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Full Length Research Paper

The effect of GA_3 and BA on the quantitative and qualitative characteristics of calla lily (*Zantedeschia aethiopica cv. Childsiana*)

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Flowering is a complex morphological happening that occurs in apical meristem of stem. This investigation was carried out to study the effects of two hormones including gibberellin (GA) and benzyl adenine (BA) on calla cut flower production. The rhizomes were dipped in GA solution with concentrations include (0, 100, 200 and 500 ppm). BA with concentrations (0, 100, 200 and 500 ppm) was sprayed on flowering stems until flowering time. The results showed that maximum flower yield was obtained in GA solution with concentrations of 500 ppm followed by BA solutions (200 and 500 ppm). However; flowering in control plants was occurred earlier than other plants. Maximum flower weight (54/97 gr) was observed in treatment 200 ppm GA followed by 0 ppm BA and application of 500 ppm GA and 500 ppm BA resulted to minimum flower weight (38/09 gr). Interaction effects of two hormones were significant on chlorophyll content. The maximum chlorophyll content was observed when 500 ppm gibberellins and 500 ppm benzyl adenine were applied in the same time.

Key words: Calla lily, gibberellin, benzyl adenine, flower yield, chlorophyll content.

INTRODUCTION

Zantedeschia spp. (Araceae) is a genus with 6-7 species, which are all native to South Africa (Dole and Wilkins, 1999). Z. *aethiopica* is commonly known as arum lily calla (lily of the Nile). The plant develops rhizomes, which are used for propagation. The arrow shaped leaf blades are borne on long thick leaf stalks that sheathe the stem base. The florets are borne on a spadix with no sterile flowers separating between male and female florets (Luria et al., 2005). The underground storage organ is thickened and fleshy and has been classified as a corm, tuber, or rhizome (Funnell, 1993). *Z. aethiopica* appears to have no true dormancy, as the plants will flower continuously if summer temperatures are not high and moisture is supplied (Brooking and Cohen, 2002; Dole and Wilkins, 1999). When temperatures stay above 16°C or reach 21°C however flower production decreased and eventually ceased (Tjia, 1989). When grows in wet marshy ground in their native habitat, calla plants often reach 180 cm in height. Some varieties are hardy and can tolerate freezing conditions. Even when leaves are damaged by frost, the rhizomes usually survive. It is a tuberous day-neutral plant in which flowering is not induced by environmental signals. Flower yield in calla lily (*Zantedeschia* spp.) is relatively low due to developmental constrains related to branching and flowering control. But as in other Araceae family, the flowering of calla can be influenced by gibberellins treatments (Hertogh and Nard, 1993; Lubovski, 1991; Wright, 2000.). Also, Naor et al. (2005) showed flower yield is increased by treatments with gibberellin and benzyladenine. Naderi et al. (2006) in study of *Cyclamen persicum* plant resulted that flower weight mean with twice spraying of 10 µM gibberellin together twice 50 µM gibberellin spraying was placed in first group and was placed in second group with once spraying by 50 µM

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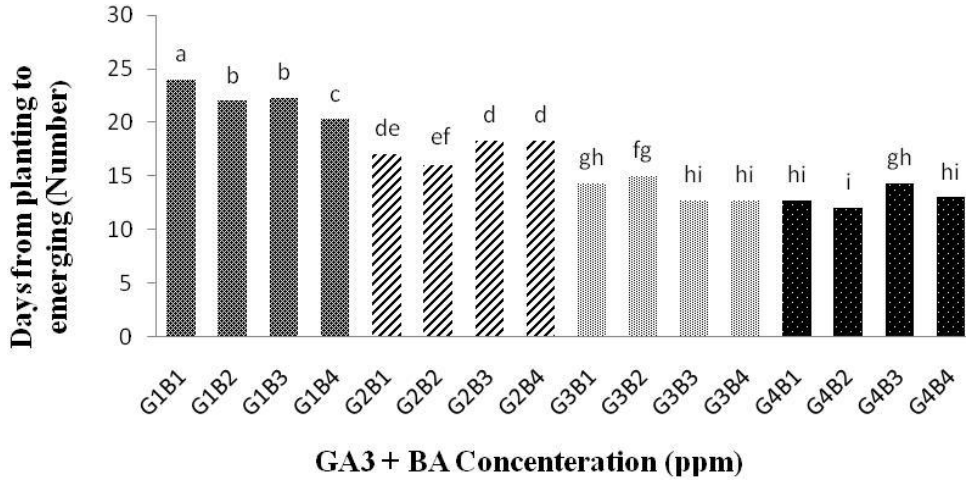

Figure 1. Interaction effect of GA_3 and BA on number of days from planting to emergency.

gibberellin.

