Bangladesh J. Environ. Sci., Vol. 43, 36-42, 2022 @ BAED ISSN 1561-9206

EFFECT OF PLANT GROWTH REGULATOR (GABA) ON GROWTH AND YIELD OF CHILLI

Sayeeduzzaman[1], M. I. Hossain[2], A. A. Madani[3] and H. Kobir[4]
[1]Dept. of Soil Science, BAU, Mymensingh-2202
[2]Dept. of Plant pathology, BAU, Mymensingh-2202
[3]SGS Bangladesh limited; [4]DAE, Khamarbari, Dhaka

ABSTRACT

An experiment was conducted to evaluate the application of plant growth regulator (GABA) on the variation in growth, yield and yield attributes of chilli *cv*. Narikalkhola under the regional condition of Mymensingh, Bangladesh. The experiment comprised of three levels of GABA *viz*. 1, 2, and 3 mgL^{-1} and fresh water sprayed as control on chilli plant at 30 DAT. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The application of GABA significantly increased the plant height, number of branches and leaves $plant^{-1}$, canopy area, root length, weight of root, stem and leaf as well as the total dry mass over control. GABA @ 3 mgL^{-1} had the most effective approach for obtaining the highest significant impact on green fruit yield due to increased number of fruits $plant^{-1}$ and fruit size followed by 2 mgL^{-1} with same statistical rank while control treatment was the least significant impact on the above traits.
Key words: Chilli, GABA, growth, yield

Introduction

Chilli (*Capsicum annuum* L.) belongs to the genus *Capsicum* and the family Solanaceae. Chilli is native of Central America and the West Indies but spread quickly throughout the tropical countries after the discovery of America and the West Indies (Pruthi, 1993). It is virtually an indispensable item in the kitchen for everyday cooking. The red chilli fruit contains 15.9% protein, 31.6% carbohydrate, 50 mg/100g vitamin-C and small quantities of vitamin A, B and E. In Bangladesh, chilli ranks 1st in area (349 thousand acres) and 2nd in production (2,54,000 m tons) among the spices (BBS, 2007). Chilli is widely grown in all parts of the country and its winter production covers about 70% of the total production (BBS, 2007). But the average yield of chilli in Bangladesh is very low compared to other leading chilli growing countries in the world (FAO, 2005) due to improper cultivation management practices. Improvement of existing spice crops through proper cultural management practices need urgent attention to meet increasing demand of edible spices for the fast growing population of Bangladesh. That is why, special attention should be made for increasing the yield per unit area by adopting improved technologies and management practices. In this connection, use of plant growth regulators (PGRs) might be a useful alternative to increase crop production. Many developed countries like Japan, China, Poland and South Korea etc. have long been using PGRs to increase crop yield. PGRs are being used as an aid to enhance crop yield (Nickell, 1982). Among the PGRs, GABA is a new plant growth regulator that may have many uses to modify the growth, yield and yield attributes of plant. GABA contains 1% GA_3 and 0.05% STC (Kamuro *et al*., 2001) which have capability to enhance the growth and yield attributes in sesame (Islam, 2007), in mungbean (Begum, 2006), in rice (Afroz, 2005), in onion (Rahman, 2005) and in soybean (Rahim, 2005). Research works with GABA on growth, yield attributes and yield of chilli are scanty. So, there is ample scope of conducting research with GABA for increasing yield of chilli. Considering the above facts, the present research work was undertaken to observe the effect of GABA on growth, canopy structure, yield attributes and yield in chilli and to find out the effective dose of GABA for getting the higher yield.

Materials and Methods

The experiment was carried out at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the period from 10 February to 25 June 2008. The

