Role of GABA on Growth, Yield Contributing Characters and Yield of Sesame

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Abstract

The experiment was carried out to investigate the effect of GABA on growth, yield attributes and yield of a popular sesame cultivar BARI Til-2. The experiment comprised of five levels of GABA, viz. 2, 3, 4, 5 and 6 mg l^{-1}, and distilled water as control. Result revealed that leaf dry weight, stem dry weight, root dry weight, TDM, CGR, RGR, number of flower bud, number of capsule, number of seeds $capsule^{-1}$ and seed yield being the highest in 5 mg l^{-1} concentration over those in control. Moreover, GABA had no significant influence on capsule length, capsule diameter and 1000-seed weight. Application of GABA at 5 mg l^{-1} as foliar spray could be the suitable concentration for enhancing growth, yield attributes and yield of sesame.

1. Introduction

Sesame (*Sesamum indicum* L.) is an important oil crop belongs to the family Pedaliaceae, which is extensively grown in different parts of the world. It ranks fourth among the oil crops in the world. It is an important oil crops next to mustard occupying about 9% of the total oil seed area in Bangladesh (BBS, 2004). According to FAO (2003), the world production of sesame is 2.9 mt in the year of 2003. It is a diversified crop with high-class edible oil having versatile usage. BARI (2001) reported that sesame is rich in oil (42-50%), protein (14-20%), and carbohydrate (20%)). It is used mostly for edible purposes in confectionary due to its superior quality because it contains less amount of eurocic acid and high amount of linoleic acid which is beneficial for human health. It is also used as hair-oil in Bangladesh. It also meets the other purposes, such as in manufacture of margarine, used as lubricant for vehicle, soap, paint, and perfumery industry, and in pharmaceutical as an ingredient for drugs and as dispersing agent for different kinds of insecticides (Cobley, 1967; Masefield, 1965; Mcllroy, 1967; Tribe, 1967). It is also used as a good fertilizer. Sesame is grown in all regions of Bangladesh. In 1999-2000, the crop covered an area of 91925 acres in Bangladesh with an average yield of 22005 mt (BBS, 2004). There is a high prospect of sesame cultivation in Bangladesh. The climate and edaphic conditions are quite suitable for the cultivation of sesame.

Plant growth regulator is one of the most important factors of crop production as well as higher yield. Mala and Selvam (1998) found that GA_3 20 ppm solution followed by foliar spraying with $MnS0_4$ (0.5%) increased growth, yield attributes and yield of sesame cv. TMV 3. Most of the plant growth regulators exhibit a broad action spectrum and thus single PGRs entirely applying PGRs exogenously in proper concentration at a proper time in a specific crop.

The GABA (a mixture of GA_3 and STC) has significant and stable effect on growth regulation. The mixture consists of 1% gibberellic acid (GA_3) and 0.05% STC marketed by Japanese BAL planting company. GABA enhances endogenous hormone of plants, which affects growth, physiological attributes and finally yield (Antonio, 1995). The hormone GABA is cheap and its application method is very easy. Hence, the present study was undertaken to estimate the optimum concentration of GABA on growth, yield and yield attributes of sesame.

2. Materials and Methods

The experiment was conducted from March 11 to June 11, 2007 on variety of sesame BARI Til-2 at Bangladesh Agricultural University (BAU), Mymensingh. Six treatments of GABA were 0 (control), 2, 3, 4, 5 and 6 mg l^{-1}. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The formulation of GABA was water-soluble powder. Prior to spraying GABA was diluted to get working solution. For preparation of working solution 2, 3, 4, 5 and 6 mg of original GABA powder were added to one litter of distilled water separately contained in five volumetric flasks. The prepared solution of different concentrations of GABA, and distilled water (control) was applied on the foliage as a fine spray with a hand sprayer until all the leaves were completely wet. Spraying was done at 38 DAS (days after sowing). Spraying was done at afternoon to avoid dehydration effect at mid day. The first crop sampling was taken at 48 DAS and continued with an interval of 7 days till maturity at 90 DAS. Five plants from each treatment were collected to record data on number of flower buds $plant^{-1}$, number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, capsule length, harvest index, yield, etc. Total dry matter (TDM) was determined by the summation of dry

weight of roots, stems and leaves of plant. The recorded data were statistically analyzed to obtain the level of significance using the MSTAT-computer package program. The means were separated following least significance deference (LSD) test.

