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HORTICULTURE

Studies on the effect of foliar application of calcium on post-harvest, corm and cormel production in gladiolus CV. summer sunshine

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Abstract

The experiment was conducted during the year 2011-2013 in Mondouri Horticultural research farm, BCKVV, Mohanpur, West Bengal to study the role of calcium and to identify its effective source and application time on the post-harvest, corm and cormel parameters of gladiolus with foliar application of calcium nitrate and calcium carbonate at different days (3-4, 6 leaf and spike emergence) after plantingand was conducted in Randomized Block Design with three replications.Analysis of variance study indicated that most of the treatments differed significantly among themselves except for days taken for basal floret open, no of corms per plot, corm weight and no of cormels per corm in both the years. The results obtained revealed that foliar spray of calcium favored most of the post-harvest, corm and cormel characters. Calcium nitrate was found superior to calcium carbonate in promoting various post-harvest, corm and cormelcharacters under study. Spraying of calcium nitrate at 6 leaves stage and spike emergence stage to gladiolus plant was most effective to influence the post-harvest, corm and cormelparameters and was found on par with calcium nitrate 300 ppm at 6 leaves stage for maximum characters like vase life, cumulative water uptake, days to incipient senescence, fresh weight of spike, days to senescence, corm diameter, corm thickness and cormel weight per plot.

Highlights

- Spraying at 3-4 leaf stage and spike emergence stage improves the vase life
- Post-harvest and corm parameters are enhanced by calcium nitrate
- Calcium nitrate increases the vase life of gladiolus spike

Keywords: Calcium Carbonate, calcium nitrate, summer sunshine, post-harvest, corm, cormel and gladiolus

Gladiolus is a monocotyledonous flowering bulbous plant, belonging to family Iridaceae and subfamily Ixoideae. Itis the largest genus in the family Iridiaceae with 260 species, which are mainly native to South Africa. Several species are distributed in western and central Europe, the Mediterranean to Southwest and Central Asia, and Northwest and East Africa (Kumari and Kumar 2015). gladiolus is one of the most important flowers in India because of its majestic spikes containing attractive, elegant and delicate florets of various shades, sequential opening of flowers for a longer duration and good keeping quality of cut spikes (Sisodia and Singh 2014). The long flower spikes are excellent as cut flower for ornamentation whenarranged in vases. It has great economic value for cut flower trade and muchvalued by the aesthetic world for beauty and loving people because its prettinessand unparalleled elegance (Sadhu and Bose 1973). Calcium (Ca) is an important secondary element that is found in 3% of the earth's crust (Campbell 1983). Calcium is an essential plant nutrient as the divalent cation (Ca^{2+}) is required for structural roles in the cell wall and membranes, as a counter- cation for inorganic and organic anions in vacuole, and as an intracellular messenger in the cytosol (Marschner, 1995). Calcium

is the chief constituent of plants as calcium pectate of middle lamella of cell wall and is therefore an important part of plant structure. Calcium is involved in formation of cell membrane (Hewitt, 1963). Nitrogen-use efficiency of urea-containing fertilizers is also increased with soluble calcium sources such as calcium nitrate. Moreover, increased calcium uptake reduces the invasion of cell wall by fungal pathogens and deficiency of calcium results in topple disorder by which spikes break down when kept in vase (Misra and Singh, 1993).In our country muchwork has not been done on effect of foliar application of calcium on post-harvest, corm &cormel quality attributes of gladiolus. Most of the available literatureisbasedon the work done in the foreign countries and those findings may become less worthy underprevailing agro-climatic conditions in India. Keeping in view the above facts, a field trial was conducted to assess the role of calcium and to identify its effective source and application time at different stages of growth of gladiolus cv. Summer Sunshine on the post-harvest, corm & cormel traits of the crop.

