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Investigating of the Effects of Calcium Concentration under Hydroponic Conditions on Quantitative and Qualitative Growth of Lilium ‘Tresor

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Abstract

The Asiatic hybrid lily, a bulbous ornamental plant, has a special position in the horticulture as cut flower. To overcome some problems in nutrition of bulb flowers, the use of hydroponic system and nutrient solution is important in the cultivation of these flowers. The Asiatic Hybrid Lilium bulbs “Tresor” cultivar, used for the current research were planted under 3 different calcium levels including 2, 4 and 6 mM as randomised completely designed with five replications. Comparing the mean values of the data showed that 6 mM calcium produced maximum height of the plant, stem diameter, procreative height, number of buds, flower diameter and longevity of cut flowers.

Keywords: Calcium, Plants nutrition, Soilless, Tresor lily.

INTRODUCTION

Commercial production of ornamental plants is a worldwide business. There has been a remarkable raise of their economical value in the last two decades and in effect, there is a vast tendency in continuous production of these plants in domestic and international markets in the future (Rout *et al.*, 2006). Lilium is a particular ornamental flower which has gained the fourth rank in the international ranking of bulbous ornamental flowers after rose, carnation and chrysanthemum. It is also high in price and very popular, due to its richness and variety of colours and the vast number of flowers it produces (Shiravand and Rostami, 2008).

Lilium longiflorum is a monocotyledon belonging to Liliaceae. Lilium is a native to Japan and southern parts of Liukiu islands, and demands tropical location for growth. The plants within Liliaceae family have high value due to their scented nature, wide range of colours, resistance and their effecting adaptation to their imperfect surroundings (Bahr and Campton, 2004). Asiatic Hybrid Lilium is produced by cross breeding in multiple kinds and compromises one of the largest groups of *Lilium longiflorum* (Karimi *et al*., 2007).

In general, carrying out plant nourishing experiments on bulbous flowers is difficult because the plant bulb itself stores nutrition required by the plant and on the other hand, most of horticulture soils used for planting also store minerals needed for the bulb (Naseri and Ebrahimi, 2002).

Calcium is one of the most necessary minerals in growth of plants and considering that it's an immobile mineral, lack of calcium occurs at ending points and growing branch heads of the plant. This can cause delay in blooming of the plant, or can occur in the same time as natal growth. It has been proven that the necroses on upper lilium leaves are occurred by calcium disorder (Chang, 2002). Upper leaf necrosis in lilium reduces its desirability in the market (Chang *et al*., 2004). It is recommended to grow lilium in hydroponic system to properly receive the nutrition (Shiraavand and Rostami, 2009).

The life cycle of cut flowers is extremely important. Presence of calcium increases the life of flowers such as rose, and prevents cut flower rose from opening prematurely. With the use of calcium, such flowers would have an increase in their life cycle by preventing early blossoming of flower buds. Calcium is also beneficial in preventing the early withering of the leaves and would also reduce the atmospheric factors that would also cause withering of the plant leaves. Higher levels of chlorophyll occur when the range of calcium is 10-3 and 10-4mM. High levels of protein would be linked to when calcium is 10-3 and 10-2mM (Robichaux, 2008).

The use of calcium nitrate and calcium chloride increase calcium concentration in aerial organs including the stem tissues which has a direct effect on increasing the life cycle of the flowers after harvesting (Buchanan *et al*., 2000). Leaves are capable of withholding the highest concentrations of calcium, in aerial organs. This is the response in relation to stomata closure and their release of moisture via the stoma (Buchanan *et al*., 2000). Luiz *et al*., (2005) reported that the use of 10 to 20 mM of calcium sulphate prior to harvesting would prove vital in controlling pathogenic attack and increase durability of the plant. Gislord (1999) reported that the use of calcium causes the increase of durability of trimmed plants and their storage capability. Bhattacharjee and Palalanikumar (2002) in their research reported that the use of calcium compounds, especially calcium nitrate increases the life expectancy of the rose flowers after harvesting, since calcium avoids the synthesis of ethylene and prevents any vascular occlusion. The aim of this study was to achieve suitable concentration of calcium to improve the quantitative and qualitative growth of Lilium.

MATERIALS AND METHODS

This study was conducted in ornamental plants and flower research center, Lahijan, Iran. Lilium hybrid Longiflorum × Asiatic applied to produces orange flower as the test plant. Premature bulbs of this flower by the approximate 18 to 20 cm in diameter and 75 numbers were planted in 15 cm plastic pots Filled with sand and perlite (1:1). Premature Lilium bulbs, due to the lack of tonic or onion scales sensitivity to drought were placed in boxes containing moist peat. The temperature range in greenhouse was 17-21°C with 70% relatively moisture. Three treatments and five replicates per treatment in a completely randomised design were implemented as follows:

A: 2 mM calcium
B: 4 mM calcium
C: 6 mM calcium

The pots were treated with nutrient solution with the basic formula of Hogland (Hogland, 1950). This formula is a complete nutrient solution containing micro- and macro-elements, that are produced at two stages. At first, it should be produce stock solution of each element in the nutrient solution, then to be maintained separately.

