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Foliar application of GABA improve growth and yield of mustard

Abstract

Exogenous applications of the plant hormone may have many uses to modify growth, yield and yield contributing characters of plant. It also consequently facilitates economic yield. The experiment was conducted at Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh from November 2015 to February 2016 to focus on the effect of GABA on growth, yield and yield traits of mustard (*cv.* BINAsarisa-6). The study comprised of four levels of GABA *viz*., 1, 2, 3 and 4mgL^{-1} and fresh water as control. The GABA was sprayed twice on mustard plant at 21 and 31 days after sowing (DAS). Results revealed that application of GABA increased plant height (8.3%), leaf area (22.1%), total dry mass (22.2%) and absolute growth rate (9.43%) over the control. The GABA at the rate of 2 and 3mgL^{-1} showed the higher seed yield (2.06 and 2.08tha^{-1}, respectively) due to increased number of siliqua plant^{-1}, seeds siliqua^{-1} and siliqua size. In contrast, application of 4mgL^{-1} GABA had adverse effect on yield attributes and yield compared to 2 and 3mgL^{-1} indicating an inhibitory effect of GABA at high concentration (i.e. 4mgL^{-1}) on mustard. Therefore, foliar application of GABA at the rate of 2.0mgL^{-1} may be used at early growth stage for getting maximum seed yield of mustard under sub-tropical condition.

Keywords: GABA hormone, growth, yield, mustard, siliqua plant

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Introduction

Mustard (*Brassica* spp.) is one of the most important oil crops of global economic importance.[1] It's oil is used mostly for edible purpose and a partly finds for industrial applications. Oil cake is used as manure and rich animal feed. The major important oilseed crops of the world are soybean, mustard, oil palm, sunflower, peanut and coconut. After soybean, mustard/rapeseed is the second most important edible oil in the world.[2] About 13.2% of the annual edible oil supply contributed from mustard crop.[2] Ten oil crops are grown in Bangladesh. Brassica as oil crop is the most important group that supplies major edible oil in Bangladesh. It covers about 72% of the total oilseed acreage with about 61% production.[3]

Bangladesh is facing acute shortage in edible oil and per capita consumption is the lowest in the world (11ghead^{-1}day^{-1}). It is one fifth of the recommended requirement for a balance diet.[2] Bangladesh required 0.30 million tons of oil equivalent to 0.85 million tons of oil seeds to nourish the existing population. At present, oilseed production is about 0.26 million tons, which covers 30% domestic need.[3] In Bangladesh, seed yield of mustard is about 740kgha^{-1} which is very low as compare to other developed countries (2400kgha^{-1}).[2] Improvements of existing oilseed crops by introduction of a new species with optimize cultural management need urgent attention for fast growing population of Bangladesh. To consider the present population growth and oil seed demand, the new variety of mustard with optimizing yield are needs to replace with local low yielding cultivars. There is a little scope for horizontal expansion of mustard. The attempt is made to increase the per unit production with attention to increase yield per unit area by adopting improved technologies and management. Scopes exists for making breakthrough in yield improvement through changes of hormonal behaviors of variety. Plant growth regulators (PGRs) could be an alternative to increase production.[4] PGRs are being used as an aid to enhance crop yield.[4] Research with GA_3, NAA, IAA and IBA has been carried out on many crops with positive influence on growth, development and yield.[5,6] GABA, a new PGR, has modified growth, yield and yield attributes in mungbean,[6] soybean[7] and sesame.[8] GABA effect on growth, yield attributes and yield of mustard is new with ample scope. Considering facts on other crops, the present research designed to study mustard *cv*. BINAsarisa-6 with different rates of GABA.