experimental field was medium high belonging to the Sonatola Soil Series of Grey Floodplain soil under the AEZ-9 (Old Bahmaputra Flood plain). The soil was silty loam. The nutrient status like soil pH, organic carbon, organic matter total nitrogen, available phosphorus, potassium and sulphur contents of the experimental field were 7.1, 1.25%, 2.06%, 0.11%, 16.50, 0.13 and 12.10, respectively. The lowest average air temperature was 20.91°C in February and maximum was 28.07°C in May followed by June 27.93°C. Average rainfall was also high (316 mm) in June and lowest 92.2 mm in March while February was rainless. Similarly, relative humidity was maximum in June (94.22%) and minimum in February (72.00%). The local landrace chilli variety, Narikalkhola and three concentrations of plant growth regulator (GABA) *viz.*, 1, 2 and 3 mgL^{-1} were used in the present study while distilled water spray was done at 30 DAT as control by a hand sprayer at afternoon. The seedlings of chilli were collected from local market of Sutiakhali, Mymensingh and the GABA was collected from Dr. Yasuo Kamuro, Marketing Director, BAL Planning Co. Ltd., Ichinomiyo, Japan by Dr. Md. Obaidul Islam, Professor and Head, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of the unit plot was 2 m × 2 m. Distances between block to block and plot to plot were 1.0 and 0.5 m, respectively while plant to plant and row to row distances were maintained at 50 cm. The doses of fertilizers were urea 260, TSP 200, MP 150 and gypsum 80 $kgha^{-1}$. Well decomposed cowdung (5000 kg) and all fertilizer except 50% urea were applied to the field before final land preparation. The remaining 50% urea was applied as top dressing at 40 days after transplanting during flowering and fruiting start stage. The seedlings were transplanted in the afternoon on 10 February 2008. Gap filling, irrigation and weeding, management of insect and pests were also done as an intercultural operation. About 1, 2 and 3 mg of GABA powder were added to one liter of water as per treatment and spraying was done on chilli plants at afternoon by using a hand sprayer. Green fruits were harvested at weekly intervals depending on the maturity. Harvesting was started at 65 DAT and continued till 135 DAT. Data were recorded on plant height, number of branches and leaves $plant^{-1}$, canopy spread, root length, weight of root, stem and leaf, total dry matter, chlorophyll content, number of fruits $plant^{-1}$, siliqua length, fruit diameter, single fruit fresh weight, fruit weight $plant^{-1}$, fruit yield (tha^{-1}). The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjusted with Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT–C (Russell, 1986).

Results and Discussion

The results of the study obtained on the regulatory effect of plant growth regulator (GABA) at different concentrations on various morpho–physiological and yield contributing characters have been presented and possible interpretations have been made in this chapter.

Effect of GABA application on morpho–physiological characters of chilli

Plant height: The application of GABA had significant influenced ($p \leq 0.05$) on plant height at all growth stages (Fig. 1) where plant height increased with increased concentration of GABA. The highest plant height was recorded at 3.0 mgL^{-1} GABA application at all growth stages while 2.0 mgL^{-1} GABA had also statistically same rank. In contrast, control always maintained the shortest plant height. Further, plant height increased rapidly until 105 DAT and thereafter increased slowly reaching a peak at 135 DAT. The GABA treated plants showing increased plant height than in control may be due to increased number of internodes or length of internodes because of increased cell number. Similar result was also reported by Abdullah (2002) in soybean and Islam (2007) in sesame. They reported that plant height increased with increased concentration of GABA.

Number of branches $plant^{-1}$: Branch production was significantly influenced by the application of different doses of GABA on chilli while it increased with the increasing concentration of GABA. Results further revealed that branch number of chilli increased with age till 120 DAT followed by a decline due to some branches were died. The dose of 3.0 mgL^{-1} produced the highest number of branches $plant^{-1}$ over its

growth period followed by 2.0 mgL^{-1} with same statistical rank. In contrast, control plants produced the fewest branches $plant^{-1}$ over its growth period followed by 1.0 mgL^{-1}. The result is supported by the report of Begum (2006), who reported that application of GABA (range 1.0-4.0 mgL^{-1}) increased branch number over control in mungbean. Similar results were also reported by Rahim (2005) in soybean. In the present experiment, branch number of chilli increased with GABA application which achieved the goal for getting higher yield in chilli by the application of GABA.

Leaf number $plant^{-1}$: The effect of GABA application on leaf production in chilli was significant at all growth stages (Fig. 3). Result revealed that leaf number increased till 105 DAT followed by declined because of leaf shedding. The leaf production by 3.0 mgL^{-1} was significantly higher over other doses in most of the growth stages. Control had the lowest leaf number at all growth stages. The variation in leaf number might occur due to the variation in number of branches $plant^{-1}$. The result obtained from the present study is consistent with result of Rahim (2005) in soybean who stated that the highest leaf area was observed in 2.0 mgL^{-1} of GABA. The results are also supported by the result of Islam (2007) in sesame.

