INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–1–63–65
http://www.fspublishers.org

Effects of Gibberellic Acid (GA_3) on Breaking Dormancy in Garlic (*Allium sativum* L.)

MUHAMMAD HAFIZUR RAHMAN, MUHAMMAD SHAHIDUL HAQUE[1], MOHAMMAD A. KARIM AND MASUM AHMED
Department of Crop Botany and Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
[1]Corresponding author's e-mail: haquems@yahoo.com

ABSTRACT

An experiment was carried out with Gibberellic Acid (GA_3) to evaluate its effects on the sprouting and early growth behavior of a local and an exotic cultivar of garlic. The aim of the experiment was to investigate possible ways to overcome the problem of dormancy in garlic. The local cultivar exhibited marked influence of GA_3 on sprouting of cloves, number of leaves /plantlet, plantlet height, number of roots /plantlet, root length and percentage of normal plantlets. The 250 ppm concentration of GA_3 gave the maximum sprouting (31.67%) whereas the 500 ppm concentration produced the minimum sprouting (10.00%). The exotic cultivar completely failed to sprout. The results revealed that application of GA_3 has the potentiality to break dormancy and accelerates the sprouting in the local cultivar of garlic.

Key Words: *Allium sativum* L.; Dormancy; GA_3; Garlic; Sprouting

INTRODUCTION

Garlic (*Allium sativum* L.) is the second most widely used cultivated *Allium* after onion (Bose & Som, 1990). It is widely used as a spice throughout the world. Garlic has been considered as a rich source of carbohydrate, protein and phosphorus (Kurian, 1995). It has a higher nutritive value than other bulb crops. Garlic has a hypocholesterolamic action and reduces the cholesterol concentration in human blood (Augusti, 1997). Its preparations are administered as a care against some long and lingering stomach diseases and sore eye and ear ache.

Ledesma *et al.* (1980) reported that cloves of garlic did not grow immediately after harvesting due to dormancy that gradually diminished during storage. *In vitro* produced garlic bulblets were also dormant (Moriconi *et al*., 1990; Nagakubo *et al*., 1993). They did not sprout immediately on *ex vitro* transplantation and little is known about their dormancy (Kim *et al*., 2003). Despite its beneficial effects on storing and human consumption of cloves, garlic dormancy creates problems in physiological and biotechnological experiments. Dormancy is controlled by a balance between growth inhibitors, such as Abscisic Acid (ABA) and growth regulators, especially Gibberellic Acid (GA_3) (Wareing & Saunders, 1971). Thomas (1969) found that in onion (*Allium cepa*) both growth inhibitors and gibberellin activities decreased before sprouting, but that there was an increase in gibberellin and auxin activities as soon as sprouting had begun. Aung and Peterson (1974) found higher gibberellin activity in non-dormant onion bulbs in comparison to dormant ones.

Plant growth regulators have been known to play a vital role in sprouting of garlic (Moon & lee, 1980; Rahim & Fordhan, 1988). Treatment of seed bulbs (cloves) in GA_3 solution stimulate to sprouting and bulbing as well as its development (Moon & Lee, 1980). However, there is no information regarding the effects of GA_3 on breaking dormancy and sprouting of garlic in Bangladesh. The present study was carried out to investigate the role of GA3 in breaking dormancy and on sprouting behavior of garlic.

MATERIALS AMD METHODS

The experiment was conducted at Bangladesh Agricultural University, Mymensingh. A local cultivar and an exotic cultivar of garlic (*Allium sativum* L.) were collected. The cloves were graded into large (6.285 g & 1.665 g for exotic & local, respectively), medium (3.01 g & 0.817 g for exotic & local, respectively) and small (2.033 g & 0.546 g for exotic & local, respectively) cloves. There were three concentrations of GA_3 viz. 125, 250, 500 ppm tested with a control (distilled water treatment). Ethanol was used to dissolve the GA_3. GA_3 was used for soaking cloves for 24 h before planting. The cloves were planted with a spacing of 3 cm x 4 cm accommodating 15 cloves of medium and small and 4 cm x 4.5 cm accommodating 10 cloves of large size per pot. There were 72 pots used for three concentrations and control with three replications. The pots were filled with the soil previously collected and prepared by mixing cowdung (500 g/pot) and fertilizers (5 g urea & 3 g triple superphosphate per pot). The cloves were dibbled at 2 cm depth for large and medium size and 1 cm depth for small size in soil. The plantlets were kept under careful observation. Several irrigation were made at 3/5 days interval. Data were recorded on number of plantlets, plantlet height, number of leaves per plantlet, number of root per plantlet and root length after 15, 20 and 25 days from starting. The three factorial experiment was laid out in