3. Results and Discussion

3.1. Effect of GABA on growth characters

The effect of GABA at different concentrations on leaf dry weight is shown in Figure 1. Leaf dry weight increased significantly ($p \leq 0.05$) with time up to 76 DAS thereafter decreased due to leaf shattering. The dose of 5 mg l^{-1} maintained highest leaf dry weight throughout the growth period and the control plant maintained the lowest leaf dry weight. The present result is in agreement with that of Rahman (2003) on mungbean. He reported that leaf dry weight was significantly enhanced by the application of GABA and TNZ-303 at 0.5, 1.0 and 2.0 mg l^{-1} and ABT-6 at 10, 20, and 30 ppm as compared to the control. The application of different concentration of GABA on the stem dry weight $plant^{-1}$ was significant (Figure 2). The maximum stem dry weight (11.55 g) was found in 5 mg l^{-1} GABA at 83 DAS. Control plant showed the lowest stem dry weight $plant^{-1}$ at all DAS. GABA might increase translocation of assimilates to the shoot which increased stem dry weight $plant^{-1}$. Sekh (2002) observed that GABA produced the highest stem dry

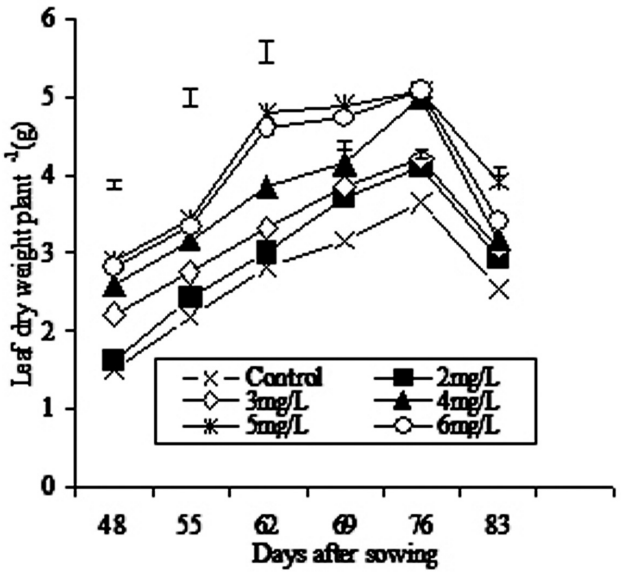

Figure 1: Effect of different concentrations of GABA on leaf dry weight at different growth stages of sesame. Vertical bars represent $LSD_{(0.05)}$

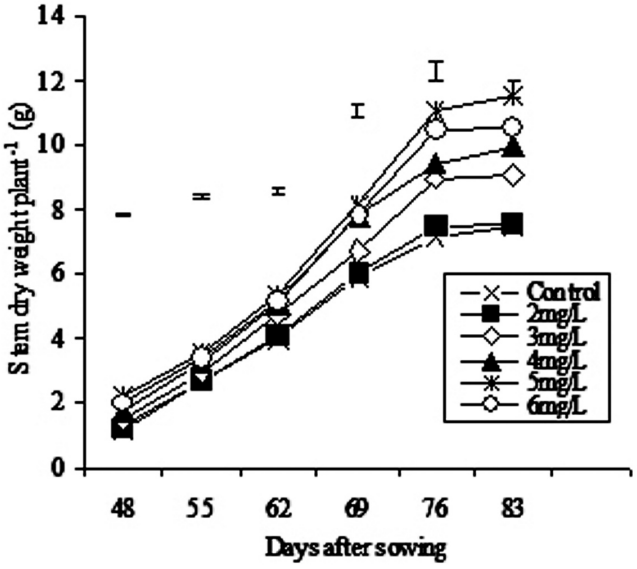

Figure 2: Effect of different concentrations of GABA on stem dry weight at different growth stages of sesame. Vertical bars represent $LSD_{(0.05)}$

weight compared to that of TNZ-303 and CL-IAA.

Root dry weight was significantly influenced by the application of different doses of GABA on sesame (Figure 3). Application of GABA at 5 mg l^{-1} showed the highest root dry weight among treatments. In contrast, control plant showed the lowest root dry weight. Sekh (2002) observed that GABA produced the highest root dry weight compared to that of TNZ-303 and CL-IAA.