Canopy spread: The canopy size had also significant influenced due to the GABA application where it increased in GABA applied plant compared to control plant and the highest canopy size was recorded in 3 mgL^{-1} GABA applied plant (35.0 cm) followed by 2 mgL^{-1} (33.2 cm) with same statistical rank. In contrast, control plant produced the lowest canopy size. The canopy size was greater in GABA applied plant due to production of higher number branches $plant^{-1}$ than control.

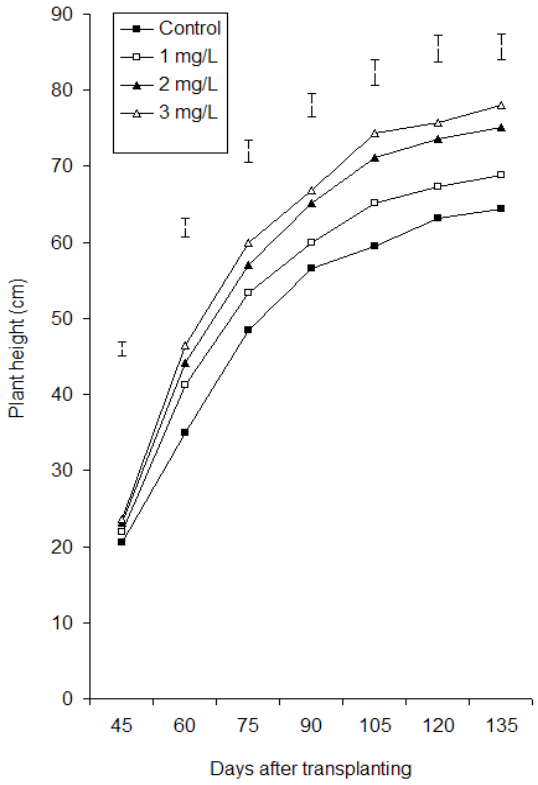

Fig. 1. Effect of GABA application on plant height at different plant growth stages of chilli *cv.* Narikalkhola. Vertical bars represent LSD $_{(0.05)}$.

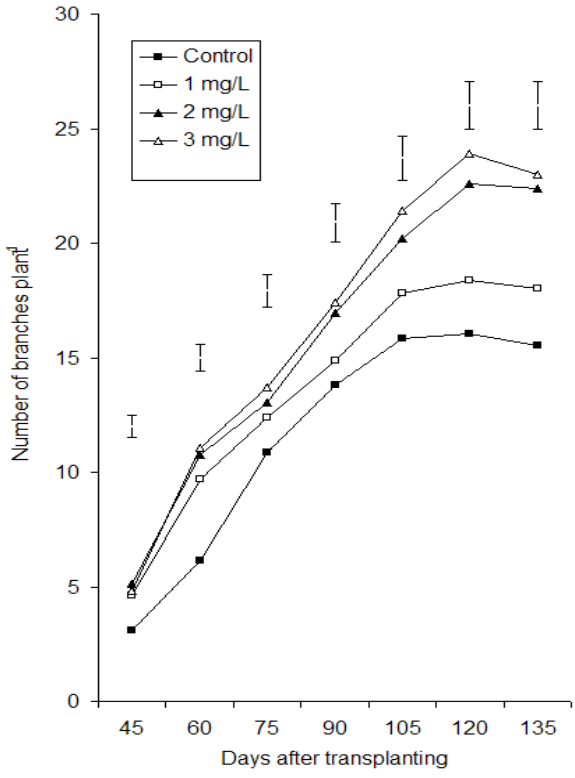

Fig. 2. Effect of GABA application on number of branches $plant^{-1}$ at different plant growth stages of chilli *cv.* Narikalkhola. Vertical bars represent LSD $_{(0.05)}$.