MATERIALS AND METHODS

To evaluation of gibberellins and benzyl adenine hormones effects on calla lily (*Zantedeschia aethiopica* cv. childsiana) were conducted a green house experiment in 2007 in greenhouse of agriculture faculty of Tehran University. Rhizomes of calla flower harvested from greenhouse in Pakdasht in Tehran in early summer. Then cleaned and for one week dried in 20°C temperature. If gibberellin treatment concentrations or duration of it become very high, leaves blade will become thin and narrow and so, if rhizomes are very dry, extra gibberellin solution can absorb.

Pretreatment with gibberellin rhizome dipped in water or sprayed by water. Then for inhibition of fungal contamination, rhizomes dipped for 15' in 1% captan solution preplanting. These rhizomes had approximately same size.

One forth of rhizomes dipped in distilled water and One forth in 100 µM gibberellin solution + tween 20 (0/15%) and one-forth in 200 µM gibberellin solution + tween 20 (0/15%) + another one-forth in 500 µM gibberellin solution + tween 20 (0/15%) for 30 min.

For study of benzyl adenine effects on secondary shoots flowering approximately 50 days after rhizome planting time (appearance of two perfect), these plants treated with benzyl adenine leaf spraying.

Respectively, per two weeks one-forth of plants from every previous treatment sprayed with distilled water and 100 µMe benzyl adenine solution + tween 20 (0/15%) and 200 µMe benzyl adenine solution + tween 20 (0/15%) and 500 µMe benzyl adenine solution + tween 20 (0/15%).

Also, with appearance of two perfect leaves was conducted leaf spraying with diluted perfect fertilizer to 1/5 /1000 concentration.

This experiment was carried as a factorial in base of randomized perfect design by 3 replicates that per experimental unit included 4 pots. Finally data analyzed by MSTAT-C soft ware.

RESULTS AND DISCUSSION

Number days from planting to emerging (DTE)

Gibberellin factor is significant on number days from planting to emerging trait in 1% probability level and causes that emerging date of plant promotes. Maximum days from planting to emerging are related to control treatment. Also, the minimum number of days was seen by application of 500 µM Gibberellin solution in plants. Between the effect of the two solutions of 200 and 500 µM, the studied trait did not show significant difference, and both solutions were placed in the same statistical group (Figure 1).

Between the effects of four different solutions of benzyladenin doesn't show significant difference on this trait. Maximum days from planting to emerging (17 days) were seen in distilled water treatment and min of that (16 days) in 500 µMe benzyl adenine solution.

Interaction effect of these two factors became significant on this trait. Maximum days from planting to emerging in control treatment and during 24 days occurred and minimum of that (12 days) is related to (14) treatment that is equal to same time application of 500 µMe gibberellin solution and 100 µMe of benzyl adenine.

Leaf chlorophyll content

Chlorophyll has primitive and important role in plants because of absorption and applying of light energy in photosynthesis. So, the effect of plant growth regulators on chlorophyll biosynthesis and analyze affected directly on photosynthesis.

Gibberellin hormone is significant in 1% probability level on plant leaves chlorophyll contents that measured by chlorophyll-meter. Between 200 and 500 µMe concentrations of hormone didn't show significant difference (Figure 2).

The lowest content of chlorophyll was seen in control treatment. Also, the highest content of chlorophyll there was in 200 µMe treatment of gibberellin hormone.