Materials and methods

The present investigation was undertaken in research field of the Department of Floriculture and landscaping, Bidhan Chandra KrishiViswavidyalaya, Nadia, West Bengal during the winter season of 2011-12 and 2012-13. The study was carried out using gladiolus cv. Summer Sunshine in a randomized block design with seven treatments replicated three times. The treatments of calcium sources sprayed on the foliage of plants were: Control (T0: distilled water spray), T_1- Ca $(NO_3)_2$ 300 ppm sprayed at 3 leaves stage, T_2- Ca $(NO_3)_2$ 300 ppm sprayed at 6 leaves stage,T_3- Ca $(NO_3)_2$ 300 ppm sprayed at 3 leaves stage & spike emergence stage,T_4- $CaCO_3$ 300 ppm sprayed at 3 leaves stage, T_5- $CaCO_3$ 300 ppm sprayed at 6 leaves stage,T_6 - $CaCO_3$ 300 ppm sprayed at 3 leaves stage & spike emergence. Corms were planted at a spacing of 30 x 20 cm at a depth of 4-5 cm. All the recommended cultural practices were followed to raise a good crop stand. A solution of 300 ppm calcium nitrate (lab chemical) and calcium carbonate (lime) was prepared at each spraying by dissolving 300 mg of calcium nitrate and calcium carbonate per literof water. The observationson thirteen quantitative charactersviz., Days taken for basal floret opening, Vase life, Days to incipient senescence, Days to senescence, Cumulative water uptake, Fresh weight change of cut spikes, Number of corms per plot, Corm diameter, Corm weight, Corm thickness, Number of cormelsper plot, Cormel weight per plotwere recorded in each treatment in each replication on an average of six randomly selected and tagged from the net plot area in each treatment and replication for the purpose of recording the biometric observations and data collected after 40, 60 and 80 days after planting.Analysis of Variance for all the characters was analyzed systematically using the SAS statistical software and means were tested at 5% level of probability as per Cochran and cox (1957). The results have been depicted graphically where ever necessary.

Results and discussion

The results on Days taken for basal floret opening Pre-harvest application of calcium nitrate and calcium carbonate as foliar spray of growth failed to influence the opening of basal floret of the cut spikes but the average days taken for basal floret opening seen highest in T_2 (2.16) days followed by T_3 (1.94) days but in case of individual years i.e. in 2011-12 highest is seen in T_2 (2.22) days followed by T_3 (2.11) days and in 2012-13 highest is seen in T_2 (2.11) days followed by T_4 (2.00) daysbecause of increased concentration of calcium nitrate which may results in cell division(Table 1). The results on Vase lifeas evident from the pre-harvest treatments exhibited significant variation among themselves in terms of vase life of cut spikes of *Gladiolus* cv. Summer Sunshine. Spikesare harvested from the plots T_3 treated with calcium nitrate at 3-4 leaf and spike emergence stage showed better longevity than control.The results are in conformity with the findings of Padmalatha *et al.* (2012). Calcium is enhanced life cycle of flowers of cut lilium grown hydroponically was reported by Seyedi *et al.* (2013) with the use of calcium in nutrition. Efficiency of calcium in increasing vase life was reported by Buchanan *et al.* (2000) and Battacharjee & Palalanikumar (2002) in roses. The results pertaining to the days taken to attain incipient senescence of individual floret was counted and data presented in (Table 1). The treatments showing significant variation among themselves. Delayed incipient senescence (6.11 days) was recorded in spikes harvested from plots

Table 1: Effect of Calcium Sprayedat 3 Different Growth Stages on Post-Harvest Parameters of Gladiolus CV. Summer Sunshine

Treatments	Days taken for basal floret open			Vase life (Days)			Days to incipient senescence		
	2011-2012	2012-2013	Average	2011-2012	2012-2013	Average	2011-12	2012-13	Average
T_0(control)	1.89	1.33	1.61	4.86	3.80	3.93	5.27	4.45	4.86
T_1	2.00	1.55	1.77	4.88	4.44	4.66	6.50	5.44	5.96
T_2	2.22	2.11	2.16	5.55	4.43	4.99	6.52	5.23	5.88
T_3	2.11	1.78	1.94	6.20	4.77	5.48	6.68	5.57	6.11
T_4	1.77	2.00	1.88	5.21	4.66	4.93	5.98	5.09	5.53
T_5	1.22	1.66	1.44	4.88	4.55	4.71	5.43	4.77	5.11
T_6	1.89	1.88	1.89	5.10	5.55	5.32	5.30	4.29	4.80
SEm (±)	0.32	0.39		0.15	0.13		0.46	0.23	
CD (0.05)	NS	NS		0.33	0.28		0.98	0.50	

Treatments: T_0- Control (distilled water), T_1- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage, T_2- $Ca(NO_3)_2$ 300 ppm sprayed at 6-7 leaf stage, T_3- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage, T_4- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage, T_5- $CaCO_3$ 300 ppm sprayed at 6-7 leaf stage, T_6- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage.

