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The Influence of Gibberellic Acid (GA₃) and Sucrose on Flowering Behaviour of *Bougainvillea glabra* Under Natural Conditions

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ABSTRACT

A study was carried out to investigate the effects of the gibberellic acid and different concentrations of sucrose on vegetative and reproductive growth of *Bougainvillea glabra* var. "Elizabeth Angus". Selected growth and flower quality parameters were monitored at three day intervals during the experimental period, using different concentrations of gibberellin and sucrose as treatments. 50 mg/L of GA₃ with 2.5% sucrose promotes maximum bract weight, number of buds and bract length, while 25 mg/L of GA₃ with 1% sucrose promotes maximum blooming rate, shoot elongation and bract wide. 25 mg/L of GA₃ promotes the highest number of buds formed and highest blooming rate of *Bougainvillea* flower. 75 mg/L of GA₃ stimulates most significant shoot elongation, bract length and bract weight, while 100 mg/L significantly increased bract wide. Both GA₃ and sucrose complement to each other to complete flower opening while GA₃ able to promotes different mode of actions. Combination of GA₃ and sucrose at lower concentration incapable of endorsing notable flowering behavior of *Bougainvillea* plant.

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INTRODUCTION

The *Bougainvillea* is a flowering ornamental plant which belong to the family Nyctinaginacea (Four-o'clock), has 18 species. *Bougainvillea*'s growth habit and beautiful showy bracts make it a popular plant for landscapes. *Bougainvillea* provides hedges, barriers, excellent ground and slope coverings. It can cover a whole hillside and can even choke out weed growth. *Bougainvillea* is also used as an accent plant, a specimen plant, in hanging baskets, in containers, and for bonsai. The true, perfect flower is small, tubular, commonly white or yellow, and surrounded by showy, vibrantly colorful petaloid bracts (Saifuddin *et al.*, 2009).

Growth regulators play integral roles in controlling the growth, development, metabolism, and morphogenesis of flowering plants (Schwechheimer, 2008). Gibberellic acid (GA₃) was demonstrated to induce inflorescence development and flowering and to increase the number of flowers (Khan and Chaudhry, 2006). In Potted plants, flower induction and longevity can be improved by using growth regulators, such as GA, at the different

development stages and flowering period (Hye and William, 2009). The phenomena of flowering is a complex developmental process consisting of at least four phases, namely, flower induction, initiation, flower opening and flower senescence (Chang and Chen, 2000). Flower induction depends on factors such as nutrient availability, flowering time, light, temperature and day length (Wurr *et al.*, 2000). It has been reported that sugars providers of carbon and energy, play a signaling role in coordination with hormonal signaling pathways (Rolland *et al.*, 2006) controlling various plant physiological processes, probably also including innate immunity (Bolouri Moghaddam and Van den Ende, 2012). Sugars have been shown to control gene expression and development processes in plants acting as signaling molecules similar to classical plant hormones (Sheen *et al.*, 1999). Flowering might be induced by other factors such as concentration of sugars and other chemicals that is used in solutions for "pulsing and "bud opening" of ornamental flowers, other than optimal effect on flower development and longevity that occurs naturally in the plant (Gay and Nichols, 1977); (Halevy, 1976); (Kofranek and Halevy, 1972).

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In other words, it is caused by subtle interactions of various promoters and inhibitors (Taiz and Zeiger, 2002). Gibberellin are known for their ability to elicit different mode of actions (Hye and William, 2008). GA3 is an essential promoter for the transition from a vegetative to a reproductive bud in *Spathiphyllum* plantlets (Yaser *et al*, 2007). GA3 reported as having remarkable result in inducing flowering of several plant (Hemant *et al.*, 2001); (Zhang and Leung, 2002); (Brooking and Cohen, 2002); (Naor *et al.*, 2002). Sucrose at lower concentration also reported in inducing flowering, for example in *Kalanchoe blossfeldiana* (Dickens and van Staden, 1988), *Torenia* (Tanimoto and Harada, 1981), *Murraya paniculata* (Jumin and Nito, 1996), *Leptinella nana* L. (Carson and Leung., 1994), bamboos (John and Nadgauda, 1999) and buckwheat (Kachonpadungkitti *et al.*, 2001). Subsequently, sucrose also act as exogenous sugar supply that maintained the pool of dry matter and respirable substrates for harvested plant to extend its longevity (Coorts, 1973); (Rogers, 1973) by promoting respiration (Coorts, 1973).