Benzyl adenine factor is significant in 1% probability

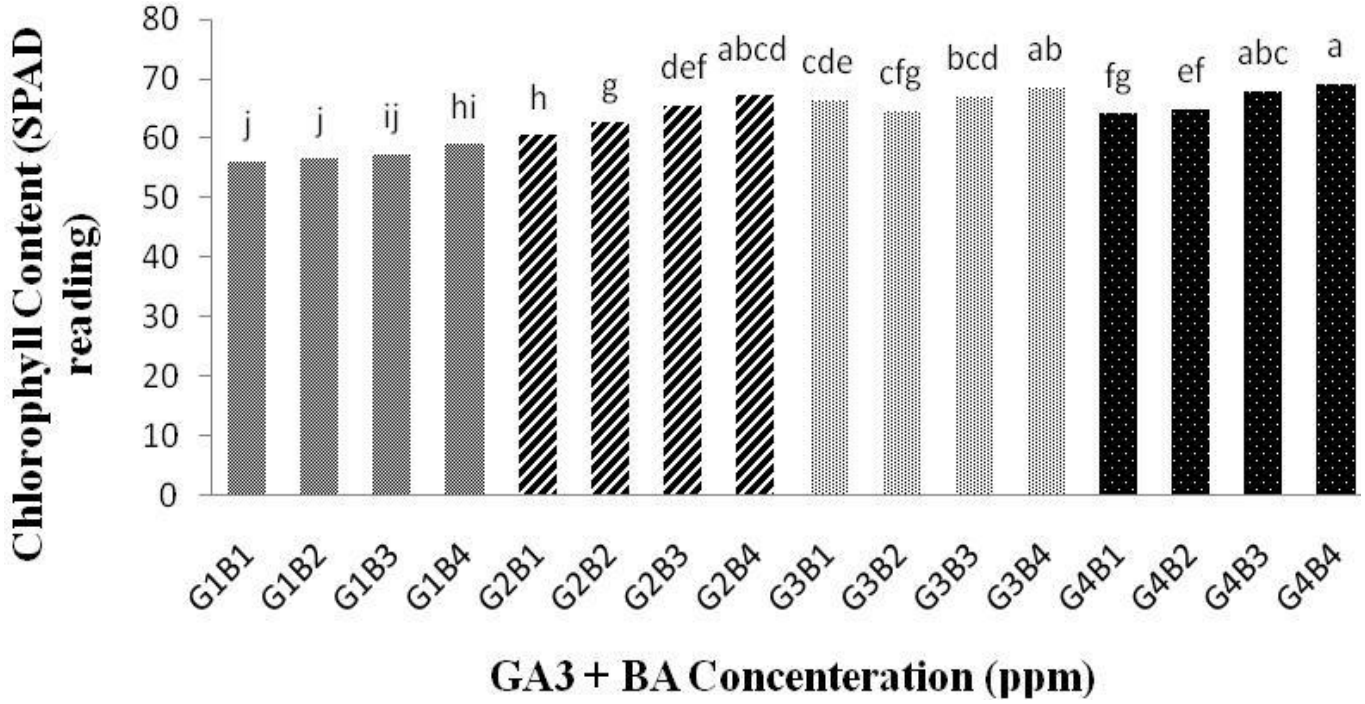

Figure 2. Interaction effect of GA_3 and BA on chlorophyll content (SPAD reading).

level. Application of this hormone increased chlorophyll content in plant leaves. Otherwise, in 500 µMe treatment of that there was the highest of chlorophyll content. Also did not show significant different between control and 100 µMe treatments of benzyl adenine in about this trait.

Interaction effect between was applied two hormones on chlorophyll content is significant in 5% probability level. The highest chlorophyll is related to (16) treatment that is equal to same time application of gibberellin and benzyl adenine with 500 µMe concentration and lowest of that was seen in control treatment (distilled water).

Although, cytokinins are not perfectly inhibited from senescence, their effects can be stimulated perfectly, especially when they are used as spray on the leaves that are joined to the plant. If only one leaf of plant treat by cytokinin, that leaf remain green and other coeval leaves become yellow and fall.

Leaf number

Gibberellin hormone decreased the leaf number. This factor is significant in 1% probability level on leaf number. Maximum of leaf number produced in control treatment and min of that in 500 µM treatment.

Means of treatments comparison show that there is significant different between four concentrations of gibberellin solution.

