70gh
$V_3 \times F_1$	4.39d	7.18de	12.15d	19.10e	17.96de
$V_3 \times F_2$	4.60c	7.51cd	12.73c	20.00d	18.81cd
$V_4 \times F_0$	4.32d	7.05ef	11.94d	18.76f	17.65ef
$V_4 \times F_1$	4.94b	8.06ab	13.65b	21.46b	20.19ab
$V_4 \times F_2$	5.17a	8.44a	14.30a	22.47a	21.13a
LSD (0.05)	0.119	0.304	0.331	0.160	1.101
CV (%)	6.72	5.64	3.45	6.34	4.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

3.2 Yield contributing characters

Days to 1st flowering

The highest days to 1st flowering (45.83 was recorded in variety V_4 (Binasoybean-5) and the lowest (38.50) was achieved from variety V_1 (Shohag (PB-1). The highest days to 1st flowering (45.34 days) was recorded in F_2 (Soybean Laxmipur) where the lowest (37.86 days) was measured in F_0 (control). The highest days to 1st flowering (49.28 days) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest (34.57 days) was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 4).

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Number of pods plant^{-1}

The highest number of pods plant^{-1} (39.49) was observed from V_4 (Binasoybean-5) while the lowest number of pods plant^{-1} (29.57) from variety V_1 (Shohag) (Fig. 4.9). The highest number of pods plant^{-1} (38.16) was recorded in F_2 (Soybean Laxmipur) where the lowest number of pods plant^{-1} (31.55) was measured in F_0 (control)). The highest number of pods plant^{-1} (16.98) was observed in variety Binasoybean-5 with application of (Soybean Laxmipur) ($V_4 \times F_2$) and the lowest (16.00) was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 4). Mahfouz and Sharaf (2007) reported that phosphorous solvent bacteria have the ability to produce organic acids that would increase solubility of phosphorus available for plants. Continuous and stable supply of mineral elements especially P to the plants, can increase growth and flowering rate. Phosphorus along with nitrogen, improves reproductive growth and fruit produce in the plant.

Pod length (cm)

The highest pod length (5.14 cm) was observed from V_4 (Binasoybean-5) while the lowest (4.32 cm) from variety V_1 (Shohag (PB-1) (Fig. 4.11). The highest pod length (5.09 cm) was recorded in F_2 (Soybean Laxmipur) where the lowest (4.25 cm) was measured in F_0 (control)) (Fig. 4.12). The highest pod length (5.53 cm) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest (3.88 cm) was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 4).

Number of seeds pod^{-1}

The highest number of seeds pod^{-1} (3.08) was recorded in variety V_4 (Binasoybean-5) and the lowest number of seeds pod^{-1} (2.59) was achieved from variety V_1 (Shohag (PB-1). The highest number of seeds pod^{-1} (3.05) was recorded in F_2 (Soybean Laxmipur) where the lowest (2.54) was measured in F_0 (control) (Fig. 4.14). The highest number of seeds pod^{-1} (3.31) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest (2.33) was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 4). Nabila *et al.* (2007) observed that application of *Azospirillum* on wheat had significant effect on number of grain per spikelet.

Weight of 100 seeds (g)

The highest weight of 100 seeds (13.07 g) was recorded in variety V_4 (Binasoybean-5) and the lowest (10.98 g) was achieved from variety V_1 (Shohag (PB-1). The highest weight of 100 seeds (12.93 g) was recorded in F_2 (Soybean Laxmipur) where the lowest (10.79 g) was measured in F_0(control) (Fig. 4.16). The highest weight of 100 seeds (14.05 g) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest (9.86 g) was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$) (Table 4.4). Zhang (2002) reported that

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inoculation with *B. japonicum* bacteria increased 100 seed weight of two soybean cultivars. Asadi Rahmani *et al.* (2000) also observed that in the grain filling stage of soybean due to higher levels of photosynthesis in treatments inoculated with *B. japonicum* bacteria, more phosphate is transported to the grain and this factor could increase the size and weight of seed requirement, may lead to reduction of nitrogen fixation by *B. japonicum* and finally plant dry weight compared to chemical fertilizer. Kandil *et al.* (2004) reported that the use of biological fertilizers in sugar beet, significantly increased plant dry weight. Raeipour and Aliasgharzadeh, (2004) also stated that *Bradyrhizobium* bacteria has positive effect on shoot dry weight, and interaction of phosphate solubilizing bacteria and *B. japonicum* was significant on shoot dry weight. Hernandez *et al.* (1995) reported that effect of *Pseudomonas fluorescens* bacteria was positive on the increasing weight of plant maize.

Table 4: Interaction effect variety and biofertilizer on yield attributes of soybean

Interaction effect	Days to 1st flowering	Pods plant^{-1} (no.)	Pod length (cm)	Seeds pod^{-1} (no.)	Weight of 100 seeds (g)
Effect of variety					
V_1	38.50d	29.57d	4.32d	2.59d	10.98d
V_2	43.54b	37.42c	4.88b	2.92b	12.41a
V_3	40.79c	34.94b	4.58c	2.74c	11.63b
V_4	45.83a	39.49a	5.14a	3.08a	13.07c
LSD $_{(0.05)}$	1.065	1.214	0.188	0.031	0.413
CV (%)	3.65	7.49	4.56	8.41	5.09
Effect of biofertilizer					
F_0	37.86c	31.55c	4.25c	2.54c	10.79c
F_1	43.30b	36.36b	4.86a	2.91b	12.34b
F_2	45.34a	38.16a	5.09a	3.05a	12.93a
LSD $_{(0.05)}$	1.023	1.032	0.165	0.026	0.335
CV (%)	3.65	7.49	4.56	8.41	5.09
Interaction effect					
$V_1 \times F_0$	34.57 h	26.36 f	3.88 g	2.33 h	9.86 g
$V_1 \times F_1$	39.53 fg	30.41 de	4.43 e	2.66 f	11.27 ef
$V_1 \times F_2$	41.39 ef	31.94 cd	4.64 de	2.78 e	11.80 ef
$V_2 \times F_0$	39.09 g	33.41 de	4.39 ef	2.63 f	11.15 f
$V_2 \times F_1$	44.71 c	38.48 bc	5.01 bc	3.00 c	12.75 bc