The previous study focus more effects of GA3 and sucrose on in vitro culture. This study will focus on the effects of GA3 and sucrose and its combination on *Bougainvillea glabra* flowering pattern to provide understanding and determine the best treatment and combination of treatments for best flowering induction and controlled of flowering under natural condition.

MATERIALS AND METHODS

Experimental Site and Plant Material:

The experiments were carried out at the Plant Physiology Garden, Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur 50603, Malaysia. Two years old *Bougainvillea* plants, 1.0 m of height and canopy length 1.5 m were selected for the study. Ten field grown *Bougainvillea* plants were used in the experiment. Five selected branches per plant of the same length, same diameter and same number of leaves were selected for treatment application. GA3 experiment consisted of four treatments (25, 50, 75, and 100 mg/L GA3). The other experiment GA3 plus sucrose also consists of four treatments (25 mg/L GA3 + 1% sucrose, 50 mg/L GA3+ 2.5% sucrose, 75 mg/L GA3 + 5% sucrose and 100 mg/L GA3 + 7.5 % sucrose) including the control, with five replications. Every branch was tagged 15 cm below the apex of the branch. The treatments were applied at both the vegetative shoot and the reproductive stages, which exhibited strong growth with prolific and dense leaves. The selected branches were sprayed twice per week until inflorescence development. A total of ten spray applications were performed, five times before flowering and five times after flowering. Treatments

were set following completely randomized design (CRD). Each treatment was repeated by 5 replications.

Data Collections and measurements:

The flower bud number, blooming rate, bract length, and shoot elongation were measured at three-day intervals. Individual bract and flower weights, as well as bract length and wide, were measured after 15 days of observation. All of the growth rates were measured using a vernier scale, and the growth per day (in cm) was calculated. Close observations were made to determine the number of nodes before the first inflorescence for each treatment.

Bract length, weight, blooming and longevity of bougainvillea:

Individual bract and bract cluster weight, including the flowers were measured using a Mettler PJ3000 balance, and bract lengths were measured on a Mitutoyo Vernier Scale. From the beginning of the experiments, 15 buds per treatment were selected for full blooming and longevity measurements. The observations were made when all of the bracts were open and abscission had occurred. Bracts of three flowers in the same stages were considered to be a unit. Throughout experiment, the plants were placed under exposed sunlight conditions.

Statistical analysis:

The experimental design was a completely random design with five replications. All the data were analyzed using MSTAT statistical software. The one way ANOVA was applied to evaluate the significant difference of the parameter studied in the different treatments. Least significant difference (Fisher's protected LSD was calculated, Following significant F-test (p=0.05)

RESULTS AND DISCUSSION

It is observed that 25mg/L of GA3 generated highest number of buds in *Bougainvillea* compared to control. Increase in GA3 concentration more than 50 mg/L however result in lower number of bud on the plant. The same pattern was observed in combination treatment of GA3 and sucrose where combination of 50 mg/L of GA3 and 2.5% sucrose give highest number of buds formed followed by other combination of treatments and control. This result was supported by Khan and Chaundry (2006) when they observed that GA3 able to induced inflorescence development and flowering, also increase the number of flowers. Yaser *et al.*, (2007) also reported that lower concentration of GA3 promotes highest inflorescence development on *Spathiphyllum* in vitro culture.