(Cont….)

Treatments	Days to senescence			Cumulative water uptake (ml)			Fresh weight of spike (g)		
	2011-12	2012-13	Average	2011-12	2012-13	Average	2011-12	2012-13	Average
T_0(control)	11.34	10.89	11.12	37.67	37.73	37.70	98.91	99.87	99.38
T_1	13.22	12.65	12.94	67.50	73.30	70.4	104.36	105.90	105.13
T_2	14.31	13.22	13.77	72.00	73.33	72.66	107.45	108.63	107.68
T_3	16.40	15.53	15.97	72.53	74.83	73.68	112.66	113.88	111.41
T_4	12.30	11.23	11.77	58.30	47.03	52.66	104.45	105.09	104.77
T_5	11.21	12.40	11.81	70.07	58.90	64.48	103.36	104.70	104.03
T_6	12.33	11.03	11.68	67.20	70.30	68.75	106.63	105.89	106.26
SEm (±)	0.40	0.38		5.34	9.72		3.08	3.10	
CD (0.05)	0.85	0.81		11.46	20.85		6.61	6.66	

Treatments: T_0- Control (distilled water), T_1- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage, T_2- $Ca(NO_3)_2$ 300 ppm sprayed at 6-7 leaf stage, T_3- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage, T_4- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage, T_5- $CaCO_3$ 300 ppm sprayed at 6-7 leaf stage, T_6- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage.

Table 2: Effect of Calcium Sprayed at 3 Different Growth Stages on Corm & Cormel Characters of Gladiolus CV. Summer Sunshine

Treatments	No of Corms per plot			Corm diameter (cm)			Corm weight (g)			Corm thickness (cm)		
	2011-12	2012-13	Average	2011-12	2012-13	Average	2011-12	2012-13	Average	2011-12	2012-13	Average
T_0(control)	23.33	21.33	22.33	5.20	5.23	5.21	56.69	59.24	61.95	2.00	2.23	2.11
T_1	23.33	23.33	23.33	5.57	5.53	5.55	60.56	62.84	63.08	2.52	2.62	2.57
T_2	21.00	23.00	22.00	5.67	5.77	5.71	64.10	66.75	64.03	2.60	2.70	2.65
T_3	22.33	23.33	22.83	5.80	5.83	5.81	69.10	70.98	65.96	3.97	2.90	3.43
T_4	22.33	23.00	22.66	5.33	5.30	5.31	58.78	60.64	61.50	2.37	2.57	2.47
T_5	23.67	23.67	23.66	5.67	5.27	5.46	61.26	63.99	60.41	2.30	2.67	2.49
T_6	21.33	22.00	21.66	5.40	5.47	5.43	63.56	64.88	61.18	2.94	2.53	2.73
SEm (±)	0.88	0.71		0.17	0.10		1.79	1.66		0.79	0.16	
CD (0.05)	NS	NS		0.37	0.21		NS	NS		1.70	0.33	

Treatments: T_0- Control (distilled water), T_1- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage, T_2- $Ca(NO_3)_2$ 300 ppm sprayed at 6-7 leaf stage, T_3- $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage, T_4- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage, T_5- $CaCO_3$ 300 ppm sprayed at 6-7 leaf stage, T_6- $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage

(Cont.…)

Table: Effect of Calcium Sprayedat 3 Different Growth Stages on Corm & Cormel Characters of Gladiolus CV. Summer Sunshine

