The Bioscan 8(4): 1153-1158, 2013
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

INFLUENCE OF ZINC, CALCIUM AND BORON ON VEGETATIVE AND FLOWERING PARAMETERS OF GLADIOLUS CV. ALDEBRAN

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KEYWORDS
Gladiolus
Zinc
Calcium
Boron
Vegetative
Flowering

Received on :
30.06.2012

Accepted on :
18.10.2012

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ABSTRACT
An experiment was carried out at, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the year 2010-11. The experiment consisted two levels each of Zn (Zn_0 and Zn_1), Ca (Ca_0 and Ca1) and B (B_0 and B_1) which were sprayed on gladiolus plant. The dose of foliar spray of Zn, Ca and B were 0.75%, 0.50% and 0.20%, respectively. The height of plant significantly increased by foliar application of Zn, B, and Ca (79.55 cm, 79.39 cm and 78.75, respectively) interaction effect was also significant between those. The yield of spike increased significantly with foliar application of zinc and calcium, maximum yield of spike (16904.50) was recorded with application of zinc 0.75%. The length of floret was significantly enhanced by the use of B (8.29) and Zn (8.23) while, effect of Ca was non-significant. Spray of calcium was found most effective in prolonging the longevity of spike (17.61 days) as compare to control (14.79 days) and more corms (3.30) were produced in the plants fertilized with zinc. Results obtained among, from the application of Zn, B and Ca and its interaction Zn exhibited most significant effect on various parameters studied under the investigation.

INTRODUCTION

Gladiolus grandiflorus, generally called "Glad", a member of family Iridaceae and sub-family Ixidaceae, originated from South Africa, is a prominent bulbous cut flower plant. Gladiolus is also known as the Sword Lily, due to its sword shaped leaves, or Corn Lily. Being an important bulbous ornamental plant, it occupies a prime position among commercial flower crops which has high demand in both domestic and international markets. It occupies eighth position in the world cut flower trade and has a global history (Ahmad, *et al.,* 2008). The major gladiolus producing countries are the United States (Florida and California), Holland, Italy, France, Poland, Bulgaria, Brazil, India, Australia and Israel. The fascinating spike bears a large number of florets with varying sizes and forms with smooth ruffle of deeply crinkled sepals, presently, in India the area under bulbous crop is about 3500 ha of which gladiolus occupies about more than 1200ha. The main gladiolus growing places are suited to the north Indian plains. It is grown in the plains as well as hills up to elevation of 2400m from mean sea levels (Singh, *et al.*, 2012). The micronutrients play crucial and vital role in gladiolus production as well as major nutrients in growth and development. To determinate the commercial value on corm production parameters, the micronutrient contributes most important role on various metabolism and synthesis process in plants. The deficiencies of micronutrients create different abnormalities like chlorosis, rosetting and scorching etc. (Singh, *et al.*, 2012). It required in small amount, Zn is essential for carbon dioxide evolution and utilization of carbohydrate and phosphorus metabolism and synthesis of RNA. Ca is the chief constituent of plants as calcium pectate of middle lamella of cell wall and is therefore an important part of plant structure. Ca is involved in formation of cell membrane (Hewitt, 1963). B is necessary for carbohydrate transport, cellular differentiation and development, nitrogen metabolism, fertilization, active salt absorption, hormone metabolism, water relation and photosynthesis within the plant and most of absorbed by the plants in undissociated boric acid (H_3BO_3) (Gauch and Dugger, 1953). In our country not much work has been done on production of spike of gladiolus with foliar spray of Zn, Ca and B. Most of the information is available based on the work carried out in the foreign countries but those recommendations cannot be help full as such under our Kanpur agro-climatic conditions. The flowers grown in this country do not meet the export standards. The specific foreign trade standards cannot be obtained unless suitable agro-techniques and cultural management are developed in the country. Hence the cultural management and technique for quality flower spike production need to be developed and standardized. Therefore, keeping in view the above facts a field trial was conducted to investigate the effect of zinc, calcium and boron on growth, flowering and corm production in gladiolus cv. Aldebran.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology Kanpur, where climatic conditions is semi-arid and sub-tropical with hot dry summer and cold winter. The corms of 'Aldebran' variety of gladiolus was procured from National Botanical Research Institute, Lucknow. The experimental field had loamy soil. Manure and fertilizers were given according to recommendation. The experiment was laid out in Factorial Randomized Block Design with three replications and 8 treatments two levels of each of zinc (0 and 0.75% indicated as Zn_0 and $Zn_{1,}$ respectively), calcium (0 and 0.50% indicated as Ca_0 and $Ca_{1,}$ respectively) and boron (0 and 0.20% indicated as B_0 and $B_{1,}$ respectively) were treated by zinc sulphate 0.75%, calcium sulphate 0.50% and borax 0.20%, respectively. The treatments were randomized for getting equal chance in respect of fertility. The corms of uniform shape and size were selected for planting of corms planting was done on 21st October 2010 at planting distance of 25 x 25cm and corms were planted about 6 cm deep. Irrigation, weeding, hoeing, earthing up and staking operations were completed according to needs. The observations on each treatment were recorded on the growth and flowering characters. The analysis of variance was done as procedure given by Panse and Sukhatme, 1978.