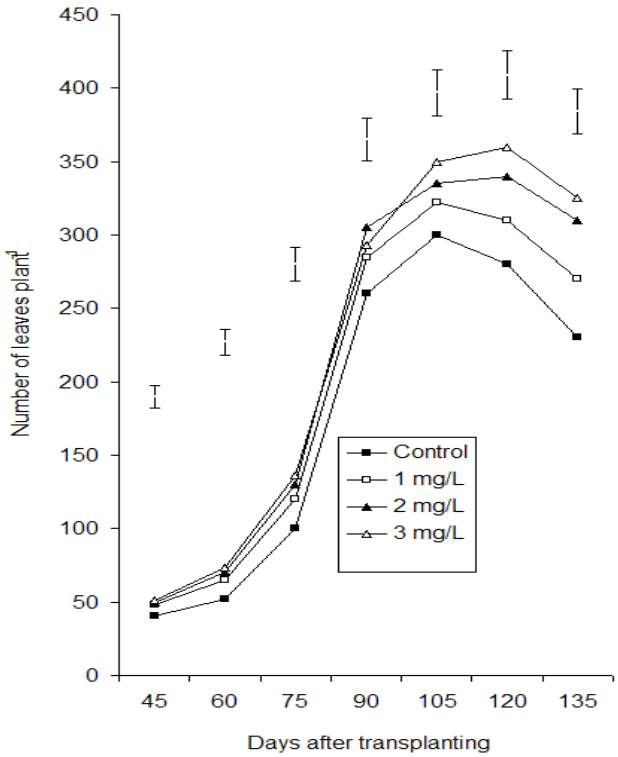

Fig. 3. Effect of GABA application on number of leaves plant^{-1} at different plant growth stages of chilli *cv.* Narikalkhola. Vertical bars represent LSD $_{(0.05)}$.

Table 1. Effect of GABA application on some plant characters in chilli *cv.* Narikalkhola

Treatments	Canopy spread (cm)	Root length (cm)	Root dry weight plant^{-1} (g)	Stem dry weight plant^{-1} (g)	Leaf dry weight plant^{-1} (g)	Total dry mass plant^{-1} (g)	Chlorophyll content in leaves (mg g^{-1}fw)
Control (T_0)	26.4 c	26.4 b	15.4 b	131.2 c	23.3 c	168.9 c	1.82
1 mg/L (T_1)	30.2 bc	27.9 b	18.3 a	155.2 b	28.2 b	201.7 b	1.90
2 mg/L (T_2)	33.2 ab	32.3 a	20.2 a	168.9 a	33.2 a	222.3 a	1.96
3 mg/L (T_3)	35.0 a	32.8 a	21.0 a	171.3 a	35.9 a	227.2 a	1.88
Level of sig.	**	*	*	**	**	*	NS
LSD $_{(0.05)}$	3.78	3.05	2.81	11.82	4.12	24.80	0.23
CV (%)	10.91	6.12	9.21	4.88	8.29	9.71	6.19

In a column, figures having the same letter (s) do not differ significantly at $p \leq 0.05$ by DMRT; Sig. = Significance; NS = Non–significant; *, ** = Significant at 5% and 1% level of probability, respectively.

Root length: The effect of GABA application on root length of chilli was significant. Results revealed that root length was higher in GABA applied plant than control with being the highest in 3.0 mgL^{-1} (32.8 cm) followed by 2.0 mgL^{-1} (32.3 cm) with same statistical rank. On the other hand, control plant produced the shortest roots (15.4 cm). This result is consistent with result of Abdullah (2002) who reported that root length increased in soybean due to GABA application.

Root dry weight: The root dry weight plant^{-1} was significantly influenced by GABA application (Table 1). Results revealed that root dry weight increased with increasing hormone concentration. The highest root dry weight plant^{-1} (21.0 g) was recorded in 3.0 mgL^{-1} GABA application which was statistically similar to 2.0 (20.2 g) and 1.0 mgL^{-1} (18.3 g). The lowest root dry weight was recorded in control plant (15.4 gplant^{-1}). The root dry weight was higher in GABA applied plant might be due to taller roots than control. Islam (2007) reported that root weight increased in GABA applied plants of sesame than control plant which supported the present experimental result.

Stem dry weight: The application of GABA at different concentrations affected the stem dry weight of chilli (Table 1). Results revealed that stem dry weight increased with increasing concentration of GABA due to increased number of branches. The higher stem dry weight was recorded in 2.0 and 3.0 mgL^{-1} with being the highest in 3.0 mgL^{-1} (171.3 gplant^{-1}). In contrast, the lowest stem weight was recorded in control plant (131.2 gplant^{-1}). This result is consistent with Afroz (2005) who reported that straw weight in creased in GABA applied plant than control in rice.

