FLOWER INDUCTION, CHLOROPHYLL FLUORESCENCE AND CAROTINOID OF ALLAMANDA SP. AS AFFECTED BY GIBBERELLIC ACID AND ALUMINUM SULFATE

A.B.M. Sharif. Hossain1,2,3 & M. Amaninah1

1Biotechnology Program, Department of Biology, Faculty of Science, Hail University, Hail, KSA.
2Biotechnology Division, Institute of Biological Science, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
3Corresponding Author

Abstract

Allamanda sp. is an important ornamental plant for environmental and medicinal values. Plant growth hormone keeps a superlative role to improve the flower quality like early flower induction, color and size as well as hybrid innovative production in the floriculture industries. The study was carried out to evaluate the effects of gibberellic acid (GA3) at 100 mg/l and aluminium salt (sulfate) on the flowers development and early initiation. Number of buds and flower, flower weight, chlorophyll fluorescence yield and total carotenoid contents were determined. The result showed that GA3 at 100 mg/l application in bud initiated spot swabbing was most effective in getting early bud and flower initiation, delaying senescence and discoloration (fresh) followed by Al2(SO4)3 and water control. Chlorophyll fluorescence yield and carotenoid contents were also highest in flowers treated with GA3. The quantum yield (Fv/Fm) was maximal in GA3 treated flower. These results indicate that hormone application (GA3) was the best treatment to develop flower quality of Allamanda sp.

Keyword: Gibberellic acid; flower initiation; weight; carotene, Allamanda flower.

Introduction

Allamanda species are native to the Americas, where they are distributed from Mexico to Argentina. Allamanda species are familiar as ornamental plants cultivated for their large, yellow and pink colorful flowers and make attractive to the environmental beautification (De Souza-Silva and Rapini, 2009). The Allamanda vine and flower perfectly combine the beauty and make them garden favorite. Allamanda cathartica has almost year-round evening fragrance from the multitude of flowers. Flowers are mostly yellow and environmental friendly (Antosh, 2012). Allamanda is used throughout the tropics as ornamentals. The flowering is a complete developmental process consisting of the sequential phases namely flower induction, initiation, flower opening, pollination and flower senescence. Flower induction or the influence of flowering time depends on some known factors such as physiological stress, nutrient availability, light, day length and temperature. The timing of the transition from vegetative growth to flowering is of paramount importance in agriculture, horticulture and plant breeding because flowering is the first step of sexual reproduction (Koning, 1982, Georges et al., 1993). The plant hormones may have a profound effect on the growth and the development of the plant organ. Plant hormones may control the plant growth and the development by affecting the cell division, elongation and differentiation (Hossain et al., 2008).

Environmental factors, such as natural stress and nutrient availability influence flowering time, but perhaps the most important are light intensity, day length and temperature (Ana et al., 2004). Other factors also have been found to induce flower earlier or frequent flowering such as plant growth regulating hormones and chemicals (Hossain et al.2008). The most reliable method of flower promotion has been found to be the application of plant growth regulators such as gibberellins and cytokinins. In most experiments, the best results have been achieved by GA3 and along with some additional chemicals such as ethanol, 8-hydroxyquinoline sulfate and aluminium sulfate (Hossain et al., 2008; Ichimura and Korenaga, 1998; Ichimura and Ueyama, 1998).

High concentration of GAs showed a positive role on flower formation in olive during induction and initiation period. In addition, the application of gibberellic acid (GA3) has the potential to control growth and flowering and induce earliness of meristem (Khan and Chaudhry, 2006; Sharma and Room, 2009).

GA3 promotes flowering in a range of plant species. Many species that flower early in response to GA3 also flower early in response to long days or vernalization (Mariko et al., 2001). Ogale et al. (2000) inferred that GA3 spraying changed the mode of action, by increasing the flower size to varying degrees (20- 40%) in all Portulaca grandiflora cultivars. Research is being carried out throughout the world on how to improve bloom cycle, flower size, flower color and flower longevity. Many techniques have been conducted but there is still a significant lack of knowledge on allamanda flower enlargement and early blooming. Therefore, the study was undertaken to...
investigate the effects of swabbing and growth regulators (100ppm GA$_3$ and aluminium sulphate) on the early bud and flower initiation and freshness (delay abscission) as well as phytochemical chemical content of Allamanda sp.

**Materials and Methods**

**Experimental site and plant materials**

**Methodology**

Three trees were selected for the experiment. Plant to plant distance was 1.5 m. The tree was designed as triangle position. The treatments were employed on three selected branches. Bud initiated spot (base of flower bud) was chosen in each branch. For GA$_3$ 100mg/l application, cotton was used to swab the solution to the base of flower bud. The swab was applied once a week and continued until 4 weeks after the treatment application. For Al$_2$(SO$_4$)$_3$ treatment the same procedure was followed. The following data was recorded.