Funnel (1992) expressed that regardless to storage and promalin treatments, flowering primary shoots moderately have 2/2±0/1 leaves when these shoots is flowering and non-flowering primary shoots have 3/8±0/2 leaves. At development time of shoot, non-flowering primary shoots for example have 5/4±0/1 leaves (Figure 3).

With increasing of promalin concentration to up 100 µM, decreases leaves number average on primary shoot. Also duration of storage is effective on leaf number in about primary shoot that probably reflects difference in growth environment temperature and daily light complements that is threefold more than storage direct effect in planting time.

Whereas gibberellin utilization preplanting (50 µM, gibberellin) increases proportion of emerging bud as a shoot, decreases total leaf area, leaf number and tuber size (Funnell et al., 1992).

Separating of flowers that stimulates by gibberellin application has no effect in tuber size difference. As regards to variance analysis table such appears that comparison of benzyl adenine different levels means on this trait has difference rather than each other and places in four separated groups. This hormone increases leaf number. In control treatment is produced min of leaf number and maximum number is related to 500 µM solution.

Interaction effect between these two hormones is significant in 1% probability level. Maximum leaf number that produced is related to (4) treatment equal to 0 µM gibberellin and benzyl adenine 500 µM solution. Also in (13) treatment includes 500 µM gibberellins and 0 µM

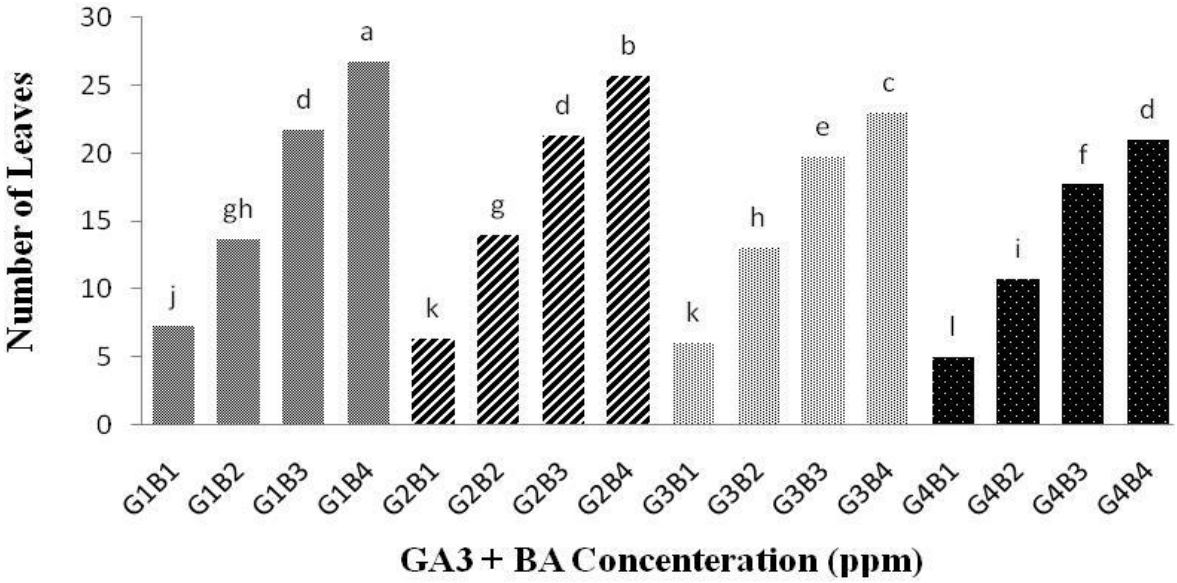

Figure 3. Interaction effect of GA_3 and BA on number of leaf.

