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GROWTH, FLOWER DROPPING, POD SET AND YIELD RESPONSE OF SOYBEAN VARIETIES AS AFFECTED BY SUPLEMENTAL FERTILIZER SPRAY AT FLOWERING

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Abstract

A field experiment was conducted during the period from January to May 2014 to study the response of growth, flower dropping, pod setting and yield of two soybean varieties to foliar fertilization of urea at early stage of flowering. Soybean varieties, BARI Soybean-5 and BARI Soybean-6, were feeded with four supplemental foliar spray treatments of fertilizer, viz. M_1: Control i.e., no additional nutrient spray; M_2: 20% of recommended urea spray at flowering; M_3: 20% dose of the recommended MoP; and M_4: 20% dose of the recommended DAP at early flowering stage. The experiment was laid out in a split-plot design with three replications. There was no significant effect of variety, fertilization spray or their interaction observed on growth parameters. However, flower and pod dropping was affected with higher flower dropping (55.2%) in BARI Soybean-5 and maximum pod dropping (16.44%) with DAP spray treatment. Higher yield attributes' values such as seeds pod^{-1} (2.42), seed yield (1.18 t ha^{-1}), stover yield (1.02 t ha^{-1}), and biological yield (2.21 t ha^{-1}) were obtained with foliar DAP spray treatment. The interaction of BARI Soybean-5 and foliar DAP spray showed the highest seed yield (1.48 t ha^{-1}), stover yield (1.26 t ha^{-1}) and biological yield (2.75 t ha^{-1}).

Introduction

Soybean is the most important oil seed crop in the world, which belongs to Fabaceae family. The crop not only provides oil, it also supplies vegetable protein to millions of people. The multipurpose use of soybean is gradually increasing day by day in Bangladesh thus the cultivated area of soybean also increasing. The area harvested for soybean in Bangladesh was above 62000 ha and the production was 96921 ton with average yield of 1.5 t ha^{-1}. However, the world average yield of soybean was about 2.9 t ha^{-1} (FAOSTAT, 2018). The reason for low yield rate of soybean is mainly due to use of low yielding varieties and insufficient agronomic management (Khanam *et al.*, 2016). Experimental evidences reveal that soybean is highly responsive to different fertilizers and its yield can be increased remarkably through the judicious fertilization (BARI, 1988; Mohamed, 1984; Kazi *et al.*, 2002).

Soybean yield depends on number of pods produced per unit area and seed weight. The number of pods depend on the number of floral buds which attain maturity. Although the crop produces abundant flowers, but a large proportion of them drop away during development (Kokubun, 2011). According to Shibles *et al*. (1975), the flower and pod dropping rate were estimated to reach 80%. Reduction of flower and pod dropping rate is an important factor in increasing yield of soybean. Generally, essential plant nutrients are applied as a basal dose during land preparation to attain maximum yield of a crop. Although soil application is the most effective method, but under some circumstances foliar fertilization is more effective and economic (Fageria *et al*., 2009).

Foliar spraying is helpful when crop roots are unable to provide enough nutrients and much more economic since foliar application rate is less compared to soil application. Many researchers reported that supplemental nutrients applied at different reproductive stages of crop through foliar application increases the yield of soybean. Specially, at early flowering or pod initiation stage, soybean requires more nutrients for the development of pod and seed along with optimum soil moisture (Dandge *et al*., 2018). It is suggested that nitrogen (N) is the determinant of seed production for crops with high seed N content (Kinugasa *et al*., 2012). Rigorous researches are still necessary to identify and specify the right nutrients for highest potential yield of soybean.

The experiment was undertaken to investigate the influence of foliar nutrient spray on flower and pod droppings of soybean, and to study the growth and yield response of two soybean varieties towards urea, MoP and DAP spray at early flowering stage.

Materials and Methods

The experiment was carried out at research field of Agronomy department, Sher-e-Bangla Agricultural University, Dhaka during the period of Jan-May, 2014. The soil of the experimental site is belonged to the Modhupur tract (AEZ No. 28). The topography of the experimental site was adequately uniform, leveled and soil was deep red brown terrace soil with pH 5.6. The full amount of recommended dose @ 60, 175, 120, 115 and 10 kg ha^{-1} of Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum and boric acid respectively (FRG, 2012) were applied during final land preparation.