During the growth period, pots were irrigated with distilled water as needed. After 4 months, the plants were harvested and the plant height, stem diameter, procreative height, flower bud number, flower diameter, day to flowering, dry matter weight and longevity of flower were measured at every treatment. The experiment was a completely randomised design in five replications and MSTATC software was used for variance analysis of data by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

The ANOVA results showed that the influence of treatment (different concentrations of calcium) on more growth indices of lilium (plant height, stem diameter, procreative height, flower bud number, flower bud number, flower diameter, flower longevity) was significant at 1% of probably level (Table 1).

Stem and Procreative Height

To compare the mean values of the data showed between the treatments, calcium concentration of 6 mM produced the tallest plant and procreative height with 75.4 and 13.1 centimetres respectively (Table 2). The results gathered from the experiments carried out, showed that the increase of calcium concentration in the nutrition soluble solution had a direct effect on the increase in height, both in blooming stem and general height of the plant. These results are similar with Those of Choi *et al*. (2008) and Chung *et al*., (2008). Calcium increased the height of the orchid flower (Gerasopoulos and Chelbi, 1999). Katsa and Narkuba (2001) also reported that calcium prevents the curvature in plant stem and introduces stability and strength to the stem of the flower. This presumably has a direct effect on the height of the stem too.

Stem and Flower Diameter

Results showed that treatment with calcium concentration of 6 mM had the greatest stem and flower diameter with 9.14 mm and 10.06 cm respectively (Table 2). From the above experiment, it became clear that by increasing calcium concentration in nutrition nourishment, the diameter of the flowers and stem thickness increases significantly. Similar results were achieved from the experiments carried out by Choi *et al*. (2001) on lily flowers, Asfabani *et al*. (2008) on rose flower. Apparently by increasing the calcium concentration in nutrition soluble solution, the calcium concentration within the aerial organs also increase. Based on the fact that calcium aids the improvement of cellular membrane, therefore the plant is expected to produce larger flower diameters.

Flower Bud Number

Maximum number of flower buds per plant by using different concentrations of calcium was related to the 6 mM calcium which was 8.6 buds (Table 2). Choi *et al*. (2008) stated that calcium concentration increases the number of flower buds but this change was not significant. In the study carried out by (Robicheux, 2008), it was stated that the increased levels of phosphorous through the increased concentration of calcium in the nutrient solution, had the greatest impact on the reproduction growth of the phosphorous plants, the reason behind the increased number of flower buds and the overall health of reproductive growth under the influence of calcium, was known to be due to the increased levels of phosphorous in the plant shoot.

Longevity of Cut Flowers

Comparing the mean values of the data showed that between the different treatments, calcium concentration of 6 mM produced 10.27 days which counted as the longest plant's life cycle (Table 2). Similar results were observed from the experiments carried out on the effect of calcium concentration on the cut flowers of ornamental plants. These experiments were done to study the effect of calcium concentration on life cycle of rose flower by Capdeville *et al*. (2004), Mehran *et al*. (2007), Bhattacharjee and Palalanikumar (2002). Also Robichaux (2008) carried out experiments on *Euphorbia pulcherrima* flower, Gerasopoulos and Chelbi (1999) on Gerbera and Sosanan (2007) on sunflower which also showed similar results. Considering the effect of calcium ion on the activity of ethylene in cellulose membrane of the leaves, apparently calcium causes delay in early withering of the plant by decreasing the atmospheric factors which help the aging and early withering of the plant and also avoids leakage. Plants will avoid the problems such as premature growth and blossoming of the plant, and showing the signs of poor health, by consuming calcium. Therefore the period of their life cycle increases.

CONCLUSION

In conclusion, the effect of 6 mM calcium was better than other concentrations of calcium in increasing the growth of lilium. Increasing the concentration of calcium in lilium nutrition caused to increase all growth indices particularly plant height, stem and flower diameter, bud numbers, vase life of cut flowers.

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Tables

Table 1. Influence of different concentrations of calcium on growth traits of lilium.

Variation resources	df	Plant height	Stem diameter	Procreative height	Number of buds	Flower's diagonal diameter	Time taken to blossom	Weight of the dried plant	Plant's vase life
Calcium Concentration	2	267.6**	1.97**	8.56**	7.21**	4.672**	15.76^{ns}	12.37^{ns}	5.75*
cv(%)		**5.3**	**3.87**	**4.41**	**7.10**	**7.51**	**5.96**	**17.75**	**12.71**

*: Significant in probability level of 5%
**:Significant in probability level of 1%
ns: Not significant

Table 2. Comparing the mean values of the effect of calcium concentration on growth traits.

Treatments (Calcium concentration)	Plant height (cm)	Stem diameter (mm)	Procreative height (cm)	Number of buds	Flower's diagonal diameter (mm)	Time taken to blossom (Days)	Dried matter (g)	vase life (Days)
2 mM	70.6c	8.72c	12.3c	7.8b	9.43b	61.8a	17.4a	9.59b
4 mM	72.6b	8.94b	12.6b	8.3a	9.63b	61.4a	17.9a	10.11ab
6 mM	75.4a	9.14a	13.1a	8.6a	10.06a	60.7a	18.4a	10.27a

According to LSD sample, in every column of data, each data accompanied with same letter is not significant in level of 5.