Treatments	No. of cormels per plot			Cormel weight per plot (g)		
	2011-12	2012-13	Average	2011-12	2012-13	Average
T_0(control)	1.81	1.05	1.43	30.33	36.33	33.33
T_1	2.25	1.83	2.04	64.67	62.67	63.67
T_2	2.70	2.05	2.38	35.67	57.00	46.34
T_3	3.17	2.78	2.97	75.00	81.00	78.00
T_4	1.14	1.60	1.37	45.00	53.00	49.00
T_5	1.78	1.11	1.45	56.33	55.00	55.66
T_6	1.64	1.22	1.43	51.33	49.00	50.16
SEm (±)	0.09	0.07		12.99	6.32	
CD (0.05)	NS	NS		27.73	13.57	

Treatments: T_0 - Control (distilled water), T_1 - $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage, T_2 - $Ca(NO_3)_2$ 300 ppm sprayed at 6-7 leaf stage, T_3 - $Ca(NO_3)_2$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage, T_4 - $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage, T_5 - $CaCO_3$ 300 ppm sprayed at 6-7 leaf stage, T_6 - $CaCO_3$ 300 ppm sprayed at 3-4 leaf stage & spike emergence stage

under the treatment spraying calcium nitrate 3-4 leaf stage and spike emergence stagefollowed by treatment spraying calcium nitrate 3-4 leaf stage (5.96 days) and 6-7 leaf stage (5.88) similar results were observed by Reddy *et al.* (2000). The data in (Table 1) indicates that the days to senescence of individual floret, up to 5 florets showing significant variation among themselves. Days to senescence (15.97 days) was recorded in spikes harvested from plots under the treatment T_3 followed by T_1 (11.12 days). Similar results were observed in Katiyar *et al.* (2012). The increase in calcium concentration increases the days of senescence

For cumulative water uptakethe data in the (Table 1)indicates that the treatments employed had a profound influence on cumulative water uptake. Maximum water uptake (73.68ml) was measured under the treatment T_3 followed by T_2 (72.66 ml) and least is recorded in control T_0. The plants in the control plot up taken (37.70 ml) as compared to other treatments. Increase in water uptake as a result of calcium spray is also reported by Chaturvedi *et al.* (1986) in gladiolus.Fresh weight change of cut spikesthe (table1)depicts that day-wise change in fresh weight of cut spike. The fresh weight of spikes receiving the treatment T_3 showed greater (111.41 g) and least is recorded in control (99.38 g). Similar findings are seenbyChoi *et al*. (2005).

The trait number of corms per plot failed to be influenced by the treatments employed. But the average number of corms per plot was recorded highest in treatment spraying with calcium at 3-4 leaf stage (23.33) followed by treatment spraying with distilled water, these results may be due to the genetical and environmental factors.

Corm diameter although the data in the (Table 2,) shows significant variation among the treatments in terms of corm diameter. The prominence in variation of the observation is markedly low. Similar results were shown by Kumar and Arora (2000) in gladiolus. Corm weightthe treatments had no significant effect on the weight of individual corm (Table 2) but the weight of corm from individual plot has recorded highest in T_3 treatment followed by T_2& T_1. These treatments are highest when comparing with control may be due to the presence of calcium and nitrogen for cell division and growth.Similar results were reported by Chaturvedi *et al*. (1986) in gladiolus. Corm thickness in (Table 2) reveals that the positive influence of treatments on corm thickness, from the pooled data it is observed that plants in plot under the treatment T_3 produced thickest corms (3.43 cm)& lesser comparisons with T_2 and T_1 as compared to other treatments the increased corm thickness with calcium nitrate spray might be due to increased cell division and greater mobilization of photosynthesis to the place where the corms are formed. Similar results were observed in Kumar *et al.* (2003).As evident from the observations recorded and depicted in (Table 2), number of cormels per corm failed to be influenced by the treatments. In case of Cormel weight the Perusal

of the data in the table, indicates the level of significance attained by the trait as result effect of the treatments. The average of the means (1st and 2nd year such that 2011-12 and 2012-13 respectively) presented in the table exhibits prominent effect of the treatment T_3, with cormel weight of 78 g per plot followed by T_1 (63.67 g/plot). The cormel weight in plots receiving calcium in the form of calcium nitrate irrespective of spraying stage recorded greater cormel weight, than those plots treated with calcium carbonate. Similar results were reported by Chaturvedi *et al*. (1986) in gladiolus.