The application of different concentration of GABA significantly influenced the accumulation of TDM (Figure 4). Result revealed that TDM production increased with age. The highest TDM production was observed at 5 mg l^{-1} GABA at all growth stages compared to other concentrations. In contrast, control plant produced the lowest TDM at all growth stages. The TDM was greater in GABA applied plants because of increased branches number, leaf number as well as leaf area (Islam, 2007), i.e. photosynthetic area that produced more assimilate than control plant and ultimately increased TDM. Sekh (2002) reported that the total dry matter production was significantly enhanced by the application of GABA, TNZ-303 and Cl-IAA at 0.16, 0.33 and 0.66 ml l^{-1}, respectively compared to the control in aman rice cultivar.

Crop growth rates with different doses of GABA were determined form 48 to 83 DAS and the results are presented in Figure 5. CGR was increased up to 62-69 DAS and thereafter decreased with progress of plant age. GABA at 5 mg l^{-1} showed the highest CGR among different concentration, whereas control plant showed the lowest CGR. Ahammed (2006) reported that CGR increased with the increasing concentration of GA_3 up to certain level. Similar results were also observed in present experiment. At 62-69 DAS, the CGR value was found to be maximum which meant that plant produced maximum assimilates at this growth stage. The declining of CGR after reaching the maximum in all treated plants was consistent with the results of Dutta and Mondal (1998).

The variation in relative growth rate (RGR) among the treatments was assessed from 48 DAS until 83 DAS and the results are presented in Figure 6. It was observed that there existed an inverse relationship between RGR and plant age. Treatment

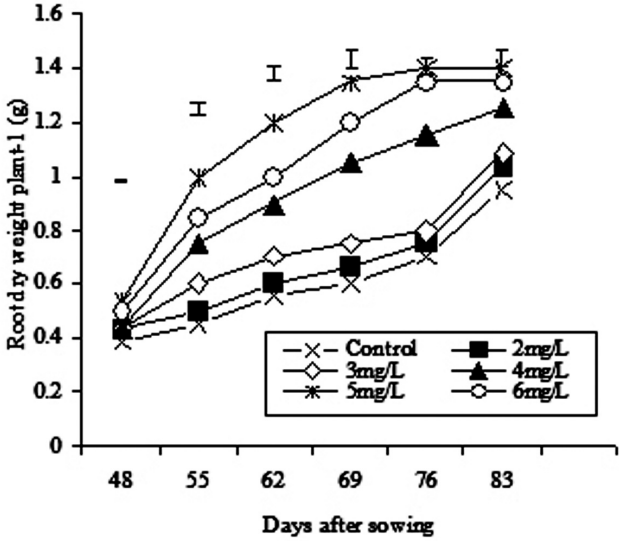

Figure 3: Effect of different concentrations of GABA on root dry weight at different growth stages of sesame. Vertical bars represent LSD $_{(0.05)}$

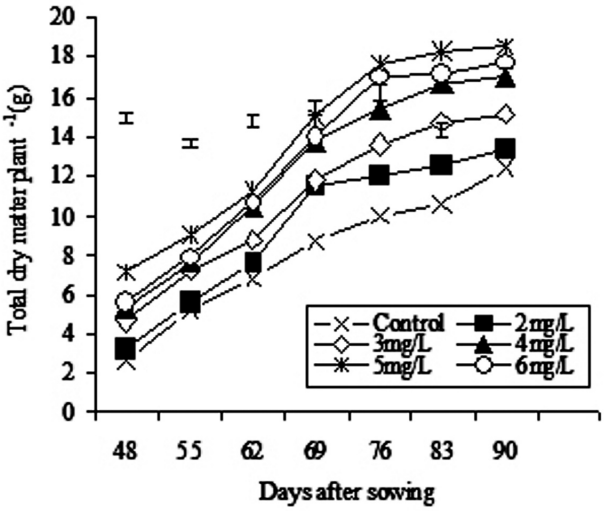

Figure 4: Effect of different concentrations of GABA on total dry matter at different growth stages of sesame. Vertical bars represent LSD $_{(0.05)}$

differences in RGR were found significant at all growth stages. The RGR showed the highest value at 48-55 DAS and continued to decline towards maturity. Generally, with the advancement of plant age, RGR decreases in most field crops (Hunt, 1978; Prodhan, 2004). RGR was greater in GABA applied plants than in control, being the highest at 5 mg l^{-1} GABA applied plants at all growth stages. At early growth stages (48-55 DAS), the highest RGR (91.91 mg $g^{-1}day^{-1}$) was observed in 5 mg l^{-1} GABA treatment. In contrast, control showed the lowest RGR (45.92 mg g^{-1} day^{-1}). The present result is in agreement with the report of Ahammed (2006) on soybean.