Materials and methods

The experiment was conducted at the farm of Bangladesh Agricultural University, Mymensingh (24⁰75´N and 90⁰50´E) and Bangladesh during November 2015-February 2016. Four concentrations of GABA *viz*., 1, 2, 3 and 4mgL^{-1} were applied twice pre flowering (i.e. 21days after sowing, DAS) and post flowering (31DAS). The GABA was sprayed with hand sprayer at 5p.m. The GABA as commercial growth regulator is marketing by BAL Planning Co. Ltd., Ichinomiyo, Japan and is a mixture of more than one growth hormone. Nonetheless, composition of GABA is still unknown for not mentioned its ingredients by the producing company (BAL Planning Co. Ltd., Ichinomiyo, Japan). The popular variety, BINAsarisha-6 was used as test crop. The soil of the experimental area is silty loam. The unit plot size was 2m×2m. Plant to plant and row to row distance were maintained at 6-8cm and 25cm, respectively.

The experiment was laid out in a randomized complete block design with four replicates. The nutrients such as nitrogen, phosphate, potassium, sulphur and boron were applied at the rate of 110, 85, 50, 45 and 1.7kgha^{-1}, respectively. The nitrogen, phosphate, potassium, sulphur and boron were used in the form of urea, triple superphoste(TSP), muriate of potash(MoP), gypsum and borux, respectively. Total amount of TSP, MP, gypsum, borux and half of urea were applied as basal dose during final land preparation. The remaining 50% urea was applied as top dressing at 25DAS at flower initiation stage. The seeds of mustard were hand sown in rows on 10 November, 2015. Seeds were placed at about 3-4cm depth from the soil surface. Plants were thinned to 6-8cm distance from one another at 20DAS. The crop field was weeded once at 20DAS. Irrigations were made at 22 and 55 DAS during flower initiation and fruit development stages. To control aphid, Malathion 57 EC was sprayed @25Lha^{-1} at afternoon by using a sprayer at later flowering and pod development stage. Other intercultural operations e.g. weeding and irrigation were done as and when required for normal plant growth and development.

To study ontogenetic growth characteristics, a total of five harvests were made and at final harvest, data were collected on some morpho-physiological, yield attributes and yield. The first crop sampling was done at 50DAS and continued at an interval of 10days up to 90DAS i.e. till attaining the physiological maturity. From each plot five plants were randomly selected and uprooted for obtaining data of necessary growth parameters. The plants were separated into leaves, stems and roots and the corresponding dry weights were recorded after oven drying at 80±2^{0}C for 72hours. The leaf area of each sample was measured by LI-COR automatic leaf area meter (Model LI-3000, USA). The total dry matter was calculated from summation of leaves, stem, root and siliqua dry weight per plant. The growth analyses like AGR, RGR and LAI were carried out following the formulae of Hunt.[9] At harvest, 10 plants were randomly selected from each plot for collecting morphological and yield contributing characters. Harvest index was calculated by dividing economic yield to biological yield of 10 plants by multiplying with 100 and expressed in percentage. The plot yield was converted in kg ha^{-1}. The collected data were analyzed statistically to obtain the level of significance following the analysis of variance (ANOVA) technique appropriate for the design and mean differences were compared by Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT-C.[10]

Results and discussion

The effect of GABA foliar application at different concentrations on plant height, number branches plant^{-1}, reproductive efficiency (RE), days to maturity and harvest index (HI) of mustard was significant (Table 1). Results revealed that plant height, number branches plant^{-1}, RE, days to maturity and HI of mustard increased with increasing concentration of GABA until 3mgL^{-1}. The higher plant height, number of branches plant^{-1}, RE, days to maturity and HI was recorded in 2 and 3mgL^{-1} GABA application. The shortest plant and lowest number of branches was recorded in control plant. On the other hand, the lowest RE, days to maturity and HI was recorded in 4mgL^{-1} GABA application. Foliar application of GABA at the rate of 4mgL^{-1} hampered plant growth, dry matter partitioning to economic yield and RE indicating 4mgL^{-1} may be toxic concentration for plant growth and development. The GABA treated plants showing increased plant height than in control might be due to increased number of internodes or length of internodes because of increased cell number. Similar result was also reported by Islam MM[8] for sesame crop.