Two soybean varieties, BARI Soybean-5 and BARI Soybean-6 were used for this experiment. The experiment consisted two factors and it was laid out in a split-plot design with three replications. Total number of plots was 24 and the size of each unit plot was 3m × 3m. Two soybean varieties were assigned in the main plot, V_1: BARI Soybean-5 and V_2: BARI Soybean-6 and the sub-plots had four supplemental spray treatments, M_1: Control (no additional nutrient spray); M_2: 20% of recommended Urea spray at flowering; M_3: 20% of recommended MoP spray at flowering and M_4: 20% of recommended DAP spray at flowering. The supplemental spray was done at flowering stage (60 days after sowing). Different intercultural operations such as thinning, irrigation, weeding and plant protection measures were done as and when needed. Five plants from each plot were randomly selected and different growth parameters (plant height, leaflet number, branches $plant^{-1}$ and dry matter $plant^{-1}$) were recorded at 75 DAS and 100 DAS. Another five plants were randomly selected for documenting flower and pod dropping rate by using a clean paper. The harvesting was done when 90% of the pods become brown in color and the plants were harvested from 5.4 m^2 central area of each plot. Yield attributes such as no. of pods $plant^{-1}$, no. of seeds pod^{-1}, grain yield, stover yield and harvest index were recorded at the time of harvesting. The collected data were statistically analyzed by using Statistix 10 statistical program and the significant differences were compared by the least significant difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Growth parameters

The growth parameters of two soybean varieties didn't show any significant variation in regards of effect of variety, fertilization, and interaction of variety x fertilizers at 75 DAS and 100 DAS (Table 1). While in terms of variety, BARI Soybean-5 performed comparatively better for plant height (57.57 cm and 58.67 cm) and branch number $plant^{-1}$ (4.03 and 3.62), highest dry weight $plant^{-1}$ (7.59 g and 15.17 g) was recorded in BARI Soybean-6 at 75 DAS and 100 DAS, respectively. Among the fertilizer treatments, DAP fertilization (M_4) showed highest plant height (55.69 cm and 58.42 cm) at 75 DAS and 100 DAS, highest branch number $plant^{-1}$ (3.83) and dry weight $plant^{-1}$ (16.92) at 100 DAS. In

terms of the interaction effect of variety and fertilization, V_1M_4 (BARI Soybean-5 and DAP) presented highest plant height and branch number plant^{-1} at 75 DAS and 100 DAS, and V_2M_4 (BARI Soybean-6 + DAP) produced highest dry matter plant^{-1} at 100 DAS. It seems that the combination of nitrogen and phosphorous fertilizer showed better result in soybean plants growth traits. A similar foliar spray was performed by Kaur and Singh (2019) at pod initiation stage with the treatments of water, urea, Mop, DAP, NPK 19:19:19, molybdenum and zinc spray, and similarly, the treatments didn't significantly influence the growth attributes of soybean.

Table 1. Effect of foliar urea, MoP and DAP spray on different growth parameters of soybean at 75 DAS and 100 DAS

Treatments	Plant height (cm)		Leaflet numbers plant^{-1}		Branch number plant^{-1}		Dry weight plant^{-1} (g)	
	75 DAS	100 DAS	75 DAS	100 DAS	75 DAS	100 DAS	75 DAS	100 DAS
Variety								
V_1	57.57	58.67	70.36	24.57	4.03	3.62	6.61	11.71
V_2	50.11	52.23	64.40	25.50	3.62	3.42	7.59	15.17
Foliar spray								
M_1	54.68	56.23	71.50	27.60	3.90	3.33	6.62	12.40
M_2	53.00	54.68	69.87	23.60	4.03	3.50	7.09	11.51
M_3	51.97	52.47	62.50	23.13	3.53	3.40	7.82	12.92
M_4	55.69	58.42	65.64	25.80	3.83	3.83	6.87	16.92
SE	4.70	4.38	11.46	3.61	0.66	0.54	1.32	3.21
Variety x Foliar spray								
V_1M_1	59.09	60.80	74.40	29.80	3.93	3.20	6.09	11.46
V_1M_2	56.47	58.47	73.33	22.27	4.27	3.80	5.68	9.64
V_1M_3	54.58	54.40	63.80	19.93	3.60	3.27	8.51	8.94
V_1M_4	60.14	61.00	69.89	26.27	4.33	4.20	6.16	16.79
V_2M_1	50.28	51.67	68.60	25.40	3.87	3.47	7.15	13.35
V_2M_2	49.54	50.90	66.40	24.93	3.80	3.20	8.51	13.38
V_2M_3	49.37	50.53	61.20	26.33	3.47	3.53	7.12	16.89
V_2M_4	51.25	55.83	61.40	25.33	3.33	3.47	7.58	17.05
SE	6.65	5.66	16.20	4.47	0.99	0.75	1.71	5.34
CV (%)	15.12	13.67	29.45	25.00	30.04	26.79	32.25	41.41

