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Flowering pattern, floral abscission and yield attributes in soybean influenced by GABA

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Abstract

An experiment was carried out in the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, to investigate the flowering pattern, floral and pod abscission under untreated and GABA (mixture of GA_3 and Abscissic acid) treated soybean and their trends concern to yield. The variety of soybean PB-1 (Shohag) was used in the investigation. GABA at 0.5, 1.0 and 2.0 mg L^{-1} of water with a control (only water) were used for foliar spray. Flower and pod initiation started from 54 and 60 DAS in all plants irrespective to GABA treatment. Flower production trend showed a deltoid pattern where pod production was gradually increased and slowed down at 74 DAS but not in GABA treated plant. The 4th node produced the highest number of flowers, then decreased and got zigzag pattern in upper nodes. GABA treated plants produced more nodes per plant and followed lower trend in flower and pod abscission indicated the efficacy of higher yield.

Keywords: Flowering pattern, Floral abscission, Yield, Soybean, GABA

Introduction

Soybean (*Glycine max* (L.) Merr.), an important oil seed producing plant of Leguminosae family is called "Protein hope of future" for its nutritional value. Seeds of soybean contain 40-45% protein and 18-20% oil. Plants help in improving soil fertility by fixing atmospheric nitrogen through *Rhizobium* sp. in root nodules. Reports indicated that *Bradyrhizobium japonicum* can fix about 300 kg nitrogen/ha/year in symbiosis with soybean (Keser and Li, 1992). Soybean accounts for approximately 50% of the total production of oilseed crops in the world (FAO, 2007). In Bangladesh about 5000 hectares of land under soybean cultivation has produced 6000 tons of seeds (BARI, 2007). The average yield of soybean in the world is about 3.0 t ha^{-1} while in Bangladesh it is only 1.2 t ha^{-1} (SAIC, 2007). The principle constraint of soybean production is its low yield potential.

Important physiological attributes such as leaf area index (LAI), crop growth rate, relative growth rate, net assimilation rate (NAR) and specific leaf weight can address various constraints of a variety for increasing its productivity. For optimum yield in soybean, the LAI should be from 3.5 to 4.5 (Jin Woong *et al.*, 2005). The dry matter accumulation may be the highest if the LAI attains its maximum value within the shortest possible time (Tandale and Ubale, 2007). In soybean, low yield potentiality is mainly for its reproductive attributes where flower production and fruit development stage incorporate to vegetative growth at same time. Therefore, developing reproductive sinks are competing for assimilates to vegetative sinks. The capability of efficient partitioning between the vegetative and reproductive parts may produce high economic yield (Maola, 2005). Floral abscission is also a great barrier in high yield potentials. From 70 - 85% of soybean flowers do not develop into mature pods and abscise. Egli and Bruening (2003) indicated that potential fruit or seed number is much lower than the number actually produced by the plant community. Pattern of flowering, fertilization and abscission might concern to yielding in soybean. The knowledge in this regard has not been documented well in soybean producing in Bangladesh. Furthermore, there might ample scope to increase potential pod number from flower produced by spraying PGR at suitable stage and optimum concentration. To select suitable stage of PGR applications, flowering as well as abscission patterns are to be realized properly. Report on flowering pattern and floral abscission in soybean is scanty.

Plant growth regulator enhances yield attributes and yield might involve in fruit setting to enhance yield (Nichell, 1982). Physiological mechanisms of soybean flower and pod abscission are hormonally mediated, might involve in changing flowering pattern and abscission. GABA (a mixture of Gibberellic acid and S-abscisic acid), a plant growth regulator influenced growth and yield in various crops (Kamuro *et al.*, 2001; Samsuzzaman, 2004). However, the functional mechanism or factors responsible in enhancing yield attribute as well as yield with GABA is not clear. Considering these views present experiment was planned to disclose the floral pattern concerning abscission both in control as well as under treatment with a plant growth regulator namely, GABA. The purpose of this research is to find out the flowering and floral abscission pattern to indicate yield attribute in soybean.