Table 1 Effect of GABA application on morphological, reproductive efficiency and days to maturity in mustard *cv.* BINA sarisa-6

GBABA concentration (mgL^{-1})	Plant height (cm)	Branches plant^{-1} (no)	Reproductive efficiency (%)	Days to maturity	Harvest index (%)
0	91.6 c	4.24 b	74.7 a	21.2 ab	22.5 ab
1	94.7 bc	4.44 ab	70.0 b	21.9 ab	24.3 ab
2	96.3 ab	4.71 ab	76.2 a	22.7 a	25.6 a
3	99.2 a	4.94 a	75.3 a	22.2 a	25.1 a
4	92.3 c	4.33 b	67.7 b	20.4 b	19.9 b
Level of sig.	**	NS	**	*	*
CV (%)	4.65	9.8	7.94	2.22	9.47

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

Seed yield is highly positively correlated with branch number in mustard.[1] In the present experiment, branch number of mustard increased with GABA application which achieved the goal for getting higher yield in mustard by the application of GABA. The higher RE in 2 and 3mgL^{-1} indicating probability of siliqua setting and dry matter partitioning was better in 2 and 3mgL^{-1} than other concentrations. The different concentrations of GABA application had significant effect on leaf area (LA) plant^{-1} and leaf area index (LAI) at all growth stages (Figure 1). Result revealed that LA plant^{-1} and LAI increased till 70DAS followed by sharp decline because of leaf shedding. The highest LA and LAI at all growth stages were recorded in 3.0mgL^{-1} followed by 2.0mgL^{-1} with same statistical rank. Control had the lowest LA and LAI at all growth stages. The variation in LA and LAI might occur due to the variation in number of leaves and their expansion. The higher LAI over the growth period in 3.0mgL^{-1} and 2.0mgL^{-1} treatments could be attributed to higher leaf number as well as leaf area. The result obtained from the present study is consistent with result of Islam MM[8] in sesame who stated that the highest leaf area was observed in 4.0mgL^{-1} of GABA. The results are also supported by the result of Samsuzzaman[6] in groundnut.

Total dry mass (TDM) production was significantly influenced by the foliar application of different concentrations of GABA on mustard (Figure 2). Result revealed that TDM production increased with time until maturity. The doses of 3.0 and 2.0mg L^{-1} maintained the higher TDM over growth period than the other two doses (1.0 and 4.0mgL^{-1}) with being the highest in 3.0mgL^{-1}. In contrast, control plants maintained lower TDM over its growth period followed by 4.0mgL^{-1}.

Increased TDM at 3.0 and 2.0mgL^{-1} doses was possibly due to greater LAI and AGR. The result is supported by the result of Samsuzzaman[6] who reported that application of GABA (range 0.5-2.0mgL^{-1}) increased TDM over control in groundnut. Similar results were also reported by Dakua[5] in lentil and Rahim[7] in soybean. The absolute growth rate (AGR) derived from four doses of GABA application was determined from flowering, fruiting stage (50DAS) to physiological maturity (90DAS) and the results have been presented in Figure 2. Results revealed that AGR in all treatments was significantly different at all growth stages. The increment of AGR was observed till 70DAS in 1, 2 and 3mgL^{-1} GABA treated plants and thereafter decreased with progress in maturity. On the other hand, the control plants and 4.0mgL^{-1} GABA treated plants showed decreased AGR value after 60DAS. The plants of 3.0mgL^{-1} GABA application maintained the highest AGR value throughout the growth period. In contrast, the control plants and plants of 4.0mgL^{-1} GABA maintained the lowest AGR over its growth period. Further, the maximum AGR was observed during fruit development and grain filling stage in all the treatments. AGR is positively correlated with LAI.[11] The AGR increased along with increase in LAI. At 60-70DAS, the AGR value was found to be maximum which mean that plants expanded it's assimilate for the growth of leaf area and feeding of fruits. The declining of AGR after reaching the maximum in all treated plants was the result of abscission of leaves.[12] The effect of GABA application on siliqua number plant^{-1}, siliqua size (single siliqua weight), number of seeds siliqua^{-1} and seed yield both per plant and per hectare was statistically significant except siliqua length and 1000-seed weight (Table 2). Result revealed that the number of siliqua plant^{-1} siliqua size (single siliqua weight), number of seeds siliqua^{-1} and seed yield both per plant and per hectare increased in GABA treated plants @1, 2 and 3mgL^{-1} compared to control. The higher number of siliqua plant^{-1}, siliqua size (single siliqua weight), number of seeds siliqua^{-1} and seed yield both per plant and per hectare was observed in 2 and 3.0mgL^{-1} GABA application. Seed yield increased in 2.0 and 3.0mgL^{-1} due to increase in siliqua number and siliqua size. On the other hand, seed yield decreased in 4.0mgL^{-1} over control which might be due to toxic effect for growth and development of plant by this concentration. Similar result was also reported by Rahim[7] who observed increased pod number due to GABA application on soybean. From the results, it may be concluded that application of GABA has tremendous effects on seed yield in mustard and application of 2.0mgL^{-1} is the economically best dose for increase seed yield.

