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Investigation on Different Sources and Levels of Calcium on Flowering, Quality and Yield in Asiatic Lily

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ABSTRACT: Calcium plays an important role in plant growth and in many physiological activities of bulbous flowers. It has been found to be the best for enhancing both vegetative and flowering attributes in bulbous flower crops. With this background, an experiment was conducted at the experimental block (under naturally ventilated polyhouse) of the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Iruvakki, Shivamogga during 2022-2023. The experiment was laid out in Randomized Complete Block Design consisting of thirteen treatments- *viz.*, T_1 - control, T_2 - 30 g/m^2 calcium ammonium nitrate, T_3 - 40 g/m^2 calcium ammonium nitrate, T_4 - 50 g/m^2 calcium ammonium nitrate, T_5 - 30 g/m^2 calcium nitrate, T_6 - 40 g/m^2 calcium nitrate, T_7 - 50 g/m^2 calcium nitrate, T_8 - 100 g/m^2 calcium oxide, T_9 - 200 g/m^2 calcium oxide, T_{10} - 300 g/m^2 calcium oxide, T_{11} - 20 g/m^2 dolomite, T_{12} - 30 g/m^2 dolomite and T_{13} - 40 g/m^2 dolomite with three replications. Among different treatments, the application of dolomite at 40 g/m^{2}had taken minimum days for flower bud initiation (29.80), first floret opening (54.53), 50 per cent flowering (61.33), maximum duration of flowering (17.33 days), number of buds per spike (3.60), bud length (8.53 cm), bud diameter (21.64 mm), petal length (11.37 cm), petal breadth (4.37 cm), length of the flower stalk (71.85 cm) and vase life of flowers with and without anthers (8.17 and 9.55 days, respectively).While, minimum was recorded in control. Hence, it is concluded that the soil application of dolomite 40 g/m^2 at the time of planting proved to be promising for enhancing the flowering and quality of Asiatic lily.

Keywords: Asiatic lily, dolomite, flowering, flower quality and yield.

INTRODUCTION

Lilium (*Lilium* spp.) is one of the most beautiful and popular ornamental bulbous flowers. They have been long admired and demanded for their aesthetic quality and have often depicted as a symbol of purity and regality. The lily is now the fourth important crop globally (Jayashree, 2020). The botanical name Lilium is the Latin form and is a Linnaean name, but is derived from the Greek "Leirion" generally assumed to refer to 'true'. Lilium is a genus of herbaceous flowering plants growing from bulbs, all with large prominent flowers belongs to the family Liliaceae (Chandrashekar, 2016).

Calcium plays an important role in plant growth and in many physiological activities of bulbous flowers (Pan and Dong, 1995). Calcium deficiency may result in problems such as upper leaf necrosis in the lilies (Chang, 2002; Chang and Miller 2003). A good fertilizer that accelerates calcium uptake enhances the quality of both cut flowers and lily bulbs (Lee *et al.*, 2004). Studies have shown that the application of calcium nitrate along with phosphorus and potassium has beneficial effects on crop growth and productivity and is being widely used for commercial cut flower and pot plant production of various lily hybrids and species (Bala, 2015).

There are several studies revealing the beneficiary effects of calcium in improving the growth and flowering of different ornamental plants *viz.*, Seyedi *et al.* (2013) found that 6 mM calcium produced maximum number of buds (8.60), flower diameter (10.06 mm) and longevity of cut flowers (10.27 days). Hamayl *et al.* (2016) revealed that combined treatment of 20 g/plant potassium sulphate + 10 cm/l calcium borate induced an increment in flowers like number of

flowers (47.30 and 52.00), flower diameter (2.60 and 2.70 cm), flower stem length (35.20 and 37.70 cm), flower stem diameter (1.27 and 1.50 cm), flower adherence strength (1904.00 and 1952.00 g/cm^3) and vase life during both the seasons.

The present experiment was conducted to evaluate the effect of different sources and levels of calcium on flowering and quality in Asiatic lily (*Lilium* spp.).