Leaf dry weight: The effect of GABA application at different concentration on leaf dry weight was significant (Table 1). The highest leaf dry weight was observed in 3.0 mgL^{-1} of GABA applied plant (35.90 gplant^{-1}) followed by 2.0 m L^{-1} (33.2 gplant^{-1}) with same statistical rank. Contrarily, control plant produced the lowest leaf dry weight. The leaf dry weight was higher in GABA applied plant due to production of greater number of leaves than control. Rahim (2005) observed that application of GABA on soybean increased leaf area as well as leaf weight.

Total dry mass plant^{-1}: Total dry mass (TDM) production was significantly influenced by the application of different doses of GABA on chilli (Table 1). The doses of 3.0 and 2.0 mgL^{-1} maintained the higher TDM with being the highest in 3.0 mg L^{-1} (227.2 gplant^{-1}). In contrast, control plants produced lower TDM by 1.0 mgL^{-1}. Increased TDM at 3.0 and 2.0 mgL^{-1} doses was possibly due to greater number of leaves which help to produce more assimilate and thereby TDM. The result is supported by the result of Samsuzzaman (2004) who reported that application of GABA (range 0.5-2.0 mgL^{-1}) increased TDM over control in groundnut with being the highest in 2.0 mgL^{-1} hormone application at 45 DAS.

Chlorophyll content in leaves: Results revealed that chlorophyll content in leaves due to GABA application was insignificant (Table 1). But apparently, the chlorophyll content was greater in GABA applied plant than control.

Effect of GABA application on yield attributes and yield in chilli

Number of fruits plant^{-1}: The effect of GABA application on fruits plant^{-1} was statistically significant at $p \leq 0.05$ (Table 2). Result revealed that the number of fruits plant^{-1} increased in GABA treated plants compared to control. The highest fruits plant^{-1} was observed in 3.0 mgL^{-1} GABA application (250 plant^{-1}) which was statistically similar to that of 2.0 mgL^{-1} (239 plant^{-1}) GABA application. The lowest fruits plant^{-1} was recorded in control plant (191 plant^{-1}). The fruits plant^{-1} was greater in GABA applied plants might be due to increased number of branches as well as fruit bearing nodes. Similar result was also reported by Begum (2006) in mungbean and Rahim (2005) in soybean who observed increased pod number due to GABA application.

Fruit length: The effect of different concentration of GABA application had non–significant influence on fruit length in chilli (Table 2). However, result revealed that numerically fruit length increased in GABA applied plants than control and the highest fruit length was recorded in 3.0 mgL^{-1} while the lowest was recorded in control plants. Rahim (2005) reported that pod length increased in GABA applied plant than control in soybean which is opposite result of the present study.

Fruit diameter: The effect GABA application on fruit diameter of chilli was significant (Table 2). Result revealed that fruit diameter increased in GABA applied plant than control. The higher fruit diameter was recorded in 1.0, 2.0 and 3.0 mgL^{-1} with being the highest in 2.0 mgL^{-1} (0.78 cm) and control plants

produced the lowest (0.71 cm). This result is consistent with Islam (2007) reported that fruit diameter increased in GABA applied plant than control in sesame.

Single fruit fresh weight: The effect of GABA application on single fruit fresh weight was statistically non–significant at $p \leq 0.05$ (Table 2). However, apparently the single fruit fresh weight was greater in GABA applied plants than control.

Table 2. Effect of GABA application on yield attributes and yield in chilli *cv.* Narikalkhola

Treatments	Fruits plant^{-1} (no)	Fruit length (cm)	Fruit diameter (cm)	Single fruit fresh weight (g)	Fresh fruit weight plant^{-1} (g)	Fresh fruit yield (t ha^{-1})	Fruit dry matter percentage
Control (T_0)	191 c	5.69	0.71 b	1.05	169 c	10.82 c	22.5
1 mg/L (T_1)	219 bc	5.77	0.76 ab	1.06	207 b	13.29 b	22.3
2 mg/L (T_2)	239 ab	5.83	0.79 a	1.15	245 a	15.60 ab	22.1
3 mg/L (T_3)	250 a	5.85	0.78 a	1.15	263 a	16.30 a	22.1
Level of sig.	**	NS	*	NS	**	**	NS
LSD $_{(0.05)}$	29.70	0.20	0.06	0.13	24.6	2.37	1.26
CV (%)	7.98	2.09	4.40	5.78	7.17	9.86	2.83

In a column, figures having the same letter (s) do not differ significantly at $p \leq 0.05$ by DMRT; Sig. = Significance; NS = Non–significant; *, **= Significant at 5% and 1% level of probability, respectively.