RESULTS AND DISCUSSION

The observations recorded on height of plant, number of leaves, duration for heading, Number of florets per spike, yield of spike, length of floret, longevity of spike and number of corms was significantly influenced by application of Zn, Ca and B and their interaction.

The height of plant was significantly affected by spraying of Ca, Zn and B. The data placed in Table 1 indicated the height of plant increased by foliar application of Zn, B and Ca (79.55cm, 79.39 cm and 78.75, respectively). The interaction effect was significant between B x Ca, Zn x B and Ca x Zn (79.16cm, 80.34 and 79.22cm, respectively). The maximum height of plant (79.55cm) was attained with the application of zinc. The possible reason for increase in height of gladiolus might be due to Zn is required for the synthesis of auxin IAA,

Table 1: Effect of Ca, B and Zn on plant height (cm)

B x Ca						
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)		
B_0	78.12	78.35	78.23	B	0.75	
B_1	79.63	79.16	79.29	Ca	0.75	
Mean	78.87	78.75	78.81	B x Ca	0.106	
Zn x B						
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)		
Zn_0	77.69	78.45	78.07	Zn	0.75	
Zn_1	78.69	80.34	79.55	Zn x B	0.106	
Mean	78.77	79.39	78.81			
Ca x Zn						
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)		
Ca_0	77.85	79.89	78.87			
Ca_1	78.29	79.22	78.75			
Mean	78.07	79.55	78.81	Ca x Zn	0.106	
B x Ca x Zn						
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)
Zn_0	76.72	78.99	78.67	77.92	78.07	
Zn_1	79.52	80.27	78.03	80.41	79.45	
Mean	78.12	79.63	78.35	79.165	78.81	B x Ca x Zn 0.150

Table 2: Effect of Ca, B and Zn on number of leaves per plant

B x Ca						
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)		
B_0	8.00	8.29	8.14	B	0.405	
B_1	8.58	8.69	8.63	Ca	NS	
Mean	8.29	8.49	8.39	B x Ca	NS	
Zn x B						
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)		
Zn_0	7.68	8.35	8.06	Zn	0.405	
Zn_1	8.61	8.93	8.77	Zn x B	NS	
Mean	8.14	8.64	8.39			
Ca x Zn						
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)		
Ca_0	7.87	8.71	8.29			
Ca_1	8.15	8.83	8.49			
Mean	8.01	8.77	8.39	Ca x Zn	NS	
B x Ca x Zn						
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)
Zn_0	7.47	8.28	7.89	8.42	8.01	
Zn_1	8.53	8.89	8.70	8.97	8.77	
Mean	8.00	8.58	8.29	8.69	8.39	B x Ca x Zn NS

Table 3: Effect of Ca, B and Zn on duration of heading (days)

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	69.56	65.60	67.58	B	0.33		
B_1	67.92	63.49	65.70	Ca	0.33		
Mean	68.74	64.54	66.64	B x Ca	NS		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	67.70	65.84	66.77	Zn	NS		
Zn_1	67.46	65.56	66.51	Zn x B	NS		
Mean	67.58	65.70	66.64				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	68.91	68.56	68.73				
Ca_1	64.63	64.46	64.54				
Mean	66.77	66.51	66.64	Ca x Zn	NS		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	69.70	68.13	65.70	63.50	66.76		
Zn_1	69.42	67.71	65.51	63.42	66.52		
Mean	69.56	67.92	65.60	63.46	66.64	B x Ca x Zn	NS