MATERIAL AND METHODS

Studies were carried out at the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, under Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Iruvakki, Shivamogga, Karnataka, during 2022-2023. The soil was prepared to fine tilth and raised beds of 1.2 m × 1.2 m were prepared under naturally ventilated polyhouse condition. Bulbs of Asiatic lily were planted at a spacing of 20 cm × 20 cm. The experiment was laid out in randomized complete block design (RCBD) with thirteen treatments and three replications. Treatments included T_1- control, T_2 - 30 g/m^2 calcium ammonium nitrate, T_3 - 40 g/m^2 calcium ammonium nitrate, T_4 - 50 g/m^2 calcium ammonium nitrate, T_5 - 30 g/m^2 calcium nitrate, T_6 - 40 g/m^2 calcium nitrate, T_7 - 50 g/m^2 calcium nitrate, T_8 - 100 g/m^2 calcium oxide, T_9- 200 g/m^2 calcium oxide, T_{10}- 300 g/m^2 calcium oxide, T_{11}- 20 g/m^2 dolomite, T_{12}- 30 g/m^2 dolomite and T_{13}- 40 g/m^2 dolomite. The treatments were applied at the time of planting. Following observations were recorded and statistically analysed.

RESULTS AND DISCUSSION

The findings were considerably interpreted and listed in Table 1, 2 and Fig. 1 based on the observations recorded in the present research.

Effect of different sources and levels of calcium on flowering parameters

Days taken for flower bud initiation. Soil application of different sources and levels of calcium at the time of planting varied significantly on days taken for flower bud initiation. The treatment 40 g/m^2 dolomite showed earliest bud initiation (29.80 days) which was on par with the treatments 30 g/m^2 dolomite and 40 g/m^2 calcium ammonium nitrate (30.20 and 31.13 days, respectively). This might be due to the applied calcium which acts as a reservoir for CO_2 storage in plants. Due to the increase in the rate of photosynthesis and the shortening of the vegetative growth period, the plant quickly enters the reproductive phase and flowering stage. While, the days taken for flower bud initiation was delayed (34.87) in control. Dordas (2009) in oregano, Seydmohammadi *et al.* (2020) in lisianthus, Kumar *et al.* (2006) in gladiolus.

Days taken for first floret opening. The treatment 40 g/m^2 dolomite showed earliest first floret opening (54.53 days) which was on par with the treatments 30 g/m^2 dolomite, 30 g/m^2 calcium nitrate and 40 g/m^2 calcium ammonium nitrate (55.13, 55.40 and 55.40 days, respectively). This might be due to the early and enhanced growth by the application of dolomite which might have increased the efficiency of transporting photosynthates for the synthesis of metabolites. The days taken for first floret opening was delayed (59.47) in control. The same results are also obtained in the reports of Memon and Khetran (2014) in snapdragon, Dordas (2009) in oregano, Seydmohammadi *et al.* (2020) in lisianthus and Abdulhadi *et al.* (2022) in snapdragon.

Days taken for 50 per cent flower opening. The data pertaining to the days taken for 50 per cent flowering, the treatments are differed significantly by the use of different sources and levels of calcium are indicated below. The treatment 40 g/m^2 dolomite had exhibited the 50 per cent flowering in minimum days (61.33). However, it was on par with the treatments30 g/m^2 calcium nitrate, 40 g/m^2 calcium ammonium nitrate, 200 g/m^2 calcium oxide and 30 g/m^2 dolomite (61.67, 62.00, 62.00 and 62.33 days, respectively). It might be due to the production of florigen hormone and also dolomite is quite effective in reducing the vegetative phase and enhances the development of reproductive phase faster. While control had taken maximum days for exhibiting 50 per cent flowering (66.00). The results are in conformity with the earlier work done by Bahrun *et al.* (2019) in soybean.