Materials and Methods

The variety of soybean PB-1 (Shohag) used in the present study was collected from the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh. The plant growth regulator (GABA) was collected from BAL PANNING Co. Ltd., Ichinomiya, Japan. The experiment was conducted in the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh from December 2004 to April 2005. The field was medium high land belonging to the Sonatola soil series of grey flood plain soil under the Agro-ecological Zone (AEZ-9) of old Brahmaputra flood plain. The soil was silt loam imperfectly to poorly drained permeability. Geographically the experimental field was located at 24°75′ N latitude and 90°50′ E longitude at the elevation at 18 m above the sea level (FAO, 1988)

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. As treatment GABA at 0.5 mg L^{-1}, 1.0 mg L^{-1} and 2.0 mg L^{-1} with a control (fresh water) were sprayed after 45 DAS by a hand sprayer at afternoon.

The land was prepared by ploughing and cross-ploughing followed by laddering, and plot size maintained to 3m $\times$ 2m. Manures and fertilizers were applied following recommendation guide of Bangladesh Agriculture Research Council (BARC, 2005). Seeds were sown on 27 December at 3-4 cm depth maintaining row to row and plant to plant distances at 30 and 10 cm respectively. Two seeds were sown in each hole. After 20 days of sowing one healthy seedling was kept in each hole and gaps were filled. Irrigation was done at 40 DAS. Two weeding were carried out at 30 and 60 DAS, respectively.

Data on reproductive attributes were collected from randomly selected 5 plants of each plot at every alternate day from 54 (beginning of flowering) to 100 (end of pod formation) DAS. For growth parameters the interval of data collection was 20 days. The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were tested with Duncan's Multiple Range Test (DMRT) using the statistical computer package program MSTAT-C (Russell, 1986).

Results and Discussion

Flowering

The initiation of flower was started from 54 DAS irrespective to the application of GABA. Number of flower produced which increased gradually up to 64 DAS, then increased sharply up to 72 DAS, and then slowed down both in plants under control and treated (Fig.1A). The pattern of flowering revealed deltoid, which was remained unchanged with spraying GABA. Plants sprayed with GABA, showed distinctly higher trend in flower production especially from 66 to 80 DAS. The lower most node (1^{st}) produced 8-9 flower per plant and attained to pick in 4^{th} node ascendingly where plant under control produced 13 and 16 flowers respectively in plant under controlled and GABA treated (Fig. 1B). From 5^{th} to 7^{th} node the number of flower per node decreased gradually and then get zigzag trend pattern up to end. In nodes of GABA treated plants zigzag flowering pattern was more prominent than that in plants under control. Furthermore, treated plants produced flowers up to 12th node, where control plants get end flowering at 11th node. This change in flowering trend might support yield increase with GABA application. The highest number of flowers per plant was 84 per plant with 1.0 mg L^{-1} GABA and the lowest was 70 found in the control. All the GABA treated plants produced significantly higher number of flowers per plant compared to that in control (Table 1).

Pod production

The pod initiation in plants was started from 60 DAS irrespective to the treatment. Initially the pod production gradually increased up to 68 DAS and then increased sharply (Fig. 1C). The trend of pod production was different to flower production trend which indicated abscission frequency indirectly. Plants treated with GABA showed a higher pod production trend compared to that in control, especially in later period of production. With application of GABA plants get stimulated and sharply increased pod initiation where control plants showed slower trend (Fig.1C). Among the different concentrations, 1.0 mg L^{-1} GABA treated plant showed a higher trend in pod production over other treatments. After 78 DAS, pod production trend slowed down in plants under control, but remained steady in GABA treated plants up to 80 DAS. This factor might be concerned to yield in soybean. A plant treated with 1.0 mg L^{-1} GABA produced 66 pod followed by 61 pod at 2.0 mg L^{-1} where control plant had 48 pod per plant (Table 1). Pod abscission in soybean was remarkable. In plants under control had 26.6 % pod abscised per plant. Application of GABA significantly reduced pod abscission to 17.9 % with 1 mg L^{-1}, and this was the most effective concentration over control as well as lower or higher concentration. Thus pod production with GABA application was significantly higher over control. However, pod production pattern in a plant was different, almost similar to that in flower production (Fig.1D). The lowest node (1st node) produced 6 pods per plant, increased at the highest in 4th node and then decreased sharply up to 7th node and finally decreased following zigzag pattern like flowering. At 4th node, control plant produced 10 pods per plant where GABA at 1.0 mg L^{-1} treated plant had 12 pods. Pod production was ended at 11th node in control plant but continued up to 12th node in GABA treated plants. Both higher trend in pod production and enhancement in node number in plant with GABA application might be concerned to yield increment.