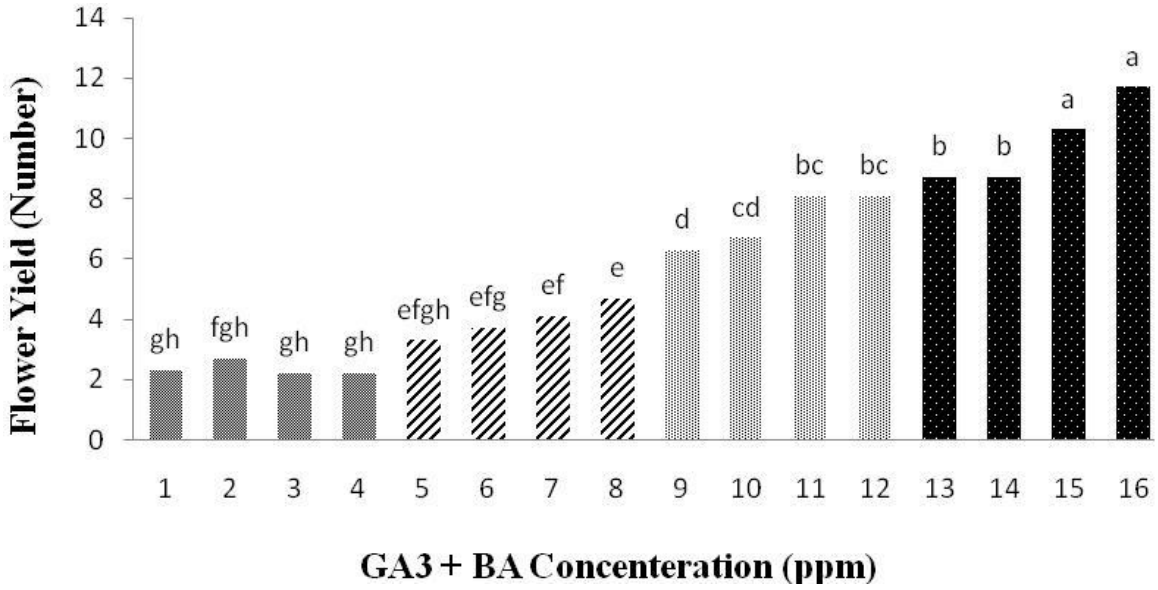

Figure 4. Interaction effect of GA_3 and BA on flower yield.

benzyl adenine showed lowest of leaf number.

Flower yield (flower number in per pot)

Application of gibberellin and benzyl adenine hormones as two effective and important chemical factors in gaining of more yield, has pleasing economical results. Plant growth regulators especially gibberellins can improve flowering in most of plants. Promalin that is combination of GA_4 and GA_7 and BA, includes 1/8% (w/w) GA_{4+7} and 1/8% (w/w) BA that results branching induction in some plants and may be as a gibberellin replacement for increasing of shoot and flower production in calla lily (Cline, 1994) (Figure 4).

Comparison of data means shows that application of gibberellin hormones has significant effect on flower yield. By 500 µM solution utilization of this hormone was produced maximum flower in per pot. Also, minimum flower number is related to control treatment.

