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FOLIAR APPLICATION OF PLANT GROWTH REGULATORS (PGRs) AND NUTRIENTS FOR IMPROVEMENT OF LILY FLOWERS

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Abstract

Foliar application of either GA_3 ($20mgL^{-1}$), or a nutrient solution (comprising of KNO_3, $19mgL^{-1}$; NH_4NO_3, 16.5 mgL^{-1}; KH_2PO_4, $1.7mgL^{-1}$, $CaCl_2$, 4.4 mgL^{-1} and $MgSO_4$, $3.7mgL^{-1}$) or both on lily plants was undertaken. It was found that flower stem length of the plants sprayed with nutrients alone increased by 25% over those of the control plants. Mean shoot length of the plants sprayed with both the hormones and nutrients increased by 33% over the control plants and by 6% over the other set of plants, which received the treatment of nutrients alone. Number of nodes per stem was also found to increase in the dually treated plants by 71% and 42% in that order. The plants receiving dual treatment harbored 92% greater number of buds per stem over the control plants whereas nutrients- alone treated lily plant showed only 28% greater number of buds. Mean number of flowers produced by nutrient fed plants was 14% greater over the control plants. Foliar application of GA_3 and nutrients application was found to have improved the productivity and quality of lily cut flowers and may be exploited commercially in horticulture industry to fetch premium price for cut flowers.

Introduction

Lily (*Lilium longifolium*) is an ornamental plant belonging to the family Liliaceae. Plants within the genus Lilium are highly prized by horticulturists because of their outstanding fragrance, range of colors, hardiness and adaptability to diverse environmental conditions (Bahr & Compton, 2004). Lily has been used for different purposes including bouquet formation, decoration of hotels, houses, luxury buildings, marriages, funeral and religious ceremonies for over 2000 years. It is mostly propagated vegetatively by bulbs and is cultivated commercially for cut flowers and potted plants. A few cultivars of Easter lily are commercially sold (Ramsay *et al.*, 2003). Production of cut flowers in Pakistan is estimated at about 10-12 thousand tons per annum and floriculture is fast emerging as a profitable venture for small farmers in this country (Rehman, 2004). Yet, Pakistan's share in the international trade of fresh cut flowers is miniscule due to low quality produce, which is attributable to non-availability of technology and formulations of nutrients and growth regulators. Various techniques are used for increasing stem length, number, quality and shelf life of lily flowers. Plant hormones are involved in controlling the growth, development, metabolism and morphogenesis of higher plants (Taiz & Zeiger, 1991). Foliar application of nutrients and plant growth regulators may improve flower quality parameters. Gibberellins possess a variety of functions in vegetative and reproductive phases of plant life cycle. They control many growth, development and differentiation processes such as seed germination, stem elongation, leaf expansion, trichome development, flower and fruit development (Davies, 1995) and *In vitro* culture responses (Kashif & Sajid 2005). There are reports that natural gibberellin like substances appear during successive stages of ripening and germination (Sarihan *et al.*, 2005).

Due to increased demands in the international markets, year round production of cut flowers has become common among the growers of industrial countries. For control of flowering that is required for year round production, the bulbs and plants are treated with specific temperatures and chemicals to impact their growth and development in order to schedule their production according to the market demands. Use of artificial growth conditions for flowering of bulbs to simulate those required by nature is referred to as flower forcing (Le Nard & De Hertogh, 1993). Many growth conditions have contrasting effects on lily flowering. Longer day lengths enhance flower development and higher irradiation increases the rate of flower development and the number of flowers but decreases plant height (Wilkins & Dole, 1997). We attempted to exploit the foliar application of a solution comprising of both GA_3 and nutrients in improving the flower production and flower quality in lily plantations and found very encouraging results which are reported in this paper for commercial applications of growth regulators and nutrients in floriculture industry.

Materials and Methods

Lily plants were grown in field conditions and split into 6 blocks to allocate 2 blocks each for every treatment and a set of control plants, which were not given any treatment. All the chemicals and plant growth regulators were of Sigma Chemical Company, USA and reagent grade. One set of plants was treated with a solution of nutrients, which included KNO_3 ($19gL^{-1}$), NH_4NO_3 ($16.5gL^{-1}$), KH_2PO_4 ($1.7gL^{-1}$), $CaCl_2$ ($4.4gL^{-1}$) and $MgSO_4$ ($3.7gL^{-1}$). Another set of plants was sprayed with a solution containing the same nutrients and also a plant growth regulator viz., GA_3 (20ppm). The solution was prepared according to the protocols outlines by Sajid *et al*., (2006). A third set of plants neither received any nutrients nor a GA_3 treatment but was simply irrigated with plain water and was referred to as the control plants. Spray on plants was executed once every alternate day by using a fine mist-producing air pressure-operated machine. Data on the flowers stem length, number of flowers and buds was recorded after 30 days of experimentation, means calculated and percent differences among these parameters for different treatments were reported.