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$V_2 \times F_2$	46.82 b	40.38 ab	5.25 ab	3.14 b	13.35 b
$V_3 \times F_0$	36.62 h	31.18 ef	4.11 fg	2.46 g	10.44 g
$V_3 \times F_1$	41.88 de	35.93 cd	4.70 c-e	2.81 e	11.94 de
$V_3 \times F_2$	43.86 cd	37.71 bc	4.92 cd	2.95 d	12.51 cd
$V_4 \times F_0$	41.15 e-g	35.27 cd	4.61 de	2.76 e	11.73 ef
$V_4 \times F_1$	47.06 b	40.60 ab	5.28 ab	3.16 b	13.41 ab
$V_4 \times F_2$	49.28 a	42.60 a	5.53 a	3.31 a	14.05 a
LSD (0.05)	2.102	2.431	0.326	0.053	0.698
CV (%)	3.65	7.49	4.56	8.41	5.09

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

3.3 Yield contributing characters

The highest seed, Stover, biological yield and harvest index (1.86, 4.52, 6.30 t ha^{-1} and 29.44%) was observed from V_4 (Binasoybean-5) while the lowest from variety V_1 (Shohag(PB-1) (Fig. 4.17). The highest seed, Stover, biological yield and harvest index (1.84, 4.42, 6.26 t ha^{-1} and 29.33 %) was recorded in F_2 (Soybean Laxmipur) where the lowest was measured in F_0 (control)) (Fig. 4.18).The highest seed, Stover, biological yield and harvest index (2.00, 6.55 t ha^{-1} and 30.49 %) was observed in variety Binasoybean-5 with application of Soybean Laxmipur ($V_4 \times F_2$) and the lowest was observed in control with variety Shohag (PB-1) ($V_1 \times F_0$). Bacteria used in these treatments (b3 and b4), maybe increase seed yield by providing macro and micro nutrients for plant growth, production of stimulate material, development of root system and anti-pathogenic effects (Jat and Ahlawat, 2006).It is reported that soybean inoculated by *Bradyrhizobium* bacteria and phosphate solubilizing bacteria increased the seed yield (Singh, 2005; Jat and Ahlawat, 2006). Phosphate solubilizing bacteria led to increased absorption of other elements by increasing the ability to access phosphorus and thereby can increase crop yield (Mahfouz and Sharaf, 2007). Priority of fertilizer level of b4 than fertilizer level of b2 was probably because phosphate-solubilizing bacteria had positive effect on activities of nitrogen stabilizer bacteria due to provision of phosphorus and other nutrients. In fertilizer level of b5, consumption of nitrogen fertilizer (up to 50% of plant requirement) may have led to reduction of nitrogen fixation by *B. japonicum* and thus, seed yield was reduced. Shirastava *et al.* (2001) and Narne*et al.* (2002) stated that in soybean, harvest index has highly correlated with grain yield.

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Table 5: Interaction effect variety and biofertilizer on yield of soybean

Interaction effect	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Effect of variety				
V_1	1.56d	4.11d	5.73d	27.22d
V_2	1.76b	4.39b	6.13b	28.76b
V_3	1.65c	4.26c	5.94c	27.82c
V_4	1.86a	4.52a	6.30a	29.44a
LSD $_{(0.05)}$	0.065	0.041	0.106	0.042
CV (%)	5.46	6.47	7.22	6.33
Effect of biofertilizer				
F_0	1.53c	4.24c	5.82c	26.36c
F_1	1.75b	4.30b	5.99b	29.24b
F_2	1.84a	4.42a	6.26a	29.33a
LSD $_{(0.05)}$	0.061	0.025	0.095	0.053
CV (%)	5.46	6.47	7.22	6.33
Interaction effect				
$V_1 \times F_0$	1.40 g	3.96 g	5.53 g	25.34 g
$V_1 \times F_1$	1.60 e	4.10 f	5.70 f	28.11 e
$V_1 \times F_2$	1.68 d	4.27 de	5.95 e	28.19 de
$V_2 \times F_0$	1.58 e	4.43 bc	5.92 e	26.78 f
$V_2 \times F_1$	1.81 c	4.29 de	6.10 d	29.71 c
$V_2 \times F_2$	1.90 b	4.47 bc	6.37 b	29.80 bc
$V_3 \times F_0$	1.48 f	4.17 ef	5.73 f	25.90 g
$V_3 \times F_1$	1.70 d	4.21 ef	5.91 e	28.74 de
$V_3 \times F_2$	1.78 c	4.39 cd	6.17 d	28.82 d
$V_4 \times F_0$	1.67 d	4.63 a	6.09 d	27.41 f
$V_4 \times F_1$	1.91 b	4.37 cd	6.27 c	30.41 ab
$V_4 \times F_2$	2.00 a	4.55 ab	6.55 a	30.49 a
LSD $_{(0.05)}$	0.053	0.131	0.092	0.696

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CV (%)	5.46	6.47	7.22	6.33

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

4. CONCLUSION

From the above findings, it may be concluded that among the varieties Binasoybean-5 and among the biofertilizers Soybean Laxmipur performed the best results and should be recommended for cultivation.

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