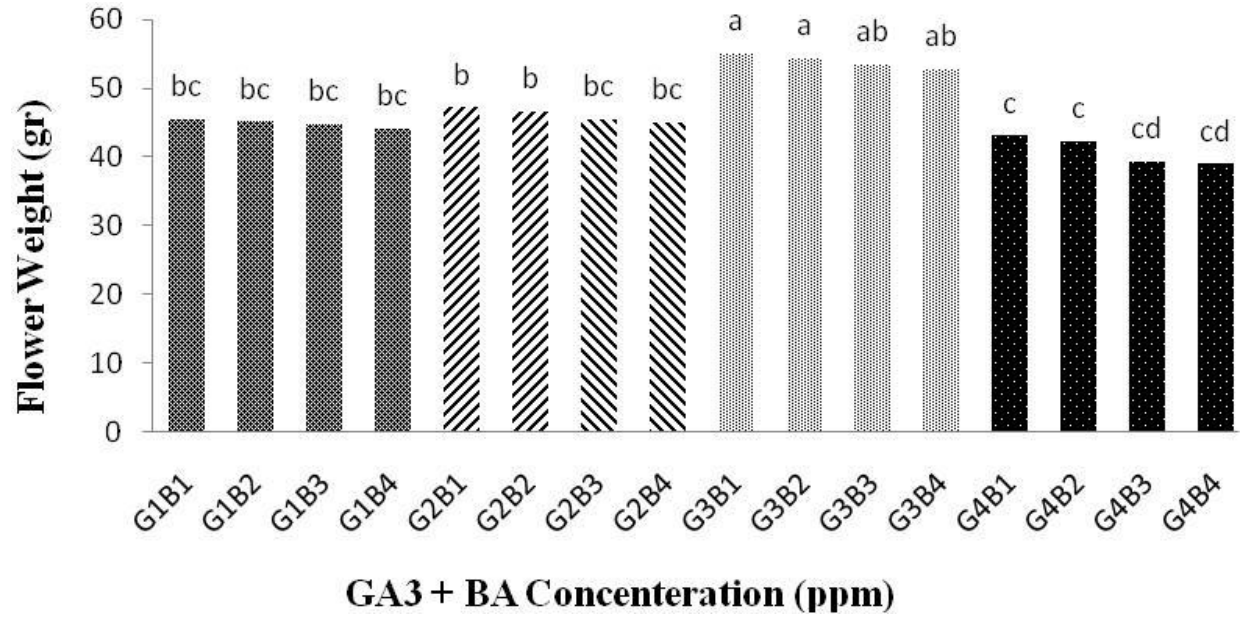

Figure 5. Interaction effect of GA_3 and BA on cut flower weight.

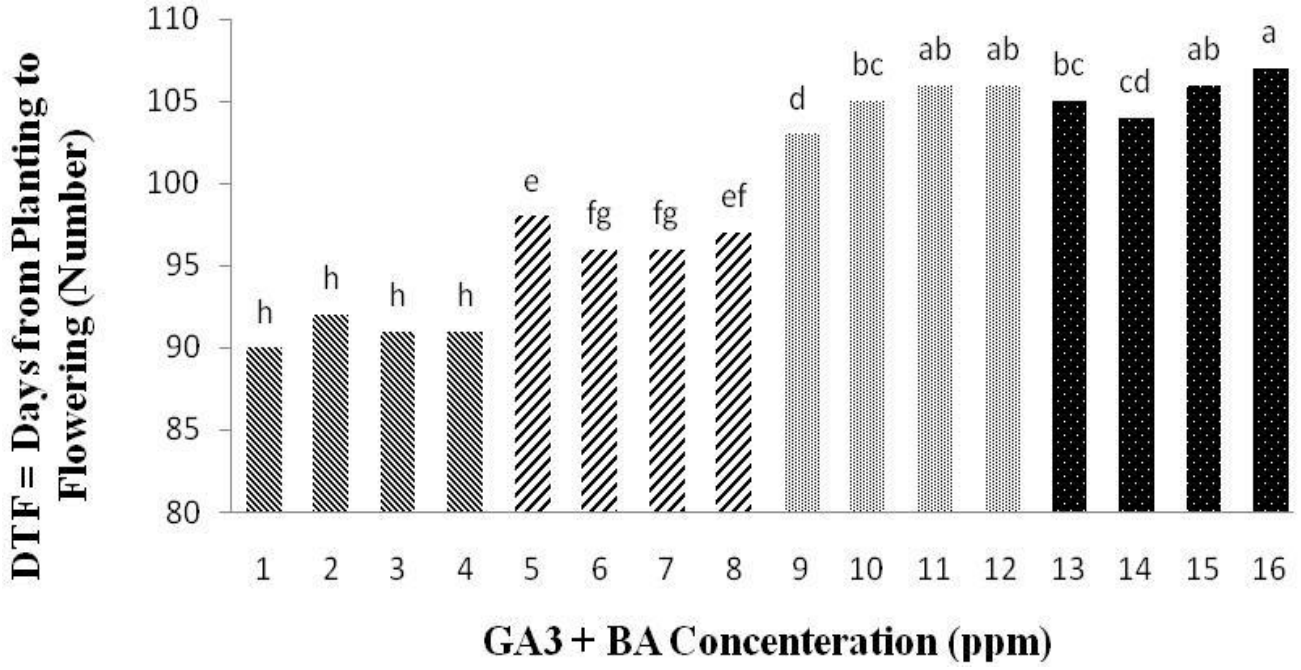

Figure 6. Interaction effect of GA_3 and BA on number days from planting to flowering.

Between benzyl adenine different concentrations effect did not show significant difference on flower yield trait. But small increasing was seen in high concentrations rather than less concentrations.