Table 2 Effect of GABA application on days to maturity, yield attributes and yield in mustard cv. BINA sarisa-6

GABA concentration (mgL^{-1})	Siliqua plant^{-1} (no.)	Siliqua length (cm)	Single siliqua weight (mg)	Seeds siliqua^{-1} (no.)	1000-seed weight (g)	Seed weight plant^{-1} (g)	Seed yield (t ha^{-1})
0	55.9 c	5.16	92.1 bc	21.2 ab	2.61	3.08 c	1.64 bc
1	63.3 b	5.26	93.6 b	21.9 ab	2.65	3.37 b	1.74 b
2	70.3 a	5.26	96.6 ab	22.7 a	2.7	4.12 a	2.06 a
3	72.2 a	5.24	99.3 a	22.2 a	2.68	4.15 a	2.08 a
4	49.4 d	5.12	90.7 c	20.4 b	2.58	2.73 d	1.42 c
Level of sig.	**	NS	**	*	NS	**	**
CV (%)	5.95	2.8	4.94	6.22	4.15	6.61	5.86

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

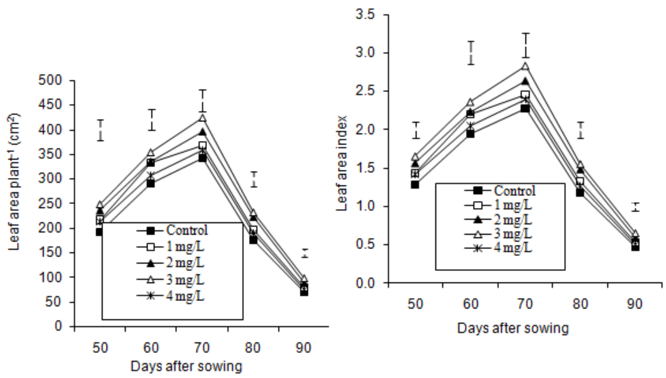

Figure 1 Effect of GABA application on leaf area plant^{-1} and leaf area index different growth stages of mustard cv. BINAsarisa-6, Vertical bars represent LSD (0.05).

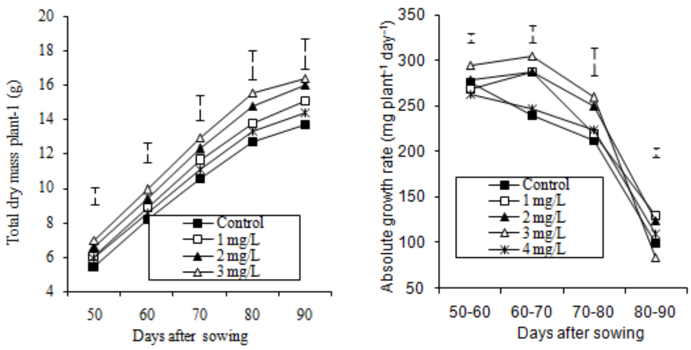

Figure 2 Variation in total dry mass production plant^{-1} and absolute growth rate with GABA application rates at different growth stages of mustard cv, BINAsarisa-6, Vertical bars represent LSD (0.05) of the mean.

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None.

Conflict of interest

Authors declare that there is no conflict of interest.

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