Completely Randomized Design (CRD) with three replications. The analysis of variances, were performed following Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Sprouting. Different concentrations of GA_3 had a significant influence on the percentages of sprouting of garlic (Table I). At different days after planting (DAP), it was observed that the percentages of sprouting, was higher in 250 ppm than 125 ppm or 500 ppm of GA_3 in case of medium and small sized cloves. However, the large cloves had highest percentage of sprouting in 125 ppm GA_3. In case of exotic cultivar, there was no sprouting of the cloves in any size group and in any treatment. Among the sizes of cloves, the maximum sprouting (31.67%) was observed in medium cloves treated with 250 ppm GA_3. There was no sprouting of the un-treated cloves of all size groups except for the medium sized cloves where only 3.33% cloves sprouted. The medium sized cloves had maximum sprouting within 15 DAP. The higher sprouting rate of the medium over small and large cloves was maintained until the 25 DAP. The results of the present study indicate that there was dormancy in the cloves of garlic and GA_3 was partially successful in breaking it and promoting their sprouting. Bhargava (1997) reported that maximum sprouting of garlic was obtained after GA_3 treatment. Soaking of garlic cloves showed that the optimum treatment for breaking dormancy was 50 ppm GA_3 (Gua *et al.,* 2000). The present findings support the above reports.

Plantlet height. Plantlet height or the stem length as recorded from 15 DAP to 25 DAP was not significantly different among different concentrations of GA_3 and size of cloves (Table II). However, the plantlets from large and medium sized cloves were taller at 15 DAP. The tallest plantlet was observed in small clove at 250 ppm of GA_3 after 25 days, while the shortest plantlet was recorded in large cloves at 125 ppm of GA_3 after 25 DAP. The plantlets from large and medium clove, was shorter but healthier than those of small cloves. In general, larger clove is known to give taller plant. However, the plants from large and medium cloves were comparatively shorter than the plants from small cloves in this study. Probably the plants of the large and medium size group would become taller at the later growth stage.

Leaf number. The number of leaves per plant was significantly different among the treatments at different days after planting (Table III). After 15 days it was found that 125 ppm and 250 ppm of GA_3 produced maximum number of leaves compared to the other treatment. However, after 25 days, 250 ppm was found to have maximum number of leaves per plant. Among the three weight groups of cloves, small cloves produced maximum number of leaves per plant. Masud (1995) reported that GA_3 enhanced rapid leaf proliferation by secondary branching and considering different concentrations the highest number of leaves per plant was obtained from 100 and 200 ppm GA_3 treated cloves. A significant variation was found in number of leaves due to the effect of GA_3 at different stages of plant growth. The maximum number of leaves per plant was achieved by 50 ppm of GA_3 applied to seeds (Haque, 2001). Production of higher number of leaves at the very early stage of growth in the present study agrees with above reports.

Root number. The number of roots per plantlet varied significantly among the treatments in different clove sizes. All the treatments of GA_3 had better root formation (Table IV). As the non-treated cloves did not sprout, they did not have any root formation. GA_3 treatment of garlic cloves showed a significant influence on the number of roots and the highest number of roots per plant was produced by 50 ppm GA_3 and it gradually decreased with increase in concentration (Masud, 1995). We found relatively higher concentration of GA_3 most efficient in producing roots at the early stage of growth. Root number was highest in 250 ppm and decreased with further increase of GA_3 in large and small cloves in this study. This difference in the optimum concentration might be due to the varietal difference.

