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Seed germination and seedling growth of brinjal, tomato and chilli treated with GA_3 and GABA

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Abstract

An experiment was conducted in the laboratory of Crop Botany Department of Bangladesh Agricultural University, Mymensingh, during the period from May 2003 to March 2004 to investigate the effect of GA_3 and GABA on seed germination and seedling growth of brinjal, tomato and chilli. The concentrations of GABA were 0.16 mlL^{-1}, 0.33 mlL^{-1}, 0.66 mlL^{-1} and of GA_3 were 25 mgL^{-1}, 50 mgL^{-1}, 100 mgL^{-1} and of water respectively along with a control where only water was used to treat seeds by soaking for 12 hours in prior to sowing on saturated tissue paper in petri-dishes. The experiment was laid out following RCBD design where each treatment replicated five times. Germination percentage of all the seeds treated with PGRs of above-mentioned concentrations was significantly higher over control. Seed germination was enhanced significantly in brinjal and tomato at 100 mgL^{-1} of GA_3. Seedling growth (shoot length and root length) increased at 25, 100 mgL^{-1} of GA_3 and 0.33 mlL^{-1} of GABA.

Keywords: GABA, Growth regulator, Seed germination, Seedling growth, Germination percentage

Introduction

Germination of seeds in field is a key factor for crop growth and yield. Low germination percentage, slow rate and lacking in seedling growth are common problem in most horticultural crops. Like others field crops brinjal (*Solanum melongena*), tomato (*Lycopersicon esculentum*) and chilli (*Capsicum frutescens*) also suffer differently due to lack of germination of seeds and/or delay in germination which affects growth and development of crop plants. The germination percentages of brinjal, tomato and chilli are 70, 70 and 60% respectively under the environment of Bangladesh (Agarwal, 1995), which was very low than other developed countries. In Bangladesh, it is highly demanding to commercial growers to adopt suitable sustainable measure for higher germination and crop growth. Good seedling establishment under some stress conditions may ensure good crop growth as well as better yield (Nayak and Patra, 2000). It has been reported that due to the lack of quality seedlings, yield of crops production decreased by about 15% in Bangladesh (FAO, 2000).

Many physical, chemical or biological efforts have long been adopted for enhancing percent germination in different crop plants. There are many reports on seed germination and seedling growth of rice, sesame, bajra enhanced with different concentrations of GA_3 and Brassinosteroids (Mohanty and Sahoo, 1992). Similarly GABA, a mixture of 1% GA_3 and 0.5% STC has enhanced germination and growth of some rice cultivars (Sekh, 2002), soybean (Abdullah, 2002) and lentil (Dakua, 2002). Application of suitable plant growth regulators is more convenient as well as economic as it needs a very small in quantity. Application of PGR do not require any special technique or expensive procedure. In Bangladesh, effects of GABA on germination and growth of brinjal, tomato and chili (day neutral plants) are not reported. Hence the present research was planned to investigate the effect of GABA and GA_3 on seed germination of those crops and to observe the effective comparison between these two PGRs.

Materials and Methods

Plant materials design and methodology

Disease free, clean and fresh seeds of brinjal, tomato and chilli were collected form BADC office of Mymensingh and used in the present study. Seeds were treated for 12 hours by soaking in aqueous solution of GABA at 0.16, 0.33 and 0.66 mlL^{-1} and Gibberellic acid (GA_3) at 25, 50 and 100 mgL^{-1} along with a control where only water was used and than uniformly sown on 4 ply of tissue paper in plastic petri dishes of 20 cm in diameter. For each species, two hundred seeds were sown on germinating papers keeping moist always by supplying tap water manually. The experiment was laid out in single factorial Randomized Complete Block Design (RCBD) where each treatment was replicated five times. The average monthly temperatures of day and night were 30°C and 27°C respectively.

Data collection on seed germination, seedling growth and analysis

The germination was considered the emergence of radicle. Data on the emergence were taken everyday with 24 hours interval starting from sowing and continued up to completion of germination. Percentage of germination was calculated. For sampling, ten seedlings were selected randomly aside from each petri dishes from 3 days after sowing (DAS) and continued up to 15 days old with an interval of 3 days. The shoot length (cm), root length (cm), and fresh weight of seedlings (gm) were recorded immediately after uprooting the seedlings.

Analysis of variance was calculated using the computer software programme MSTAT-C (Russell, 1986) and the statistical analysis was done following single factorial Randomized Complete Block Design. Co-efficient of variation in treatment was calculated to measure the precision of the experiment and the treatment means were compared by Duncan's Multiple range test (Gomez and Gomez, 1984).