Flower and pod abscission

Flower abscission was found to be started from 60 DAS (Fig. 1E). From the beginning, the floral abscission trend in plants under control revealed steady which slowed down after 70 DAS. In plants treated with GABA floral abscission increased gradually up to 68 DAS and then got steady up to 74 DAS and finally slowed down prominently with 1.0 mg L^{-1}. All the concentrations of GABA showed a lower trend in abscission of flower of which 1.0 mg L^{-1} GABA showed the least. The percentage of flower abscission per plant was significantly influenced by the different GABA concentrations. Per cent number of abscised flower per plant was the highest in control and the lowest one was for 1.0 mg L^{-1} of GABA. Flower and pod abscission was calculated following the formula of Josephine and Brun (1984) revealed that flower and pod abscission under control was about 50%, much lower than earlier reports indicated 70-80 % flower abscission (Egli and Bruening, 2003). This variation might be due to varietals difference or environmental factors. However, GABA at 1.0 mg L^{-1} has reduced the flower abscission per cent significantly at 21.5 from 31.5 in control. With application of 1.0 mg L^{-1} GABA flower and pod abscission reduced to 17.9 % from 26.6% in control (Table 1). Similarly pod abscission also reduced significantly with GABA application. Considering both flower and pod, GABA at 1 mg L^{-1} reduced abscission at 35.6% from 50% in control. Present result indicated that external application of PGR in the form of spray enhanced yield of soybean (Table 2). However, it is not clear from the present research whether applied GABA was directly involved in physiological process or indirectly by stimulating endogenous PGR and thus remains for further investigation.

Table 1. Flower and pod production and abscission in soybean under control and GABA treated plants up to harvest