**Treatments setting**

Treatments were applied maintaining completely randomized design (CRD). Each treatment was conducted in three replications and swabbed for 4 weeks. The selected branches flower bud (before initiation) were swabbed with GA$_3$ (100 ppm) and Aluminium S (100 ppm). The controlled branches were swabbed with the distilled water.

**Quantum yield measurement**

Chlorophyll fluorescence was measured by using Plant Efficiency Analyser (Hansatech Instrument Ltd., England). A leaf clip was attached to one of the leaves (selected closed to flower base) and kept in dark for 30-45 minutes to maintain dark adaptation. Then, the leaf clip was oriented with the shutter plate. When the light intensity was applied on the leaf, the fluorescence signal was counted for 3 seconds and observed the Quantum yield or Photosynthetic yield. The maximal fluorescence (Fm) and minimal fluorescence (Fo) value was taken from the display pad of Plant Efficiency Analyser machine. The yield of variable fluorescence (Fv) was calculated as Fm-Fo. Calculation of quantum yield was determined according to the equation Fv/Fm (Temperature = 28ºC, Time range = 10 µs- 3 sec).

**Measurement of bud and flower initiation and number**

Bud and flower status was observed every week. Number of bud and flower, and longevity (freshness) was counted as the number of days from flower initiation to flower abscission and full blooming days was counted from flower initiation to full blooming stage.

**Determination of Total Carotenoid Content**

Total carotenoids were determined according to the methods of Lichtenthaler and Buschmann. The method consisted of repeated acetone extraction, until obtained colorless residue, with a pestle and mortar and filtered over filter paper. The extracts were made up to 50 ml with acetone. The concentration of carotenoids was measured at 450nm in a Shimadzu UV 160A spectrophotometer. The amount total carotenoid content was calculated were considered as the number of days from flower initiation to flower abscission and full blooming days was counted from flower initiation to full blooming stage.

**Results**

The influence of all treatments on bud and flower initiation was observed throughout the experiments. In the present work, the number of bud initiation per branch was higher in GA$_3$ and aluminum sulfate than in water control . In fifth week bud number was observed to be two in water control, while it was nine and five in GA$_3$ and Aluminum sulfate respectively (Fig. 1). In the case of bud initiation, bud was initiated 3 days earlier in GA$_3$ and aluminum sulfate than in water control (Fig. 1). The new bud initiation was particularly delayed and decreased by control (Fig. 2).

The influence of all treatments on flower initiation was observed throughout the experiments. The number of flower initiation per branch was higher in GA$_3$ and aluminum sulfate than in water control . In fourth week flower number was observed to be one in water control, while it was four and two in GA$_3$ and Aluminum sulfate respectively (Fig. 2).

Flower fresh weight was remained higher on 2nd day and from 3rd day it was decreasing for all treatments (Fig. 3). However, bract longevity, abscission and color was prolonged by applying GA$_3$ and aluminum sulfate compared to the water control.

It has been seen in Figure 3, flower treated in GA$_3$ showed the highest percentage of weight compared to other treatments. On the other hand, water exhibited lowest weight. The increasing effect of flower weight in GA$_3$ was significantly better than aluminum sulfate (Fig. 4a). Flower longevity was higher (8.7d) in aluminum sulfate followed by 5.5 and 4 d in GA$_3$ and water control.

The quantum yield of dark-adapted leaves determining the maximum efficiency of photosystem was showed (Table 1). The photosystem of dark-adapted leaves, measured by quantum yield showed lower values in control plants. Whereas, significantly highest value of photosynthetic yield, chlorophyll florescence and quantum yield was observed in GA$_3$ treated plants (Table 1). In aluminum treated plants, the quantum value increased.

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The carotenoid content showed a significant difference with respect to the applied chemical treatments compared to the water control (Table 1). The effects of the treatments on flower longevity were showed in Figure 4b. Very strong correlation was found between quantum photosynthetic yield and carotene content (Fig. 5).

Discussion

It has been described well that the commercial value of flowers is very dependent on its early flower initiation and blooming including flower color and weight. Allamanda plant is well known for its beautiful flowers and in rising landscaping activities. Its commercial value could be improved through early blooming and increasing its quality in terms of size and weight (Tjosvold et al., 1994). Flower initiation and blooming rate could be improved also by using growth regulating hormones, such as GA3. Gibberellins are well known to increase hydrolysis of starch and sucrose into glucose and fructose, which were utilized by the flowers for floret opening (Emongor, 2004). The increased sugars in the flower heads and stems may increase the osmotic potential of the petals, thus improving their ability to absorb nutrients and maintain their turgidity, which may explain the increase of flower weight in different developmental stages and observed in this study too.