Duration of flowering (days). The data related to the flower duration of different treatments affected by the different sources and levels of calcium on Asiatic lily. The flowering occurred for the maximum period with the treatment 40 g per m^2 dolomite (17.33 days), it was on par with the treatments 30 g/m^2 dolomite, 200 g/m^2 calcium oxide and 40 g/m^2 calcium ammonium nitrate (16.33 days). The maximum flower duration in dolomite applied plants might be due to the applied dolomite which provides the continuous supply of photosynthetic assimilates for longer duration and also it reduces the ethylene content by the accumulation of more carbohydrate reserves and makes flowers to be active for a longer period. Torre *et al.* (1999) in rose and Seydmohammadi *et al.* (2020).

Effect of different sources and levels of calcium on flower quality parameters

Number of buds per spike. The maximum number of buds varied significantly among the treatments. Application of 40 g/m^2 dolomite exhibited maximum number of buds (3.60), it was on par with the treatments 30 g/m^2 dolomite and 200 g/m^2 calcium oxide (3.53 and 3.33, respectively.), while minimum number of buds (2.87) are noticed in control. The increase in the reproductive attributes might be due to the production of maximum leaves and leaf area by the dolomite application which results in maximum production and accumulation of more photosynthates, thus the photosynthates produced were transported towards reproductive parts for the development of floral parts and the application of dolomite does not only add Ca and Mg, but also increase other nutrients supply and improve the physical properties of the soils in order to promote optimal growth and yield of the plants. The results are similar to the work done by Seyedi *et al.* (2013) in Asiatic lily.

Bud length (cm). The bud length on application of different sources and levels of calcium on Asiatic lily

varied significantly among the treatments. The treatment 40 g/m^2 dolomite exhibited maximum bud length of 8.53 cm where it was on par with (8.25 cm) 30 g/m^2 dolomite, while minimum bud length was recorded in control (6.64 cm). The increased bud length might be due to the dolomite which is involved in the production of more food material in leaves due to enhanced photosynthetic activity, in turn led to the production of bigger size of buds. The results are in accordance with the Seyedi *et al.* (2013) in Asiatic lily and Bala *et al.* (2019) in lily.

Bud diameter (mm). The effect of different sources and levels of calcium on bud diameter resulted in a significant difference among the treatments. The treatment 40 g/m^2 dolomite exhibited maximum bud diameter (21.64 mm), while minimum diameter of flower bud (19.38 mm) was noticed in control. The increase in bud diameter is might be due to the applied dolomite which promotes vegetative growth, increased photosynthetic and metabolic activity resulting in more transportation and utilization of photosynthetic products to the developing buds. The results are in line with the findings of Seyedi *et al.* (2013) in Asiatic lily and Bala *et al.* (2019) in lily.

Petal length (cm) and petal breadth (cm). The petal length and petal breadth were varied significantly on the application of different sources and levels of calcium on Asiatic lily. The treatment 40 g/m^2 dolomite has exhibited maximum petal length (11.37 cm) and the petal breadth (4.37 cm). While, minimum petal length (9.11 cm) and petal breadth (3.44 cm) was observed in control. This might be due to the activity of dolomite which helps in cell elongation and enlargement. The same effect was also observed in the findings of Seyedi *et al.* (2013) in Asiatic lily and Bala *et al.* (2019) in lily.

Length of the flower stalk (cm). The data regarding the length of flower stalk showed that the maximum flower stalk length was obtained under treatment 40 g/m^2 dolomite (71.85 cm), while the minimum length of flower stalk was obtained under control (53.40 cm). This might be due to the applied dolomite which helps in promoting the vegetative growth and increases the photosynthetic and metabolic activity which causes more cell elongation, rapid cell division and help in transportation and utilization of photosynthates, this might be responsible for maximum stalk length. The results align with the earlier reports of Sultana *et al.* (2022) in lisianthus, Salazar *et al.* (2011) in oriental lilies, Hamayl *et al.* (2016) in dahlia and Abdulhadi *et al.* (2022) in snapdragon.

Vase life of flowers with and without anthers (days). The vase life of flowers with and without anthers showed a significant difference among the different sources and levels of calcium on Asiatic lily are represented in Fig. 1.