Results and Discussion

Effect on seed germination

Germination percentage of brinjal, tomato and chilli seeds were affected differently by GA_3 and GABA. In brinjal, GA_3 enhanced germination percentage over GABA and control. At 100 mgL^{-1}, GA_3 gave the highest percentage of seed germination of 15%, 28%, 63% and 95% after 24, 48, 72 and 96 hours of sowing, respectively (Fig. 1a). Lower concentration of GA_3 also enhanced seed germination, which was significantly higher than that of different concentrations of GABA. Among the different concentration of GABA, the medium concentration (0.33 mlL^{-1}) gave better performance than that of lower (0.16 mlL^{-1}) and higher concentration (0.66 mlL^{-1}). The seed germination percentage in control was 68.25% after 96 hours of sowing, which was the lowest one. Thus, the highest germination percentage was obtained in birnjal by treating with 100 mgL^{-1} of GA_3. Rate of germination up to 48 hours after sowing was slow, then became distinct and steady over after 96 hrs (Fig. 2).

Seed germination of tomato, a day neutral crop was completed within 72 hours after sowing. After 24 hrs, 19% and 39% seeds were germinated in control and with 100 mgL^{-1} of GA_3, respectively. Second highest seed germination was obtained at lower concentration of GA_3 (25 and 50 mgL^{-1}). GABA also stimulated seed germination significantly over control, but percentage values were lower than that of GA_3 (Fig. 1b). Among the concentrations, 0.66 mlL^{-1} of GABA gave better performance than other concentrations. Similar trend in seed germination was observed after 72 hours of sowing. Rate of germination from starting was highly steady in tomato (Fig. 2) compared to other crop seeds in the present study.

For chilli, GA_3 also showed better performance than GABA in seed germination. The data presented in Fig. 1c revealed that the highest percentage of seed germination was 25.3% with 25 mgL^{-1} of GA_3 after 48 hours of sowing where only 10.3 % seeds were germinated in control. Among the concentrations of GABA, 0.33 mlL^{-1} increased seed germination compared to that of lower and higher concentrations. Similar trend in seed germination was found in subsequent period, which ended after 120 hours. The percentage of seed germination was 66.3% and 89.5% in control and GA_3 at 25 mgL^{-1} respectively after 120 hours of sowing. All PGRs of present study were enhanced seed germination significantly over control after 120 hours.

Germination of brinjal seeds (a day neutral plant) was started from 24 hours and ended at 96 hours after sowing. At beginning, rate of germination was medium compared to tomato and chilli. Tomato was steady, but chilli was slow (Fig. 2). This two day neutral plants, tomato and chilli behaved different to that of brinjal. Moreover, GA_3 found more suitable than GABA in enhancing seed germination. However, brinjal and tomato preferred comparatively higher concentration of GA_3 and chilli chose the lower concentration. The present result agreed to the earlier research in rice (Sekh, 2002) and tomato (Castor *et al.*, 1987).

Effect on shoot length of brinjal, tomato and chilli

Results showed that PGRs had stimulatory effect on shoot length of brinjal all along the growth period. At 9 DAS, there was no statistical difference among GA_3, GABA and control (Table 1). The highest shoot length (2.67cm and 3.53cm) was observed at the concentration of 100 mgL^{-1} of GA_3 at 12 and 15 DAS respectively. The shoot length was gradually increased with proceeding of time after sowing. Up to 15 DAS, the shoot length was similarly increased by different concentrations of GA_3 and GABA and the values were significantly higher over control.

In tomato, the data on shoot length showed that the GA_3 at 100 mg L^{-1} produced the highest shoot length and these were 4.00 cm, 5.08 cm, 5.75 cm and 6.99 cm at 6, 9, 12 and 15 DAS respectively (Table 2). The minimum shoot length (6.29 cm) was recorded in control condition at 15 DAS. Both GA_3 and GABA similarly enhanced shoot growth, which was significantly higher over control.

For chilli, the effect of PGRs on shoot length was found statistically significant at different days after sowing. The lower concentration (25 mgL^{-1}) of GA_3 produced the maximum shoot length at 6 DAS followed by 100 mgL^{-1} of same PGR (Table 3). Different concentrations of GABA similarly supported the shoot length. The minimum shoot length (2.91 cm) was recorded in control condition. However, all treated seeds produced higher shoot length compared to that in control.