In study of two factors interaction effects on calla lily flower yield trait, Comparison of means in this experiment indicates that maximum flower yield is related to apply 500 µM gibberellin solutions together each of 200 or 500 µM benzyl adenine concentrations.

Hertogh and Nard (1993) and Lubowski (1991) showed that gibberellin spraying on *Zantedeschia aethiopica* cv. Childsiana increased flower yield. Our experiment results is agree to Luria et al. (1992) that indicated benzyl adenine and gibberellins treatments are effective in

flowering. Rhizomes dipping in 350 µM gibberellin together 350 µM benzyl adenine caused five–fold increasing in flower yield.

Treder (2005) showed that in Florex Gold and Pink Persuasion cultivars, 5 – 6 flowers and in Cameo and Black Magic cultivars, 3–4 flowers produced from one tuber. In Pink Persuasion and Black Magic cultivars, difference in yield was not significant between 50 and 100 µM gibberellin solutions. Flower yield in Black Magic, Florex Gold, Pink Persuasion and Cameo, after treatment by gibberellin was more than control plant, 1/6, 1/7, 2/4 and 2/8 times, respectively.

This information is agreed to previous observation of Corr and Widmer (1990) and Dennis et al. (1994) and Janowska and Krause (2003) on calla lily.

Cut flower weight

Comparison of data means shows that utilization of gibberellin hormones has different effects on cut flower weight. Application of 200 and 100 µM gibberellin solutions produced respectively cut flower weight equal to 53/88 and 46/06 gr that flower weight in both treatments was more than control treatment (44/87 gr). But in 500 µM gibberellin solution, cut flower weight was less than control treatment (Figure 5).

Benzyl adenine application decreased cut flower weight. Experiment results shows such that maximum cut flower weight produces in control treatment and min of that in 500 µM treatment of this hormone. In study of interaction effects of these two hormones on cut flower weight trait was seen that there is maximum flower weight in 200 µM gibberellin and 0 µM benzyl adenine treatments and min of that in treatment include 500 µM gibberellin and 500 µM benzyl adenine.

DTF (number days from planting to flowering)

Rhizome treating with gibberellin preplanting caused flowering is delayed. Control treatment flowered earlier rather than other treatments. Between 200 and 500 µM concentrations of gibberellin hormone didn't show significant difference. Maximum days from planting to flowering are related to 200 and 500 µM treatments of gibberellin. It may be because of further vegetative growth in gibberellin treatments which flowering delayed in this experiment. Application of benzyl adenine is effective on number days from planting to flowering. 500 µM concentration of BA caused delay in flowering. Also, between control and 100 µM treatments of BA did not show significant difference on this trait and both of them flowered after 99 days.

Variance analysis table shows that the interaction effect between GA×BA is significant in 1% probability level. Generally, such resulted that flowering occurs earlier in control plants rather than others. Delay in flowering of calla lily after gibberellin treatment had shown by Janowska, Krause (2003) on Pink Persuasion and Sensation cultivars and by Treder (2003) on Mango, Black Magic cultivars. Although Funnell et al. (1993) in comparison of promalin and gibberellin effects on Galaxy cultivar had shown that flowering of plants occurred regardless to these treatments and all of them had flowered approximately at the same time.

Treder (2005) in experiment on 4 cultivars of calla lily showed that earliest flowering occurred in Florex Gold (54 days) then in Black Magic, Pink Persuasion (58 days). Among these 4 cultivars, Cameo flowered 63 days after application of gibberellin.

Conclusion

Finally it was concluded that maximum flower yield was obtained in GA solution with concentrations of 500 ppm following by BA solutions in calla lily (Zantedeschia aethiopica cv. 'Childsiana'. However; flowering in control plants was occurred earlier than other plants. Maximum flower weight was observed in treatment 200 ppm GA followed by 0ppm BA and application of 500 ppm GA and 500 ppm BA resulted to minimum flower weight (38/09 gr). Interaction effects of two hormones were significant on chlorophyll content. The maximum chlorophyll content was observed when 500 ppm Gibberellins and 500 ppm Benzyl adenine were applied in the same time.

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