Table 4: Effect of Ca, B and Zn on number of florets per spike

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	14.43	15.74	15.08	B	0.298		
B_1	16.18	18.56	17.37	Ca	0.298		
Mean	15.30	17.15	16.22	B x Ca	0.421		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	15.68	17.33	16.50	Zn	0.298		
Zn_1	14.49	17.41	15.95	Zn x B	0.421		
Mean	15.08	17.37	16.22				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	15.21	15.40	15.30				
Ca_1	17.80	16.50	17.15				
Mean	16.50	15.95	16.22	Ca x Zn	0.421		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	14.31	16.11	17.05	18.55	16.50		
Zn_1	14.56	16.25	14.43	18.57	15.95		
Mean	14.43	16.18	15.74	18.56	16.22	B x Ca x Zn	0.596

carbohydrate metabolism, protein synthesis, internode elongation for stem growth and in pollen formation. Zn^{2+} ions at low concentration (0.01ppm) slightly enhance the activity of tryptophan synthesis leading to biosynthesis of auxin (Shukla, *et al*., 2009). This finding has the same trend as was reported by Singh and Singh (2004), Sharma, *et al*., (2004), Jauhari *et al*. (2005) and Halder, *et al*. (2007) in gladiolus.

The Table 2 indicates that the application of B and Zn significantly increased the number of leaves per plant where as Ca could not affect the production of leaves. More leaves per plant were recorded with the application of B (8.64) and Zn (8.77) in comparison to its control (8.14). The interaction of Ca x Zn was found non-significant however, numerically more number of leaves per plant (8.93) was produced when zinc and boron were applied at Zn_1 x B_1 levels to the plants. Zinc deficiency in plants resulted in stunted growth, little leaf and fruit sizes which are attributed to altered IAA metabolism. Application of zinc was found to increase the green pigments of necrotic leaf of plants (Srivastava, 2003). These findings are agreement by Charturvedi, *et al*. (1986) and Reddy and Chaturvedi (2009) in gladiolus.

The analysis of data (Table 3) indicates that duration for heading was significantly affected by foliar spray of B and Ca it was not so with regard to Zn. Earlier heading was noticed with the foliar application of Ca (64.54 days) and B (65.70 days) over their control. Interactions were found non-significant. Boron is an essential element found in the meristematic regions of plants such as root tips, emerging leaves and buds. Flowering of the plant is the reproductive phase of the plant life. It always comes after a defined number of days. However, this period can slightly be affected by the size of seed corm, health of plant and climatic conditions prevailing those days. Health of plant is affected by the availability of nutrients to the plant.

Number of florets per spike is a parameter for the judgment of quality of spike. In gladiolus the florets always face in one direction and as such more number of floret per spike enhance the beauty of the spike. The data presented in Table 4 indicate that the production of florets per spike was significantly affected

Table 5: Effect of Ca, B and Zn on yield of spike per hectare

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	14941.50	16282.50	15612.00	B	NS		
B_1	14934.50	17280.00	16107.50	Ca	614.00		
Mean	14938.00	16781.25	15859.62	B x Ca	NS		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	14312.50	15317.50	14815.00	Zn	614.00		
Zn_1	16911.50	16897.00	16904.50	Zn x B	NS		
Mean	15612.00	16107.25	15859.62				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	13663.00	16213.00	14938.00				
Ca_1	15967.00	17595.50	16781.25				
Mean	14815.00	16904.25	15859.62	Ca x Zn	NS		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	13378.00	13948.00	15247.00	16687.00	14815.00		
Zn_1	16505.00	15921.00	17918.00	17873.00	16904.25		
Mean	14941.50	14934.50	16282.50	17280.00	15859.62	B x Ca x Zn	NS

Table 6: Effect of Ca, B and Zn on length of floret (cm)

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	7.63	7.81	7.72	B	0.372		
B_1	8.22	8.36	8.29	Ca	NS		
Mean	7.92	8.08	8.00	B x Ca	NS		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	7.47	8.09	7.78	Zn	0.372		
Zn_1	7.97	8.49	8.23	Zn x B	NS		
Mean	7.72	8.29	8.00				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	7.69	8.16	7.92				
Ca_1	7.87	8.30	8.08				
Mean	7.78	8.23	8.00	Ca x Zn	NS		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	7.42	7.97	7.53	8.22	7.78		
Zn_1	7.85	8.47	8.09	8.51	8.23		
Mean	7.63	8.22	7.81	8.36	8.00	B x Ca x Zn	NS

Table 7: Effect of Ca, B and Zn on longevity of spike on plant (days)