Effect on root length

Root length of brinjal significantly varied from control due to application of GA_3 and GABA. At 6, 9, 12 and 15 DAS, root lengths were higher with GA_3 at 100 mgL^{-1} followed by lower concentration of same PGR. GABA also increased the root length over control (Table 1). Among the concentrations of GABA 0.66 mlL^{-1} gave the highest root length. However, the lowest root length was obtained in control condition.

In tomato, GA_3 at 100 mgL^{-1} enhanced root length significantly higher over other treatments. After 12 DAS, the highest root length was 12.72 cm at 100 mgL^{-1} of GA_3 followed by 12.45 cm produced by GABA at 0.33 mlL^{-1} (Table 2). In control, the lowest length of roots was observed.

In chilli, root length stimulated distinctly with GA_3 (Table 3). After 12 DAS, GA_3 at 25 mgL^{-1} was the best in enhancing length of roots. However, after 15 DAS, all concentrations of PGRs found similar in increasing root length over control. In early stage, variation in root length might affect the establishment of seedling after germination. The results obtained in the present experiment support the findings of Bhore *et al.* (1999) in tomato. They reported that 100 ppm of GA_3 promoted root elongation.

Effect on fresh weight per plant

In brinjal, the data revealed that there was no significant difference in fresh weight of plants treated with GA_3 and GABA compared to that in control at 6, 9, and 12 DAS (Table 1). However, after 15 DAS, 100 mgL^{-1} of GA_3 enhanced fresh weight significantly over other treatments followed by GABA at 0.66 mlL^{-1}. The lowest fresh weight was obtained in control. Similar fresh weight was revealed in tomato. The fresh weight at 6, 9, 12 and 15 DAS with GA_3 at 100 mgL^{-1} was significantly higher over that in GABA and control (Table 2).

In chilli, fresh weight was the highest with GA_3 at 25 mgL^{-1}. The data revealed that the fresh weight of seedling at 6 and 9 DAS was not affected due to application of GA_3 and GABA compared to that in control (Table 3). However, after 15 DAS, effect of GA_3 at lower concentration (25 mgL^{-1}) was significantly higher over other treatments of GA_3, GABA and control.

In the process of germination, imbibition of water is the first step. The second step is the activation of enzyme, which stimulates cell division and ultimately step up the embryo activity. Exogenous application may enhance activity of endogenous PGRs. In present study, all treatments of PGRs observed, enhanced germination and growth in post germination stage. PGRs might enhance imbibition because radicle or plumule emergence were enhanced in the present study. Although, imbibition was a physical process, its rate was truly a physiological process. Further study in these regard may clarify the fact (s) which was not clear from the present research. To study imbibition process, osmotic gradients should be prepared to detect osmotic potential and to classify imbibitions processes.

After germination, almost in seeds, there is a plateau, which might responsible for indifferentiation among fresh weight at 15 DAS in the present study. During the plateau period after germination, the seeds develop the metabolic systems necessary for growth and enzymatic components of these systems.

Table 1. Effect of GA_3 and GABA on seedling growth of Brinjal

Treatments PGRs mgL^{-1}	Shoot length (cm) at days after sowing of				Root length (cm) at days after sowing of				Fresh weight (g) at days after sowing of			
	6	9	12	15	6	9	12	15	6	9	12	15
0.0 (Cont.)	0.62b	1.76	2.15c	2.70b	1.17e	1.98e	3.18f	4.33d	0.007	0.016	0.019	0.022c
GA_3 25 mgL^{-1}	1.06a	1.94	2.57ab	3.45a	1.36a	2.13ab	4.27b	5.26a	0.008	0.017	0.020	0.083b
GA_3 50 mgL^{-1}	1.06a	2.07	2.51b	3.42a	1.33ab	2.68cd	4.38ab	4.76c	0.009	0.018	0.021	0.083b
GA_3 100 mgL^{-1}	1.12a	2.11	2.67a	3.53a	1.27c	3.27a	4.47a	5.35a	0.008	0.017	0.020	0.089a
GABA 0.16 mlL^{-1}	1.05a	2.08	2.63ab	3.33a	1.22d	2.51d	4.03c	4.90bc	0.008	0.017	0.020	0.083b
GABA 0.33 mlL^{-1}	1.08a	2.08	2.59ab	3.48a	1.28c	3.02b	3.57e	5.01b	0.008	0.018	0.021	0.081b
GABA 0.66 mlL^{-1}	1.08a	2.10	2.50b	3.36a	1.30bc	2.81c	3.78d	5.12ab	0.008	0.017	0.020	0.085ab