Fruit yield: There was a remarkable difference in respect of fresh fruit yield both per plant and unit area (Table 2). Result showed that fruit yield both per plant and unit area increased due to GABA application compared to control. Results further revealed that fruit yield increased with increasing concentration of GABA. The highest fresh fruit yield (263 gplant^{-1} and 16.30 tha^{-1}) was recorded in 3.0 mg L^{-1} followed by 2.0 mgL^{-1} (245 g plant^{-1} and 15.60 tha^{-1}) with same statistical rank. In contrast, the lowest fruit yield was recorded in control plant (169 gplant^{-1} and 10.82 tha^{-1}). Seed yield increased in 2.0 and 3.0 mgL^{-1} due to increase in fruit number and fruit size. Similar result was reported by Rahim (2005) in soybean. They observed that seed yield increased due to application of GABA and the highest seed yield was found in 2.0 and 1.0 mgL^{-1} GABA application, respectively.

Fruit dry matter percentage: The effect of GABA application at different doses on fruit dry matter percentage was insignificant (Table 2). Moreover, % dry matter in fruit was numerically lower in GABA applied plants than control. The application of GABA has tremendous effects on fruit yield in chilli and application of 2.0 and 3.0 mgL^{-1} is the best dose for increased fruit yield.

Conclusion

From the results obtained from the present findings it was clearly found that the application of GABA had significant influence on most of the plant parameters while GABA 3.0 mgL^{-1} had remarkable superiority for plant growth, yield components and yield of Chilli over the other doses of GABA.

References

Abdullah, M. 2002. Effect of synthetic plant growth regulators on growth, yield and yield contributing characters of soybean. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.

Afroz, I. 2005. Effect of GABA on growth and yield of boro rice cv. BRRI dhan29. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.

BBS. 2007. Hand book of Agricultural Statistics, December, 2007. Bangladesh Bureau of Statistics (BBS), Ministry of Planning, Govt. People's Repub. Bangladesh. p. 66.

Begum, S. 2006. Effect of GABA on growth and yield attributes of mungbean. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.

Dakua, M. F. 2002. Effect of CI–IAA, TNZ–303 and GABA on growth, yield and yield contributing characters of lentil. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.

FAO. 2005. Production Year Book of 2003. No. 62. Published by Food and Agriculture Organization (FAO), Rome, Italy. P. 54.

Islam, M. M. 2007. Effect of GABA on growth, yield and yield contributing characters of sesame. M. S. Thesis. Dept. Crop Bot., Bangladsh Agric. Univ., Mymensingh.

Kamuro, Y., Zheng, J. and Matsui, S. 2001. The protive effect of applying mixture of growth and retarded hormones on flowering in long day plant. *Plant Growth Regulator*,33: 194-199.

Nickell, L. G. 1982. Plant Growth Regulators: Agricultural uses. Springer Verlag, Berlin. p. 122-139.

Pruthi, J. S. 1993. Major spices of India. Crop management and post harvest technology. Publication and information Division. Krishi Anusandhan Bhavan, Pusa, New Delhi. p. 48-53.

Rahim, M. A. 2005. Effect of GABA on flowering pattern, floral abscission and yield attributes in soybean. M. S. Thesis. Dept. Crop Bot., Bangladsh Agric. Univ., Mymensingh.

Rahman, M. M. 2005. Effect of GA_3 on grain maturity and yield performance of BINA dhan-6. M. S. Thesis, Dept. Crop Bot., Bangladesh Agric. Univ., Mymensingh.

Samssuzzaman, M. 2004. Effect of NAA and GABA on growth and yield contributing characters of groundnut. M. S. Thesis. Dept. Crop Bot., Bangladsh Agric. Univ., Mymensingh.