Table I. Sprouting of garlic cloves at different dates after planting as influenced by pre-planting GA_3 treatment

Clove size	Concentration (ppm)	Sprouting percent		
		15 DAP	20 DAP	25 DAP
Large	0	0.00 h	0.00 h	0.00 h
	125	20.00 a	23.33 ab	26.67ab
	250	13.33 bcd	18.44 b	20.00 b
	500	13.33 bcd	16.67 bc	21.67 b
Medium	0	3.33 ef	3.33 e	3.33 de
	125	16.67 ab	23.39 ab	28.33 ab
	250	16.67 ab	26.78 a	31.67 a
	500	6.67 de	11.67 c	11.67 cd
Small	0	0.00 h	0.00 h	0.00 h
	125	11.11 bcd	16.66 bc	18.89 bc
	250	14.44 bc	17.89 bc	20.00 b
	500	1.10 g	5.54 de	10.00 c
LSD(0.05)		0.01	0.05	0.05

Table II. Effect of GA_3 on pseudo-stem elongation of garlic plantlets

Clove size	Concentration (ppm)	Pseudo-stem length (cm)		
		15 DAP	20 DAP	25 DAP
Large	0	0.00	0.00	0.00
	125	3.00	5.00	5.27
	250	1.83	3.50	4.17
	500	0.83	2.83	4.00
Medium	0	0.33	3.00	3.50
	125	1.33	2.83	5.00
	250	3.50	4.83	5.83
	500	1.83	2.00	4.00
Small	0	0.00	0.00	0.00
	125	1.58	3.50	4.67
	250	2.50	5.17	7.17
	500	1.00	2.67	3.67
LSD(0.05)		NS	NS	NS

Values with different letters within a column differ significantly at 5% level of significance; DAP = Days After Planting; NS = Non-significant

Table III. Generation of leaves in garlic plantlets due to pre-planting GA_3 treatment

Clove size	Concentration (ppm)	Number of leaves Plantlet^{-1} 15 DAP	20 DAP	25 DAP
Large	0	0.00 d	0.00 f	0.00 d
	125	1.33 a	2.00 bc	3.33 ab
	250	1.00 ab	1.83 bc	3.50 ab
	500	1.00 ab	2.00 bc	3.00 b
Medium	0	1.00 ab	1.00 e	1.83 c
	125	1.33 a	2.00 bc	2.67 b
	250	1.67 a	2.17 b	2.83 b
	500	0.67 bc	2.17 b	3.00 ab
Small	0	0.00 d	0.00 f	0.00 d
	125	1.17 a	1.67 cd	3.00 b
	250	1.17 a	2.67 a	3.83 a
	500	0.33 cd	1.33 de	1.83 c
LSD(0.05)		0.05	0.05	0.05

Table IV. Influence of GA_3 on formation and elongation of roots in garlic

Clove size	Concentration (ppm)	Root characters Number	Length (cm)
Large	0	0.00 d	0.00
	125	6.50 a	5.00
	250	6.67 a	4.83
	500	4.17 c	3.50
Medium	0	0.00 d	0.00
	125	4.50 b	5.83
	250	5.00 b	4.33
	500	5.50 b	3.50
Small	0	0.00 d	0.00
	125	4.00 c	5.00
	250	5.00 b	3.33
	500	4.00 c	3.67
LSD(0.05)		0.05	NS

Table V. Effect of GA_3 on percentage of normal and abnormal Plantlets of garlic

Clove size	Concentration (ppm)	Plantlets behavior Normal	Abnormal
Large	0	0.00 h	0.00
	125	23.33 ab	3.33
	250	18.33 b	1.67
	500	21.67 ab	0.00
Medium	0	3.33 e	0.00
	125	26.67 a	1.67
	250	26.67 a	5.00
	500	10.00 cd	1.67
Small	0	3.33 h	0.00
	125	16.67 bc	2.22
	250	18.89 b	1.11
	500	10.00 cd	0.00
LSD(0.05)		0.05	NS

Values with different letters in a column differ significantly at 5% (DMRT); DAP = Days After Planting ; NS = Non-significant

Different treatments of GA_3 had no significant difference in respect of root length. The large, medium and small sized cloves had insignificantly different root lengths (Table IV).