V_1 = BARI Soybean-5, V_2 = BARI Soybean-6, M_1 = No Supplemental spray, M_2 = Supplemental spray of Urea, M_3 = Supplemental spray of MoP, M_4 = Supplemental spray of DAP

Flower and pod dropping

In case of flower and pod dropping attributes, flower dropping and pod dropping displayed significant variation for two varieties and fertilizer treatments respectively. There was no statistically significant variation found among soybean variety and fertilization interaction (Table 2).

The maximum flower dropping (%), pod dropping (%), and total pod dropping (%) was recorded under BARI Soybean-5 (55.2, 15.36, and 70.56 respectively). Although, highest flower dropping % (55.30) was found under urea treatment (M_2), maximum pod dropping % and subsequently total dropping % (16.44, and 68.99, respectively) was found in DAP treatment (M_4). The highest remaining pod was found under MoP treatment (M_3). Oko *et al*. (2003) reported reduced flower abortion rate in soybean when foliar urea was applied at reproductive stages compared to control. Roy (2013) reported minimum flower dropping and pod dropping under supplemental irrigation + N spray before flowering

in chickpea. The result inconsistency might be due to differences in variety, soil moisture availability and subsequent treatments.

Table 2. Effect of foliar urea, MoP and DAP spray on flower and pod dropping percentage of two soybean varieties

Treatments	Flower dropping (%)	Pod dropping (%)	Total dropping (%)	Pod remaining (%)
Variety				
V_1	55.2 a	15.36	70.56	29.45
V_2	50.89 b	13.89	63.87	35.96
Foliar spray				
M_1	52.61	14.22 ab	66.83	32.84
M_2	55.3	12.93 b	68.24	31.76
M_3	51.73	14.93 ab	64.82	35.22
M_4	52.56	16.44 a	68.99	31.01
SE	3.78	1.12	4.38	4.42
Variety x Foliar spray				
V_1M_1	55.36	16.31	71.67	28.33
V_1M_2	55.77	12.58	68.35	31.65
V_1M_3	52.81	16.66	69.47	30.59
V_1M_4	56.87	15.89	72.77	27.23
V_2M_1	49.86	12.13	61.98	37.35
V_2M_2	54.83	13.29	68.13	31.87
V_2M_3	50.64	13.19	60.16	39.84
V_2M_4	48.24	16.98	65.22	34.78
SE	4.65	3.63	6.1	6.21
CV (%)	12.35	13.27	11.29	23.41

V_1 = BARI Soybean-5, V_2 = BARI Soybean-6, M_1 = No Supplemental spray, M_2 = Supplemental spray of Urea, M_3 = Supplemental spray of MoP, M_4 = Supplemental spray of DAP

Maximum flower dropping and total dropping was found in V_1M_4 (BARI Soybean-5 x DAP spray) and consequently, minimum pod remaining was found in the same interaction. The lowest total dropping was recorded under V_2M_3 (BARI Soybean-6 + MoP) and consequently, maximum remained was found under same interaction (Table 2).

Yield and yield attributes

Among the yield attributes, pod length, seed yield and biological yield showed significant differences for two soybean varieties, while other yield attributes didn't show any significant differences (Table 3). The higher pods number plant^{-1} and harvest index was recorded in BARI Soybean-6 and higher pod length (cm), seeds pod^{-1}, 1000-seed weight, seed yield, stover yield and biological yield was found in BARI Soybean-5.