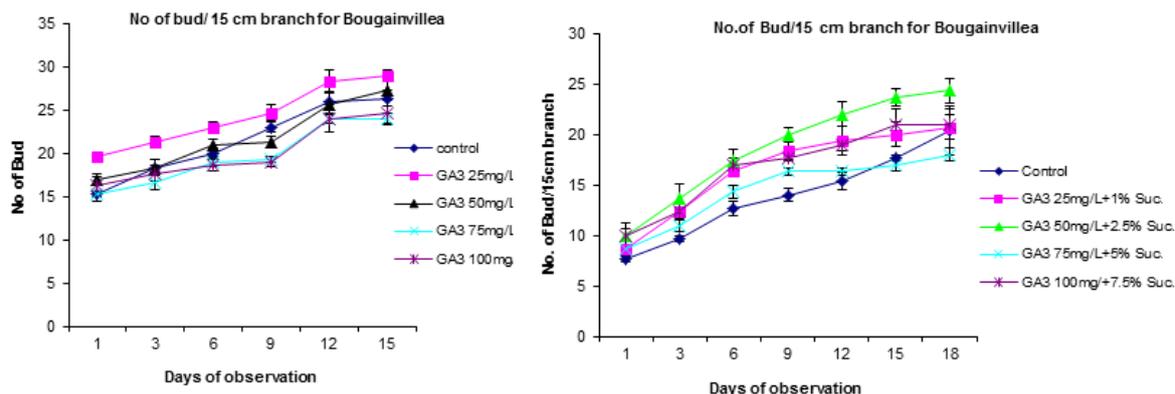


Fig. 1: The effect of GA3 on bud initiations of *Bougainvillea glabra* versus time