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	14.24	17.18	15.71	B	0.799		
B_1	15.34	18.04	16.69	Ca	0.799		
Mean	14.79	17.61	16.20	B x Ca	NS		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	15.66	16.64	16.15	Zn	NS		
Zn_1	15.76	16.74	16.25	Zn x B	NS		
Mean	15.71	16.69	16.20				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	14.75	14.83	14.79				
Ca_1	17.55	17.67	17.61				
Mean	16.15	16.25	16.20	Ca x Zn	NS		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	14.21	15.30	17.12	17.98	16.15		
Zn_1	14.28	15.39	17.25	18.10	16.25		
Mean	14.24	15.34	17.18	18.04	16.20	B x Ca x Zn	NS

Table 8: Effect of Ca, B and Zn on number of corm as per plant

B x Ca							
B Ca	Ca_0	Ca_1	Mean	C.D. (P= 0.05)			
B_0	2.35	2.32	2.34	B	0.16		
B_1	2.55	2.63	2.59	Ca	NS		
Mean	2.45	2.48	2.46	B x Ca	NS		
Zn x B							
Zn B	B_0	B_1	Mean	C.D. (P= 0.05)			
Zn_0	1.49	1.76	1.63	Zn	0.16		
Zn_1	3.18	3.42	3.30	Zn x B	NS		
Mean	2.34	2.59	2.46				
Ca x Zn							
Ca Zn	Zn_0	Zn_1	Mean	C.D. (P= 0.05)			
Ca_0	1.64	3.26	2.45				
Ca_1	1.61	3.34	2.48				
Mean	1.63	3.30	2.46	Ca x Zn	NS		
B x Ca x Zn							
	B_0Ca_0	B_1Ca_0	B_0Ca_1	B_1Ca_1	Mean	C.D. (P= 0.05)	
Zn_0	1.57	1.72	1.42	1.81	1.63		
Zn_1	3.14	3.39	3.23	3.46	3.30		
Mean	2.35	2.55	2.32	2.63	2.46	B x Ca x Zn	NS

by foliar spray of Ca, B and Zn. All the interaction between Ca, Zn and B has significantly affected the number of florets per spike. Sharma *et al*. (2004), Jauhari *et al*. (2005) and Halder *et al*. (2007) in gladiolus have also reported similar results.

It is evident from Table 5 that the yield of spike increased significantly with foliar application of zinc and calcium. The maximum yield of spike (16904.50) was recorded with foliar application of zinc and calcium (16781.25). The interaction manifested non significant effect. Improvement in yield due to these micronutrients application might basically be due to enhanced photosynthetic and other metabolic activities related to cell division and elongation. The results are in agreement with the results of Singh and Singh (2000) and Katiyar *et al*. (2005) in gladiolus.

Length of floret is a qualitative parameter in gladiolus. More the length and width of floret, compact will be the spike, giving better look of the spike. It is clear from Table 6, that the length of floret was significantly enhanced by the use of B and Zn. The effect of Ca was non-significant. The longer florets (8.29cm) were found in the plants sprayed with boron followed by Zn (8.23cm). The effect of interaction was not impressive during the course of investigation. This finding is in consonance with Chaturvedi *et al*. (1986) Sharma, *et al*., (2004), Jauhari *et al*. (2005) and Halder *et al*. (2007) in gladiolus.

Beauty of flower looks better on the plant itself. Therefore, any treatment which increases the duration of flowering on the plant will always be recognized universally. In this trial observation given in Table 7 indicate the spray of calcium was found most effective in prolonging the longevity of spike Ca (17.61days) while of control (14.79 days). B was also effective in prolonging the longevity of spike (16.69 days) while of control (15.71 days) but zinc failed to enhance the longevity. The interactions were found non-significant. Similar beneficial results regard to longevity of spike on plant has been reported by Mostafa (1996) in carnation and Chaturvedi *et al*. (1986) in gladiolus.

Number of corms was counted at the time of digging. Data (Table 8) indicate that foilar spray of Zn and B significantly affected but it was not affected by Ca. More corms 3.30 were produced in the plants fertilized with zinc as compared to plant with no zinc application. All the first and second order interactions were not significantly affect in this character. Zinc is indispensable for proper growth and development of plants. Zinc is effective in plant nutrition for the synthesis of plant hormones and balancing intake of P and K inside the plant cells. More cormels with better nutrition has also been reported by Kumar *et al*. (2003), Sharma *et al*. (2004), Jauhari *et al*. (2005) and Halder *et al*. (2007) in gladiolus.

The results obtained revealed that the foliar spray of Zn, B and Ca to gladiolus plant was significantly influence the vegetative growth, flowering, longevity of spike as well as corms production. The foliar spraying of Zn @ 0.75% to gladiolus plants was most effective in influencing most of parameters rather than B and Ca.

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