Normal growth of plantlets. In the final harvest on 25 October, the number of normal plantlets was counted (Table V). The percentages of normal plantlets were significantly different among the treatments. Medium sized cloves treated with 125 ppm and 250 ppm gave the highest percentages of normal plantlets. Whereas, 500 ppm gave lowest percentages of normal plantlets in case of small sized cloves. This treatment caused relatively higher rate of abnormality in garlic plantlets. However, the percentage of abnormality was insignificant among the treatments.

The results obtained from this investigation exhibited influence of GA_3 on the sprouting and other early growth behaviors of garlic and gave an indication of breaking dormancy in garlic by the application of GA_3. The percentage of success is still low. However, the information on breaking dormancy by the application of GA_3 has potential application in various physiological and tissue culture experiments.

REFERENCES

Augusti, K.T., 1997. Hypocholestrolaemc effect of garlic (*Allium sativum* L.). *Indian J. Expt. Bot.*, 15: 489–90

Aung, L.H. and C.E. Peterson, 1974. Gibberellin like substances of dormant and non-dormant bulbs of (*Allium cepa* L.). *J. American Soc. Hort. Sci.*, 99: 279–81

Bhargava, R., 1997. Changes in abscisic acid and gibberellic acid contents during the release of potato seed dormancy. *Biologia Plantarum*, 39: 41–5

Bose, T.K. and M.G. Som, 1990. *Vegetables Crops in India*. Naya Prakash, Calcutta, India

Duncan, D.B., 1955. Multiple range and multiple F tests. *Biometrics*, 11: 1–42

Gua, C.H., M. Onjo., M. Hayashi and C.H. Guo, 2000. Studies on seed tuber production using small tubers and on the breaking of dormancy in potatoes using GA. *Japanese J. Trop. Agric.*, 44: 152–7

Haque, M.M., 2001. Effect of GA_3 on growth and yield of Mungbeen (*Vigna radiata* L.). *M.S. Thesis*, Depertment of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh

Kim, E.K., E.J. Hahn, H.N. Murthy and K.Y. Paek, 2003. High frequency of shoot multiplication and bulblet formation of garlic in liquid cultures. *Pl. Cell Tiss. Org. Cult.*, 73: 231–6

Kurian, J.C., 1995. *Plant that Heal*. Oriental Watch Man Publishing House, Pune, India

Ledesma, A., M.I. Reate, R. Racea and J.L. Burba, 1980. Effect of low temperature and pre planting storage time on garlic clonal type Rosado Paraguya Growth. *Phyton*, 39: 37–48

Masud, A.M.H.R., 1995. Effects of planting date, growth regulators and cold treatments on the growth and yield of garlic. *M.S. Thesis*, Department of Horticulture, Bangladesh Agricultural University, Mymensingh, Bangladesh

Moon, W. and B.Y. Lee, 1980. Influence of short day treatment on the growth and levels of endogenous growth substances in garlic (*Allium sativum* L.) plants. *J. Korean Soc. Hort. Sci.*, 21: 109–18

Moriconi, D.N., V.C. Conci and S.F. Nome, 1990. Rapid multiplication of garlic (*Allium sativum* L.) *in vitro*. *Phyton*, 51: 145–51

Nagakubo, T., A. Nagasawa and H. Ohkawa, 1993. Micropropagation of garlic through *in vitro* bulblet formation. *Pl. Cell Tiss. Org. Cult.*, 32: 175–83

Rahim, M.A. and R. Fordham, 1988. Effect of storage temperature on the initiation and development of garlic cloves (*Allium sativum* L.). *Sci. Hort.*, 37: 25–38

Thomas, T.H., 1969. The role of growth substances in the regulations of onion bulb dormancy. *J. Expt. Bot.*, 20: 124–37

Wareing, P.F. and P.F. Saunders, 1971. Hormones and dormancy. *Ann. Rev. Pl. Physiol.*, 22: 261–88

(Received 12 May 2005; Accepted 20 October 2005)