3.2. Effect of GABA on yield attributes and yield

The effect of GABA on number of flower buds $plant^{-1}$ was significant at 48 and 55 DAS (Table 1). At 48 DAS, the maximum number (28) of flower buds $plant^{-1}$ was found at 5 mg l^{-1} of GABA which was statistically similar to that of 6 mg l^{-1}. Again at 55 DAS, the highest number (37) of flower buds $plant^{-1}$ was also obtained at 5 mg l^{-1}. In both the cases, the lowest number of

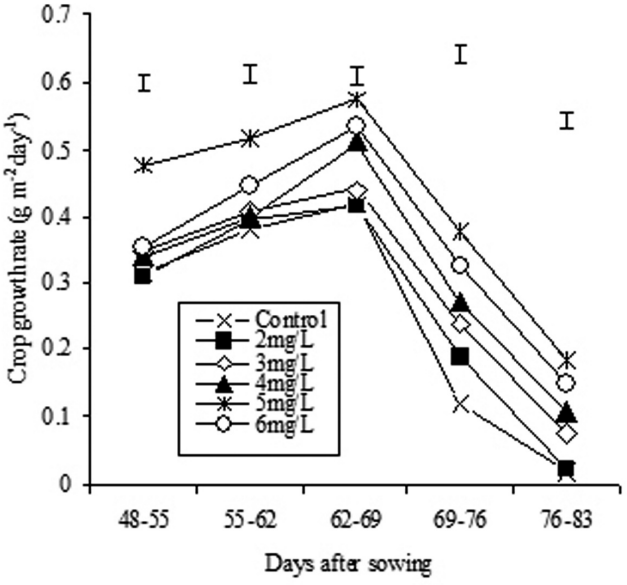

Figure 5: Effect of different concentrations of GABA on crop growth rate at different growth stages of sesame. Vertical bars represent LSD $_{(0.05)}$

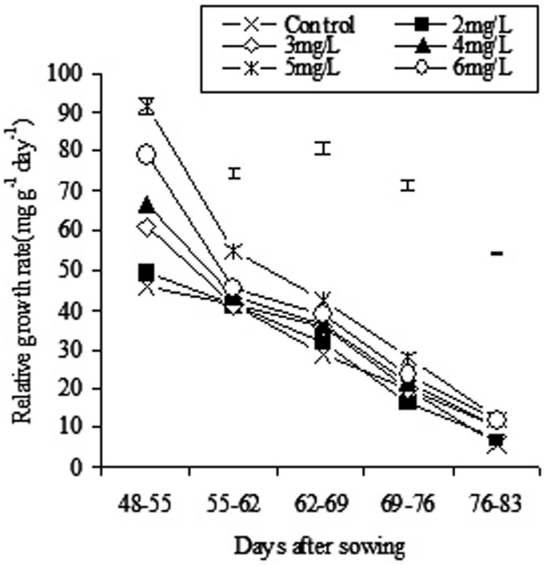

Figure 6: Effect of different concentrations of GABA on relative growth rate at different growth stages of sesame. Vertical bars represent LSD LSD $_{(0.05)}$

flower buds plant^{-1} was achieved at control treatment. From the results, it is clear that GABA had stimulatory effect on number of flower buds plant^{-1}. The result of present study is similar to the finding of Rahman (2004) who found that application of GABA with 1.0 mg l^{-1} produced the highest number of flower in mungbean.

Table 1: Effect of GABA on yield contributing characters

Treatment	Flower number plant^{-1}		Capsule number plant^{-1}	Seed number capsule^{-1}	Capsule length (cm)	Capsule diameter (mm)	1000-seed weight (g)	Yield plot^{-1} (g)	Yield (t ha^{-1})	HI (%)
	48 DAS	55 DAS								
Control	13.33 c	22.33 d	42.33 b	55.16 b	2.3	5.49	2.34	135.34 b	0.90 d	14.47 b
2mg l^{-1}	23.17 b	30.00 c	44.83 b	56.00 b	2.3	5.54	2.35	170.16 ab	1.13 c	17.11 a
3 mg l^{-1}	24.33 ab	33.00 bc	50.66 a	57.66 b	2.3	5.55	2.36	182.10 a	1.21 bc	16.07 ab
4 mg l^{-1}	23.70 ab	36.00 ab	52.50 a	58.33 b	2.3	5.52	2.38	191.52a	1.27 abc	14.38 b
5 mg l^{-1}	28.00 a	37.30 a	55.83 a	64.50 a	2.4	5.6	2.4	206.31a	1.37 a	14.84 b
6 mg l^{-1}	27.00 a	31.33 c	55.00 a	60.00 ab	2.3	5.56	2.38	201.75a	1.34 ab	15.87 ab
LSD (p=0.05)	4.09	3.88	5.72	4.66	NS	NS	NS	53.78	0.141	1.57
CV %	9.68	6.75	6.27	4.37	2.7	2.99	3.22	10.85	6.31	5.6