In this experiment, the GA exhibited short period for bud formation and flower number/branch, flower weight and longevity was increased by GA and Aluminium sulfate. Hossain et al (2008) has shown that GA3 increased the supply of total sugar in petal and treated leaf. It might be responsible for stimulating cell division, new leaf formation and ultimately more flower and frequently flower bud initiation. However, in the case of control treatment, the number of flower/branch was low due to the prolonged vegetative stage for shoot initiation and lack of leaves to utilize in photosynthetic process or lack of contribution of cytokinins from root towards shoot (Hossain and Mizutani, 2009; Calatayud, 2004; Hossain et al, 2007a). In addition, plants produced fewer flowering buds in water control than in chemical treatment. This indicated that the switch to early flowering was maintained at subsequent flower formation under preferable condition. Hossain et al. (2008) reported a similar report that plants initiate more and larger leaves in order to capture more sunlight and decrease the flowering time. But in control treatment, the plant showed a greater tendency toward vegetative reproduction rather than reproductive growth. The quantum system of this sp declined in control and increased GA3 chemical. The quantum efficiency in the dark adapted leaf (Fv, Fo and Fm) has been carried out extensively as an indicator of hormonal and chemical stress on leaves or plant morphology (Bibi et al., 2008). However, measuring quantum yield of photosynthesis with the light-adapted test in our studies proved the positive effect of chemical on leaf photosynthesis process. The present value indicated that quantum system of PSII increased significantly in GA3 treatment. The lowest values were obtained in water treated branch leaves. Maximum efficiency of photosystem of dark-adapted leaves, measured by fluorescence quantum showed lower values in control plant leaf. Fv and Fm reflected the potential quantum efficiency and were used as a sensitive indicator of plant performance, with optimal values of around 0.8 measured for most plant species (Calatayud et al., 2002; Johnson et al., 1993). The value obtained by fluorescence, indicate that GA treated branch promoted better photosynthetic light reaction than control branch. This fact can be attributed, among other causes, to a higher radiation intercepted by the leaves to the enhancement of photosynthetic rates in the remaining mature leaves or to changes in photosynthetic capacity of mature leaves (Mediene et al., 2002).

The accumulation of chlorophyll was significantly higher in plants which underwent in GA. Enhanced synthesis of chlorophyll and carotenoid by GA treatment had previously been reported and it has been suggested that the enhanced synthesis was attributed to the increased hormone activity in rose and bougainvillea plants (Angeles et al., 2008; Hossain et al, 2007a). Jidapha et al (2006) observed the carotene content was varied from 0.4 to 4.5 g/kg at different species of Allamanda flower which agreed with our results.

Conclusion

It can be concluded that, 100ppm GA3 and aluminium sulphate showed the effective growth regulators to induce bud and flower production, increase flower weight and longevity, photosynthetic fluorescence, quantum yield and carotenoid content. In addition, the results suggested that these growth regulators[GA3 and Al2(SO4)3, 100ppm] using swabbing technique instead of spray were effective for the flower development and longer the flower longevity with less chemical cost and quantity of chemicals without hazarding the environment instead of spray.

References


Annexure

Fig. 1. Number of flower bud at different treatments. Values followed by different alphabets indicate the existence of significant differences according to LSD $0.05$ test.

Fig. 2. Number of flower initiation at different treatments. Values followed by different alphabets indicate the existence of significant differences according to LSD $0.05$ test.
Fig. 3. Fresh weight at different days. Values followed by different alphabets indicate the existence of significant differences according to LSD_{0.05} test.

Fig. 4a. Flower longevity at different treatments
Table 1. Determination of Chlorophyll fluorescence (photosynthetic yield, quantum yield) in all treatments. Values are means of 3 measurements ± SE. Values followed by different alphabets indicate the existence of significant differences according to LSD$_{0.05}$ test.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fo</th>
<th>Fm</th>
<th>Fv</th>
<th>Fv/Fm</th>
<th>Carotinoid (µg/gfw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>230a</td>
<td>1620b</td>
<td>1418b</td>
<td>0.85b</td>
<td>0.8b</td>
</tr>
<tr>
<td>GA</td>
<td>201a</td>
<td>1978a</td>
<td>1777a</td>
<td>0.89a</td>
<td>1.9a</td>
</tr>
<tr>
<td>Aluminium S.</td>
<td>222a</td>
<td>1683b</td>
<td>1461b</td>
<td>0.86b</td>
<td>1.2b</td>
</tr>
</tbody>
</table>

Fo: Lower photosynthetic yield, Fm: Higher photosynthetic yield, Fv: Variable of photosynthetic yield, Fv/Fm: Quantum yield