Results and Discussion

Lily plants grown in field conditions were sprayed with either a solution containing nutrients or both the nutrients and GA_3 for three weeks. They were then observed for differences in length of flower stalks, number of nodes, number of flowers and number of buds. Results of these experiments are summarized in the Table 1. Control plants had very poor growth and maximum shoot length achieved by them in the prescribed duration was only 62.5cm whereas shoot length of the plants sprayed with nutrients increased to 78 cm which is about 25% longer than the control plants. Similarly, mean shoot length of the plants sprayed with both the hormones and nutrients was 82 cm which is about 33% higher than the control plants and 6% higher than the other set of plants which received the treatment of nutrients alone. Number of nodes per stem was also enhanced due to the

Table 1. Lily growth parameters as affected by foliar application of GA_3 alone or a combination of both GA_3 and nutrients as compared with the control plants.

Treatments	Stem length (cm)	No. of nodes	No. of buds	No. of flowers
Hormones plus nutrients	82	6	13.5	4.5
Nutrients minus hormones	78	5	9	3.5
Control plants	62.5	3.5	7	3

nutrients and hormonal treatments as control plants exhibited a mean of only 3.5 nodes per stem whereas the nutrients treated plants had 5 nodes per stem amounting to 42% greater than the untreated plants. Plants which received dual treatment of hormones and nutrients, showed the highest number of nodes per plant i.e., 6.5, which amounts to 71% higher than the control plants. Number of buds per stem in case of untreated plants was only 7, whereas nutrients-treated lily plants showed 9 buds per stem (28% greater) and the plants receiving dual treatment harbored 13.5 buds per stem (92% greater). Mean number of flowers in control plants was three whereas in nutrients-fed plants, it was 3.5, which are 14% more than untreated plants. Number of flowers per plant in the set of plants, which received dual treatment, was 4.5, which are 50% more than control plants.
Nutrient deficiency has been shown to result in severe productivity and quality losses in flower plant species. Calcium application has been reported to correct upper leaf necrosis, a calcium deficiency disorder and decreases the market value of flowers and reduces its appeal to customers (Chang, 2002 and Chang *et al.,* 2004). Calcium also corrects tip burn in Asiatic hybrid lily (Berghoef, 1986). Nitrogen, an essential component of protein, nucleic acid and many important substances like chlorophyll, is required for vegetative growth and has been used for higher production of quality flowers (Viradia & Singh, 2004). Phosphorus has been found to affect leaf size, number of nodes and amount of flowering (Zhang *et al.*, 2004) and its deficiency reduces vegetative growth and flowering of chrysanthemum (Hansen & Lych, 1998). Magnesium increased resistance to breakdown of fruit by applying the higher concentration of Mg (Perring, 1968). Thus, foliar application of these nutrients to cut flower species may be exploited for production of greater number of cut flowers per unit area and also for improving the quality of cut flowers grown commercially.

All of these nutrients not only help to combat deficiencies but also increase stem length, number of flowers, buds and nodes. By combining growth hormones like GA_3 with nutrients, stem length, number of nodes, buds and flowers increased as compared to control plants. GA_3 has been reported to prevent chlorophyll degradation in *Zantedeschia* leaves (Janowska & Jerzy, 2003). Biles & Cothren (2001) have also been able to produce more flowers in GA_3 treated plants than in the control plants by the 40th day of flowering through the end of flowering. Growth and flowering of Philodendron was also found to be affected by application of gibberellic acid (Chen *et al.*, 2003). Conversely, Kadioglu & Atalay (2002) have shown that GA_3 applications led to decreased levels of total phenolic substances in *Diospyros lotus* fruits. Their results showed that GA_3 not only induced parthenocarpic fruit formation, but they also changed chemical content of the fruit. Therefore, GA_3 application has been advocated as a means to produce high quality fruit in *D. lotus* and perhaps other species. Gibberellins are the most powerful of the growth promoters because they increase internode spacing, induce and promote flowering in many plants and modify the flower sex expression in some plants (Davies, 1995). Flowers have been induced and initiated by high concentration of GA_3 in olives (Ulger *et* *al*., 2004). Similarly, rose sepals synthesize GA_3 during flower development as their removal reduced the fresh and dry weights, as well as the length of buds and the peduncles (Ganelevin & Zieslin, 2002).

More recently, Khan & Chaudhry (2006) have shown that lead and mercury toxicity effects on flowering of cucurbits can be partially mitigated with the help the GA_3 application. This implies that lands polluted with heavy metals such as those near the tanning industry of Pakistan and elsewhere can be partially reclaimed with exploitation of plant growth regulators. However, more extensive studies may be required to verify the findings. Plant growth regulators (PGRs) have yet not been fully exploited in this country and extensive studies may be undertaken for their optimization for commercial application in apple trees to promote fruit reddening; treatment of cherry, hazel and walnut trees to advance fruit loosening; treatment of cucumbers to induce stunting and to promote female sex expression; treatment of tobacco to hasten maturation and to inhibit tillering and treatment of cotton plants prior to harvesting to provide defoliation synchronized with increased boll opening in preparation for harvest of quality cotton in high yields. These areas are of particular interest to Pakistan's agricultural scenario. It is very vital that horticulture industry of Pakistan exploits plant growth regulators for fruit and flower induction and quality improvement for domestic and export earnings.

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