In a column figures having the same letter or without letter (s) do not differ significantly at $p \leq 0.05$ by DMRT.
DAS=Days after sowing

The effect of different concentration of GABA had significant influence on capsule production plant^{-1} (Table 1). Result revealed that capsule number plant^{-1} was greater in GABA treated plant than in control. The highest number of capsule (56) was observed in 5 mg l^{-1} which was statistically similar to 3, 4 and 6 mg l^{-1} GABA. The lowest number of capsule (42) was recorded in control plant which was statistically similar to 2 mg l^{-1}. These results indicated that GABA had positive effect on capsule production. These results are in agreement with the report of Sultan (2005) in mungbean.

GABA significantly increased the number of seeds capsule^{-1} (Table 1). The highest number of seed capsule^{-1} (64) was found in 5 mg l^{-1} whereas the lowest number of seeds capsule^{-1} (55) was recorded in control which was statistically similar to 2, 3 and 4 mg l^{-1} GABA. The results are in agreement with that of Arora et al. (1998) who reported that IAA applied at the flowering stage of chickpeas had increased the number of seeds pod^{-1} as compared to those of the control plants.

The application of different concentration of GABA had no significant effect on the length of capsule (Table 1). However, the length of capsule varied from 2.25 to 2.35 cm. The result of the present study is similar to the findings of Akter (2004), and Bouttier and Morgan (1992) who reported that application of GABA at different levels on mustard showed no positive influence on length of capsule.

The application of different doses of GABA on sesame had no significant influence on capsule diameter. However, the diameter of capsule varied from 5.49 to 5.60 mm.

The effect of GABA application on 1000-seed weight was statistically insignificant at $p \leq 0.05$ (Table 1). However, 1000-seed weight was increased apparently in GABA treated plants over control. The results are in contradiction with the result of Abdullah (2002) who found that application of GABA (0.332 or 0.662 mg l^{-1}) significantly enhanced 1000-seed weight in soybean. But, in soybean, Ahammed (2006) reported that seed size was controlled genetically not by environment.

The effect of GABA at different concentrations on seed yield (g) plot^{-1} is shown in Table 1. The highest (206.31g) seed yield was obtained at 5 mg l^{-1} GABA and the lowest (135.34 g) was obtained at control treatment. The highest yield produced at 5 mg l^{-1} was due to the production of higher number of capsules plant^{-1} and the maximum number of seeds capsule^{-1}. Lower yield at control treatment might be attributed to lower number of capsules plant^{-1} and seeds capsule^{-1}. These results were supported by Samsuzzaman (2004) who reported that application of GABA (0.5, 1.0 and 2.0 mg l^{-1}) enhanced seed yield in groundnut. .

The effect of GABA on seed yield was significant (Table 1). Result revealed that seed yield increased with increasing concentration of GABA. The highest seed yield was recorded in 5 mg l^{-1} GABA (1.37 t ha^{-1}) which was statistically similar to that of 6 mg l^{-1} GABA (1.34 t ha^{-1}). In contrast, the lowest seed yield was recorded in control plant (0.902 t ha^{-1}). Seed yield increased due to increasing number of capsule plant^{-1}. These results are in agreement with the report of Sultan (2005).

The effect of different levels of GABA application on harvest index (HI) was statistically significant (Table 1). The highest HI (17.11) was recorded in 2 mg l^{-1} GABA treated plant, whereas the lowest was in 4 mg l^{-1} GABA applied plant. It is interesting to note that high yielding plant did not show high HI. According to Poehlman (1991), high HI percentage does not contribute to high yield. High yield is determined by physiological process

leading to a high net accumulation of photosynthetes and its partitioning into plant and seed. This opinion was supported by the present study. Here, 5 mg l^{-1} GABA applied plant produced high seed yield but showed inferiority in HI which might be due to the production of increased TDM.

4. Conclusion

From the results, it may be concluded that application of 5 mg l^{-1} GABA on sesame had remarkable superiority on plant growth and produced the highest seed yield. Therefore, 5 mg l^{-1} GABA may be applied for increasing seed yield of sesame.

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