Table 2. Effect of GA_3 and GABA on seedling growth of Tomato

Treatments PGRs conc.	Shoot length (cm) at days after sowing of				Root length (cm) at days after sowing of				Fresh weight (g) at days after sowing of			
	6	9	12	15	6	9	12	15	6	9	12	15
0.0 (Cont.)	3.31c	3.83d	4.75c	6.29b	7.08d	8.36d	11.21d	13.37d	0.032c	0.046c	0.051c	0.061c
GA_3 25 mgL^{-1}	3.67ab	4.64c	5.33b	6.86a	8.61ab	10.31c	12.22bc	14.88ab	0.090b	0.114b	0.152b	0.155b
GA_3 50 mgL^{-1}	3.59bc	4.89abc	5.52ab	6.88a	6.08c	11.05b	11.83c	13.84c	0.099a	0.115b	0.153ab	0.154b
GA_3 100 mgL^{-1}	4.00a	5.08a	5.75a	6.99a	8.33abc	12.17a	12.72a	15.31a	0.101a	0.122a	0.154a	0.205a
GABA 0.16 mlL^{-1}	3.85ab	4.99ab	5.68ab	6.95a	8.77a	10.95b	11.86c	14.68b	0.091b	0.133b	0.152b	0.155b
GABA 0.33 mlL^{-1}	3.62bc	4.83abc	5.50ab	6.87a	8.50abc	10.39c	12.45ab	14.39b	0.100a	0.133b	0.152b	0.155b
GABA 0.66 mlL^{-1}	3.75ab	4.68bc	5.60ab	6.90a	8.23bc	10.67bc	11.99bc	14.45b	0.090b	0.109b	0.152b	0.153b

In a column, figures with common letter(s) do not differ significantly at 5% level of significance by DMRT

Table 3. Effect of GA_3 and GABA on seedling growth of Chilli

Treatments PGRs conc.	Shoot length (cm) at days after sowing of				Root length (cm) at days after sowing of				Fresh weight (g) at days after sowing of			
	6	9	12	15	6	9	12	15	6	9	12	15
0.0 (Cont.)	0.98e	1.69d	2.48d	2.91c	1.73c	2.57c	3.49e	4.23b	0.017	0.026	0.036c	0.043c
GA_3 25 mgL^{-1}	2.56a	3.87a	4.45a	5.07a	2.15a	3.48a	4.67a	5.26a	0.019	0.032	0.105a	0.211a
GA_3 50 mgL^{-1}	1.29c	2.63b	2.74c	3.82b	2.08a	3.18b	4.30cd	5.24a	0.018	0.029	0.097b	0.152b
GA_3 100 mgL^{-1}	1.51b	2.58b	2.89b	3.69b	1.93b	3.02b	4.60ab	5.07a	0.018	0.028	0.097b	0.150b
GABA 0.16 mlL^{-1}	1.18d	2.29c	2.75c	3.54b	1.92b	2.96b	4.40bc	5.23a	0.018	0.028	0.097b	0.147b
GABA 0.33 mlL^{-1}	1.15d	2.27c	2.81bc	3.50b	1.77c	2.62c	4.61ab	5.13a	0.019	0.027	0.096b	0.149b
GABA 0.66 mlL^{-1}	1.10d	2.33c	2.76c	3.51b	1.90b	2.12b	4.11d	4.93a	0.018	0.028	0.096b	0.149b

In a column, figures with common letter(s) do not differ significantly at 5% level of significance by DMRT