The vase life of flowers with anthers increased with the application of dolomite. The maximum vase life of flowers with the presence of anthers are obtained in the treatment 40 g/m^2 dolomite (8.17 days), while minimum vase life of flowers with anthers observed in control (6.56 days). The maximum vase life is might be due to the inhibition of cellular respiration by the dolomite which led to increase in the vase life of flowers. Calcium plays an important role in delaying the senescence process and increasing the longevity of cut flowers. The results confirm with the Karimi *et al.* (2012) in Asiatic lily, Seyedi *et al.* (2013) in Asiatic lily, Sharma *et al.* (2013) in gladiolus and Mohammadbagheri and Naderi (2017) in gerbera.

The maximum vase life of flowers without anthers achieved with the application of 40 g/m^2 dolomite (9.55 days), while minimum vase life of flowers without anthers was observed in control (7.06 days). The maximum vase life obtained in removing of anthers because the ethylene production by pollen grains can be controlled and thus it prevents the early shedding of petals and also might be due to physiological role of dolomite which helps in delay the senescence of flowers. The results are in conformity with the Emami *et al.* (2011) in *Lilium longiflorum*, Kumari *et al.* (2017) in Asiatic lily.

Yield parameters. The effect of different sources and levels of calcium on number of spikes per square meter varied among the treatments. The number of spikes obtained maximum per square meter (25.00) with the treatments 40 g/m^2 dolomite, 30 g/m^2 dolomite, 20 g/m^2 dolomite, 300 g/m^2 calcium oxide, 200 g/m^2 calcium oxide, 50 g/m^2 calcium nitrate, 40 g/m^2 calcium nitrate and 40 g/m^2 calcium ammonium nitrate, which was found on par with 30 g/m^2 calcium nitrate and 50 g/m^2 calcium ammonium nitrate (24.67 and 24.67, respectively). While the minimum number (23.33) of spikes per square meter was recorded in control. It might be due to the improvement in nutrient availability influenced by calcium application which helped in enhancing the growth of plants, resulting in higher flower yield per plant and also it might be due to the variation in sprouting percent of bulbs. These results are in agreement with earlier reports done by Kiani *et al.* (2011) in rose, Bala *et al.* (2019) in lily, Mohammed and Abood (2020) in gerbera, Putra *et al.* (2018) in okra, Aisyah *et al.* (2017) in maize and Krismawati *et al.* (2021) on maize.

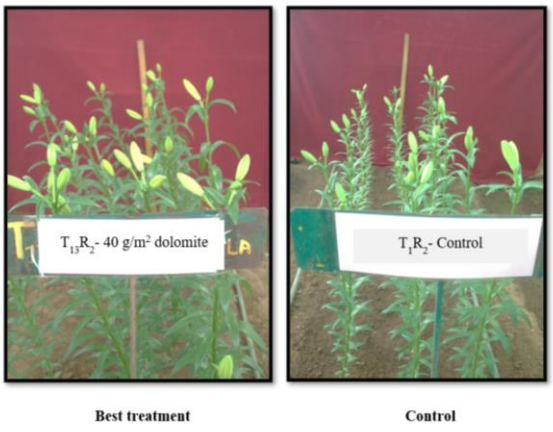

Plate 1. Effect of different sources and levels of calcium on flowering of Asiatic lily.

Table 1: Effect of different sources and levels of calcium on flowering parameters of Asiatic lily.

Tr. No.	Treatment details	Days taken for flower bud initiation	Days taken for first floret opening	Days taken for 50 per cent flower opening	Duration of flowering (days)
T_1	Control	34.87	59.47	66.00	14.00
T_2	30 g/m^2 CAN	33.60	58.87	64.33	15.67
T_3	40 g/m^2 CAN	31.13	55.40	62.00	16.33
T_4	50 g/m^2 CAN	34.27	58.27	65.00	15.67
T_5	30 g/m^2 calcium nitrate	31.40	55.40	61.67	15.67
T_6	40 g/m^2 calcium nitrate	32.47	56.47	64.67	15.33
T_7	50 g/m^2 calcium nitrate	31.80	55.80	63.67	16.00
T_8	100 g/m^2 calcium oxide	33.07	56.73	64.33	15.67
T_9	200 g/m^2 calcium oxide	31.40	57.20	62.00	16.33
T_{10}	300 g/m^2 calcium oxide	32.40	56.40	63.33	15.33
T_{11}	20 g/m^2 dolomite	34.07	58.13	64.67	16.00
T_{12}	30 g/m^2 dolomite	30.20	55.13	62.33	16.33
T_{13}	40 g/m^2 dolomite	29.80	54.53	61.33	17.33
S. Em±		0.50	0.37	0.58	0.34
C.D@ 5%		1.47	1.09	1.70	1.00