Among the fertilizer treatments, seeds pod^{-1} and 1000-seed weight showed significant differences for different foliar fertilization at early flowering stage. The highest pods number plant^{-1} (57.72), pod length (3.47 cm), and harvest index % (59.01) was recorded under MoP treatment (M_3), however, highest number of seeds pod^{-1}, highest stover yield, and biological yield was found in DAP treatment (M_4). A similar result was obtained by Vinoth Kumar *et al*. (2013), where highest number of pods plant^{-1}, number of seeds pod^{-1}, grain yield was recorded under 2% DAP treatment. Singh *et al*. (2018)

also performed a similar experiment at pod initiation stage and reported highest pods plant^{-1} and seed yield under 2% DAP spray.

The interaction effect of variety and fertilizer showed statistically significant differences in seeds pod^{-1}, pod length, seed yield, and biological yield. The maximum seeds pod^{-1} (2.48) was recorded from V_1M_3 (BARI Soybean-5 + MoP) which was statistically similar (2.43) to V_1M_4 (BARI Soybean-5 + DAP). On the other hand, maximum seed yield (1.48 t ha^{-1}) and biological yield (2.75 t ha^{-1}) was recorded from V_1M_4 (BARI Soybean-5 + DAP at flowering). The harvest index didn't show any significant variation among interaction treatments; however, maximum harvest index was found from V_2M_2 (BARI Soybean-6 + Urea spray at early flowering).

Table 3. Effect of foliar urea, MoP and DAP spray on yield attributes of two soybean

Varieties Treatments	Pods plant^{-1} (No.)	Pod length (cm)	Seeds pod^{-1} (No.)	1000-seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Variety								
V_1	50.33	3.51 a	2.41	103.47	1.29 a	1.03	2.32 a	55.56
V_2	60.45	3.36 b	2.36	95.9	0.95 b	0.71	1.66 b	57.38
Foliar spray								
M_1	55.67	3.44	2.33 c	104.04 a	1.03	0.81	1.84	55.37
M_2	54.43	3.43	2.37 b	102.39 ab	1.21	0.91	2.11	57.94
M_3	57.72	3.47	2.41 ab	96.59 b	1.07	0.73	1.79	59.01
M_4	53.73	3.41	2.42 a	95.74 b	1.18	1.02	2.21	53.54
SE	9.24	0.04	0.02	3.13	0.19	0.14	0.29	3.24
Variety x Foliar spray								
V_1M_1	53.73	3.44 bc	2.29 d	111.33	1.17 ab	0.91	2.08 ab	55.01
V_1M_2	46	3.49 b	2.42 b	104.33	1.28 ab	1.13	2.40 ab	53.47
V_1M_3	56.23	3.68 a	2.48 a	98.66	1.21 ab	0.82	2.03 ab	59.35
V_1M_4	45.33	3.41 bc	2.43 ab	99.57	1.48 a	1.26	2.75 a	54.41
V_2M_1	57.6	3.44 bc	2.37 b	96.74	0.88 b	0.71	1.59 b	55.74
V_2M_2	62.87	3.36 cd	2.33 cd	100.44	1.13 ab	0.69	1.81 b	62.42
V_2M_3	59.2	3.25 d	2.34 cd	94.52	0.92 b	0.64	1.56 b	58.67
V_2M_4	62.13	3.41 bc	2.4 b	91.91	0.87 b	0.78	1.66 b	52.58
SE	13.42	0.05	0.03	4.42	0.23	0.21	0.38	5.74
CV (%)	28.91	1.87	1.39	5.43	28.85	27.2	26.03	9.94

V_1 = BARI Soybean-5, V_2 = BARI Soybean-6, M_1 = No Supplemental spray, M_2 = Supplemental spray of Urea, M_3 = Supplemental spray of MoP, M_4 = Supplemental spray of DAP

Conclusion

In conclusion, it appears that foliar application of urea, MoP and DAP at early flowering stage had no significant effect on plant growth traits of soybean. In case of flower & pod dropping and yield attributes, the results showed inconsistency with previous findings of other researchers. It is suggested that further study is required before recommending foliar nutrient application for optimum soybean production.

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