Conclusion

It can be concluded that foliar application of calcium on to gladiolus plants significantly increases their performance as it was evident from the present study. The plants in the control plots were proven poor in terms of the traits under study when compared to the foliar spray of calcium. Among the two sources of calcium used in this study, calcium nitrate showed better results for most of the characters than calcium carbonate and was found non-significant for days taken for basal floret open, no of corms per plot, corm weight and no of cormels per corm. Calcium nitrate 300 ppm applied at 3 leaves and spike emergence stage was most effective in yielding better performance of various post-harvest a, corm and cormel characters under study than other treatments. Besides, for most of the important characters like vase life, cumulative water uptake, days to incipient senescence, fresh weight of spike, days to senescence, corm diameter, corm thickness and cormel weight per plot it was *on par* with calcium nitrate 300 ppm at 6 leaves stage. Therefore, single spray of calcium nitrate 300 ppm at 6 leaves stage would be economical.

References

AnjanaSisodia and Singh, A.K. 2014. Influence Gamma Irradiation on Morphological Changes, Post-Harvest Life and Mutagenesis in Gladiolus, *International Journal of Agriculture, Environment and Biotechnology* **7**(3): 535-545. doi number: 10.5958/2230-732X.2014.01358.8

Bhattacharjee, S.K. and Palalanikumar, S. 2002. Postharvest life of roses as affected by holding solution. *Journal of Ornamental Horticulture* **5**(2): 37-38.

Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and molecular biology of plants.*Amer. Soc. Plant Biology* 152-153.

Chaturvedi, O.P., Shukla, L.N. and Singh, A.R. 1986. Effect of Agromin on growth and flowering of gladiolus. *Progressive Horticulture* **18**(3-4): 196-199.

Choi, J.M., Lee, K.H. and Lee, E.M. 2005. Effect of calcium concentrations in fertilizer solution on growth and nutrient uptake by oriental hybrid lily 'Casa Blanca'. *Acta Horticulturae* **673**: 755-760.

Cochran, W.G. and Cox, G. M. 1957. Experimental designs. pp. 127–131.

Katiyar, P., Chaturvedi, O.P. and Katiyar, D. 2012. Effect of foliar spray of zinc, calcium and boron on spike production of Gladiolus cv. eurovision *HortFlora Research Spectrum* **1**(4): 334-338.

Kiran Kumari and Santosh Kumar 2015. Effect of Gamma Irradiation on Vegetative and Propagule Characters in Gladiolus and Induction of Homeotic Mutants, *International Journal of Agriculture, Environment and Biotechnology* **8**(2): 413-422. doi number: 10.5958/2230-732X.2015.00049.2

Kumar, P. and Arora, J.S. 2000. Effect of micro nutrients on gladiolus. *Journal of Ornamental Horticulture* **3**(2): 91-93.

Kumar, R., Singh, G.N. and Misra, R.L. 2003. Effect of boron, calcium and zinc on gladiolus. *Journal of Ornamental Horticulture* **6**(2): 104- 106.

Marschner, H. 1995. Mineral nutrition of higher plants. Academic Press, London, U.K.

Padmalatha, T, Reddy, G.S., Chandrasekhar, SivaShankar, A. and Chaturvedi, A. 2012. Effect of foliar spray of chemicals and plant growth regulators on corm production and vase life in gladiolus plant raised from cormels, *Plant Archives* **12**(2): 685-690.

Reddy, A.G.K. and Chaturvedi, O.P. 2009.Effect of zinc, calcium and boron on growth and flowering in *Gladiolus* cv. Red Majesty. *Crop Research* **38** (1, 2 and 3): 135-137.

Sadhu, M.K. and Bose, T.K. 1973. Tuberose for most artistic garlands. *Indian Horticulture* **18**: 17-21.

Seyedi, N.A., Torkashv, M. and Allahyari, M.S. 2013. Investigating of the Effects of Calcium Concentration under Hydroponic Conditions on Quantitative and Qualitative Growth of Lilium 'Tresor, *Journal of Ornamental and Horticultural Plants* **3**(1): 19-24.