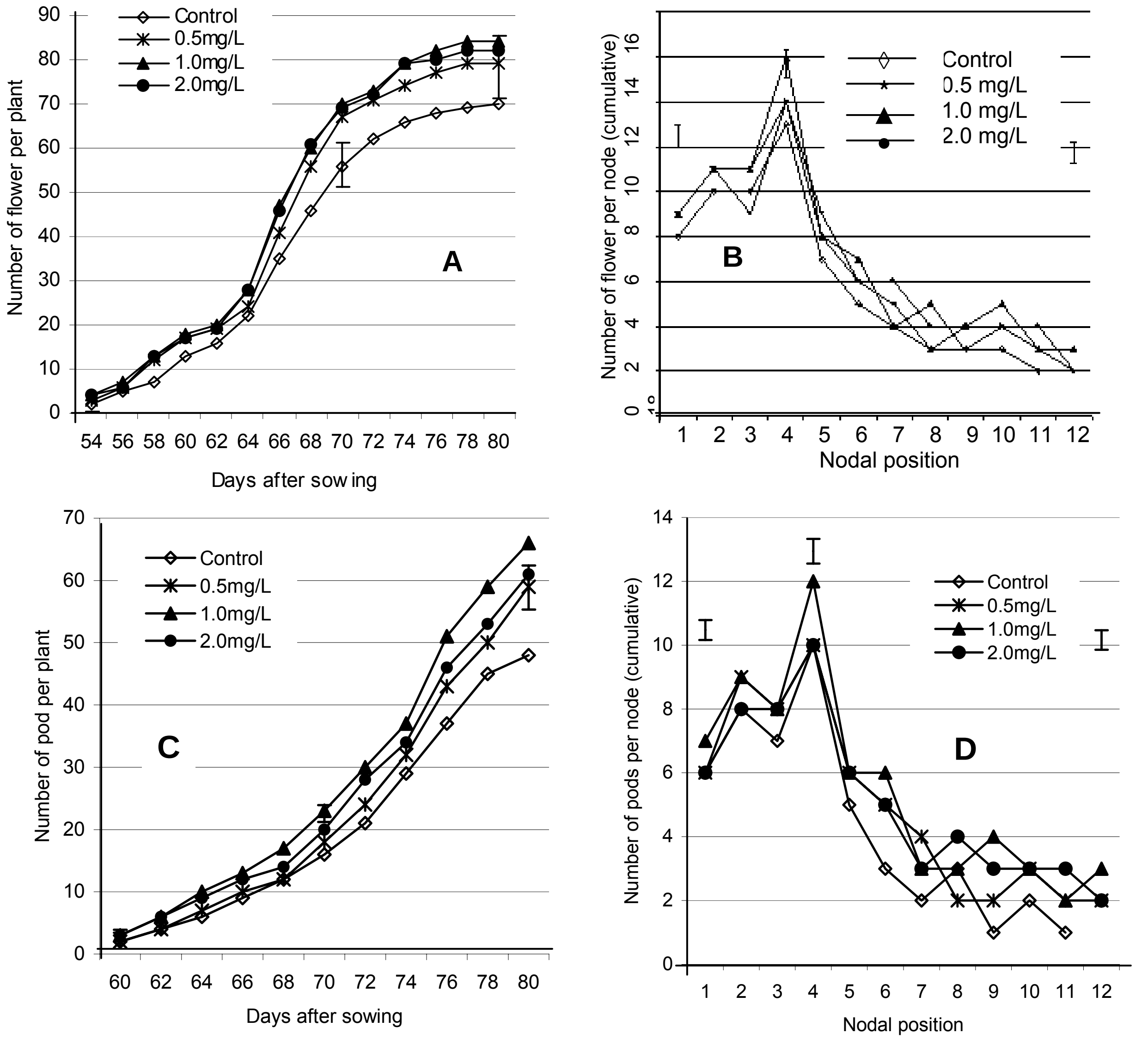
GABA concentration mg L^{-1}	Number per plant			Abscission per plant (%)		
	flowers	initiated pods	mature pods	flowers	Pod	Flower & pod
0.0 (Control)	70c	48c	35c	31.74a	26.68a	49.94a
0.5	79b	59b	46b	25.56b	22.02b	41.95b
1.0	84a	66a	54a	21.55c	17.93c	35.62c
2.0	82a	61b	47b	25.84b	22.56b	42.57b

Values with different letters within a column differ significantly at 5% level of probability as per DMRT

Table 2. Effect of GABA on yield of soybean (var. Shohag)

GABA concentration	0.0 mg/L (Control)	0.5 mg/L	1.0 mg/L	2.0 mg/L
Seed yield (t/ha)	1.79c	2.50b	2.87a	2.73a

Values with different letters within the row differ significantly at 5% level of probability as per DMRT.



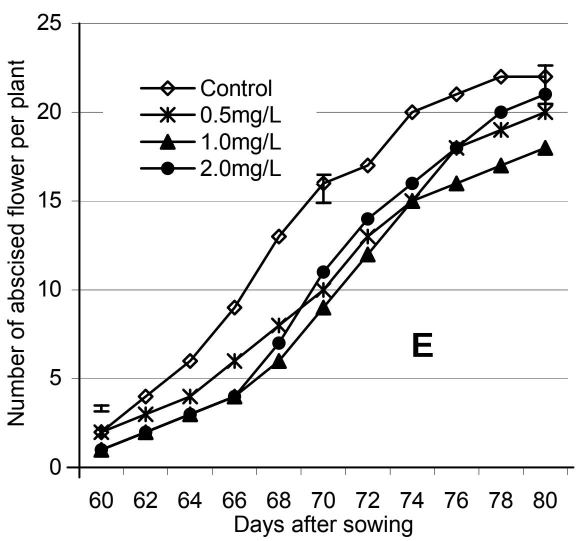


Fig. 1. The flowering pattern (A), number of flower per node (B), number of pod per plant (C), number of pod per node (D) and number of abscised flower per plant (E) in soybean plants under control and GABA treatment as spray

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