Note: CAN - calcium ammonium nitrate

Table 2: Effect of different sources and levels of calcium on flower quality and yield parameters of Asiatic lily.

Tr. No.	Treatment details	Number of buds per spike	Bud length (cm)	Bud diameter (mm)	Petal length (cm)	Petal breadth (cm)	Length of flower stalk (cm)	No. of spikes/m^2
T_1	Control	2.87	6.64	19.38	9.11	3.44	53.40	23.33
T_2	30 g/m^2 CAN	3.00	7.49	19.78	9.89	3.89	65.05	24.00
T_3	40 g/m^2 CAN	3.13	7.20	20.24	10.18	3.62	64.87	25.00
T_4	50 g/m^2 CAN	3.19	6.95	19.92	10.21	3.90	66.63	24.67
T_5	30 g/m^2 calcium nitrate	3.13	6.99	19.46	9.89	3.56	66.32	24.67
T_6	40 g/m^2 calcium nitrate	3.13	8.05	20.47	10.04	3.71	67.29	25.00
T_7	50 g/m^2 calcium nitrate	2.93	7.23	20.53	10.13	3.75	63.95	25.00
T_8	100 g/m^2 calcium oxide	3.00	7.84	20.64	10.23	3.72	67.34	24.33
T_9	200 g/m^2 calcium oxide	3.33	7.37	20.77	10.95	4.15	68.39	25.00
T_{10}	300 g/m^2 calcium oxide	3.00	7.75	20.45	10.30	3.61	68.21	25.00
T_{11}	20 g/m^2 dolomite	3.18	8.05	20.00	10.64	3.95	70.31	25.00
T_{12}	30 g/m^2 dolomite	3.53	8.25	20.91	11.10	4.23	70.69	25.00
T_{13}	40 g/m^2 dolomite	3.60	8.53	21.64	11.37	4.37	71.85	25.00
S. Em±		0.13	0.16	0.23	0.11	0.10	0.17	0.19
C.D@ 5%		0.39	0.46	0.68	0.31	0.28	0.51	0.56

Note: CAN - calcium ammonium nitrate

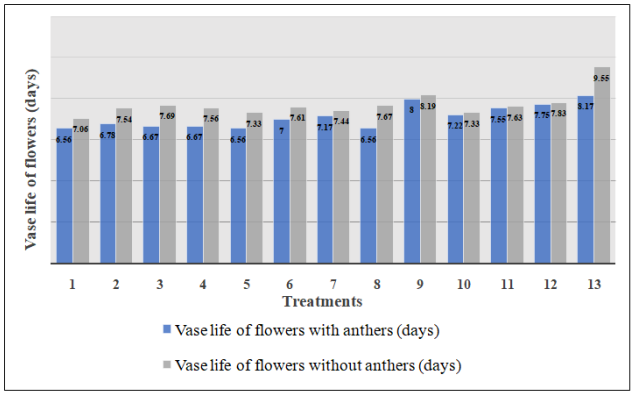

Fig. 1. Effect of different sources and levels of calcium on vase life of Asiatic lily.

CONCLUSIONS

On the basis of the result obtained in the present investigation it is concluded that, the soil application of 40 g per m^2 dolomite at the time of planting proved significant for improving the flowering and quality of Asiatic lily under protected cultivation. Hence, the treatment 40 g/m^2 dolomite may be recommended for commercial cultivation of Asiatic lily.

FUTURE SCOPE

Future studies need to be carried out on effects of higher levels of dolomite along with other micro nutrients on quality and yield of Asiatic lily.

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Conflict of Interest. None.

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