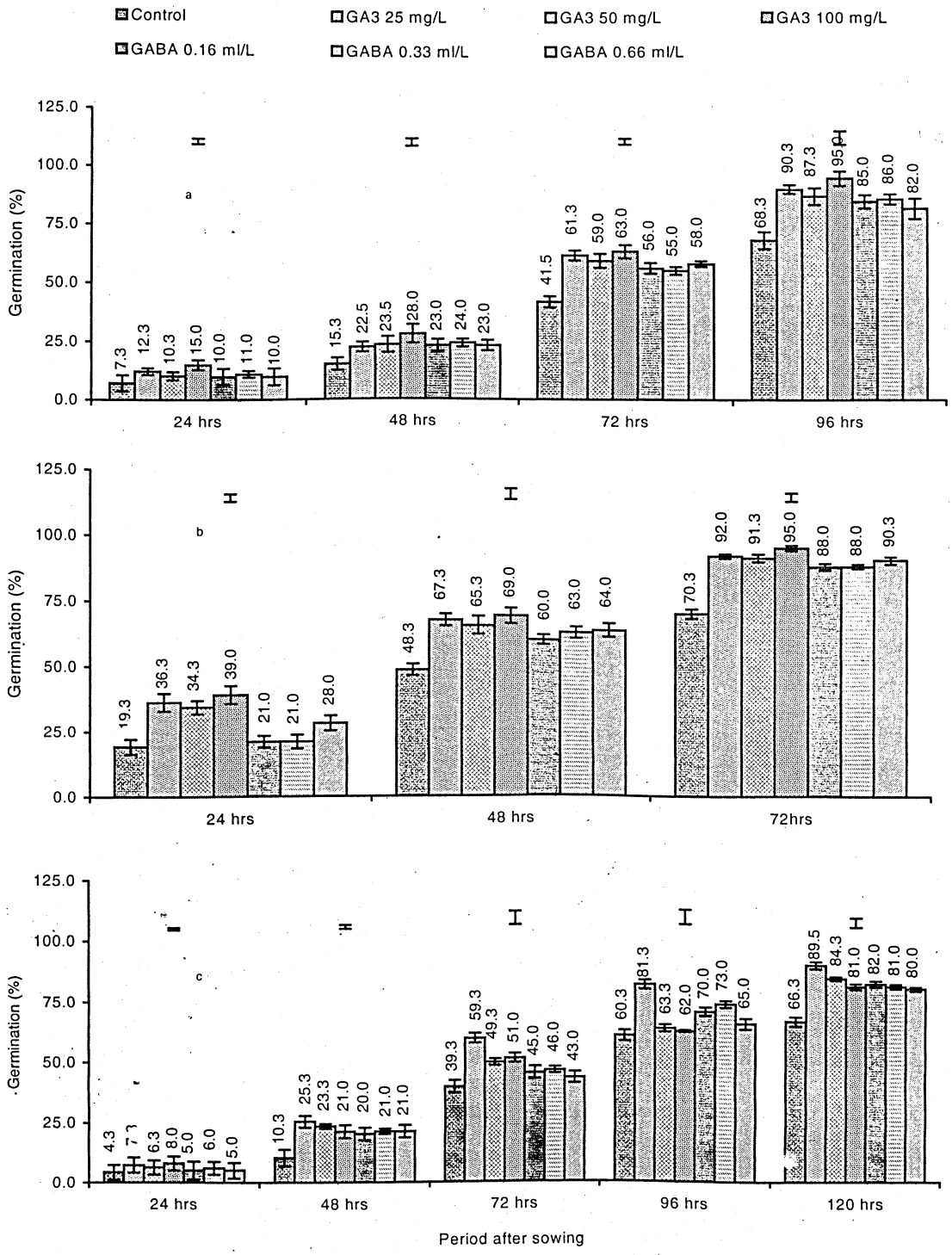

Fig. 1. Showing effect of GA3 and GABA on seed germination of a) Brinjal b) Tamato and c) Chilli. Isolated narrow bars showing LSD values at 5% level of significance. Narrow bars at the top of wide bars indicate standard values

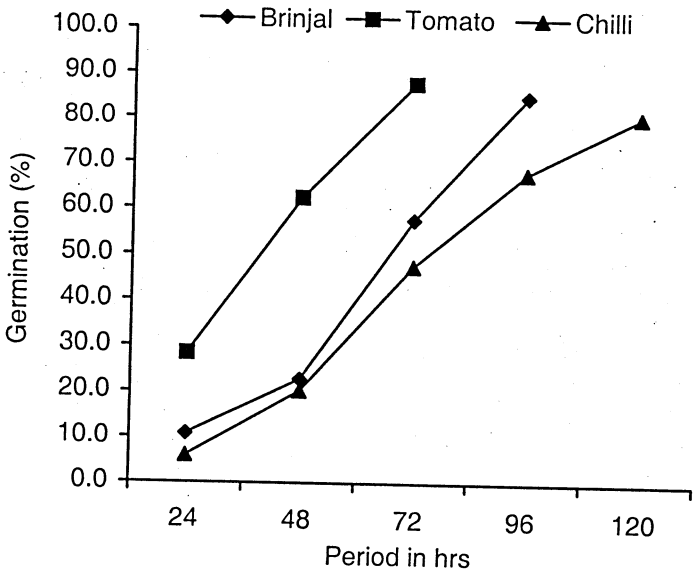

Fig. 2. Showing the rate of seed germination

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