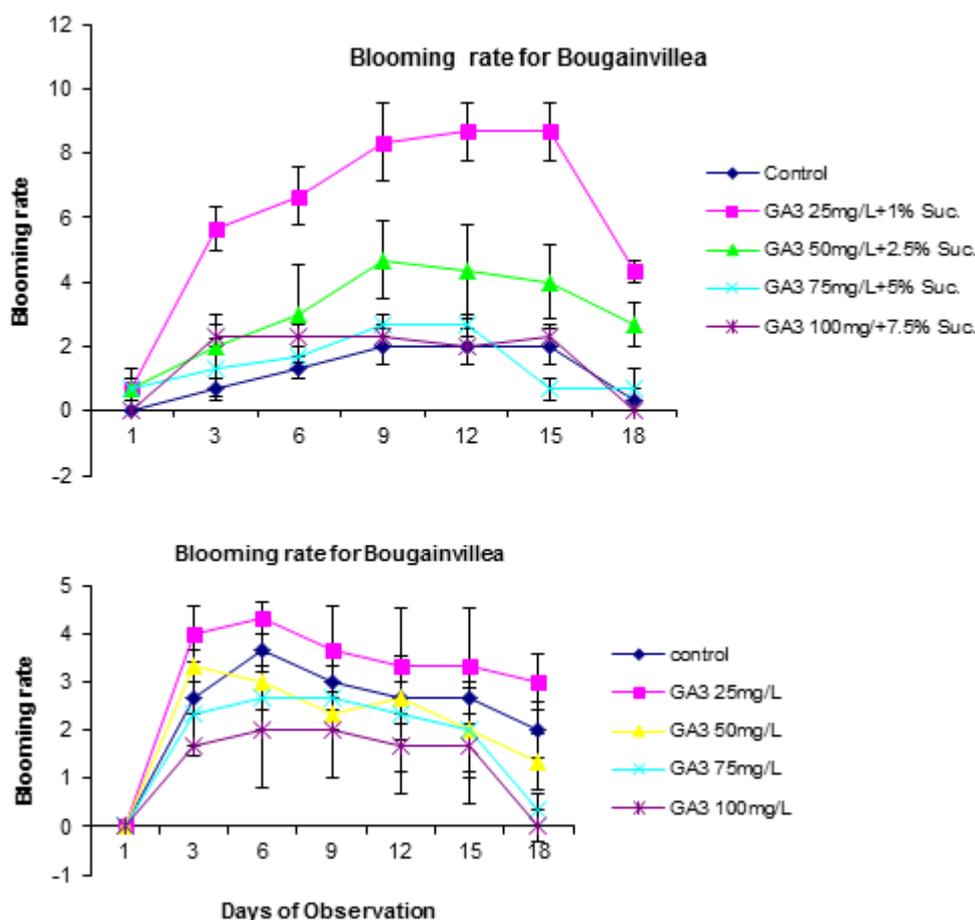


Fig. 2: The effect of GA3 on blooming rate of *Bougainvillea* bract

Highest blooming rate were observed at 25 mg/L GA3 and 25 mg/L GA3 + 1% sucrose. Moderate growth was observed at 50 mg/L GA3 and 50 mg/L GA3 + 2.5% sucrose. Higher concentration of GA3 and sucrose more than 50 mg/L have lower blooming rate. Motoaki and Michael, (1995) demonstrated that low concentration and continuous supply of 2% sucrose promoted bud opening of Hybrid *Limonium* flowers and prolong its longevity up to 15 days.

Moneruzzaman *et al.* (2010 a,b) reported that sucrose application and removal of young leaf increase the blooming rate and quality of *Bougainvillea*. Emongor (2004) suggested that gibberellin also act by increase the hydrolysis of starch and sucrose into glucose and fructose, which will then utilized by flowers for disc floret opening. Bud opening is promoted in spikes of *Gladiolus* treated with GA3 and sucrose (Rao and Mohan Ram, 1979).

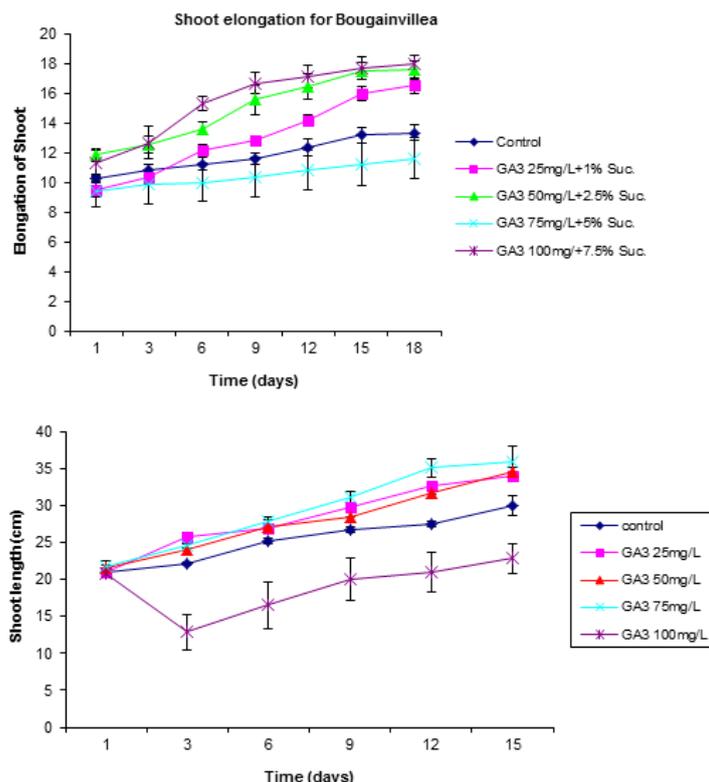


Fig. 3: Shoot elongation as affected by GA3 treatment under natural condition

25 mg/L of GA3 and 1% sucrose result in highest shoot elongation, followed by other treatments and control. On the other hands, 75 mg/L of GA3 shows spike increasing compared to other treatments. Longer shoot length also observed at GA-3 concentration of 25 mg/L and 50 mg/L. Longest bract length observed at combination

treatment of 50 mg/L of GA3 and 2.5% sucrose, followed by 25 mg/L of GA3 with addition of 1% sucrose. Shortest bract length was observed at treatment 100 mg/L of GA3 and 7.5% sucrose. In opposed, 75 mg/L of GA3 stimulated longest bract length compared to other treatments.

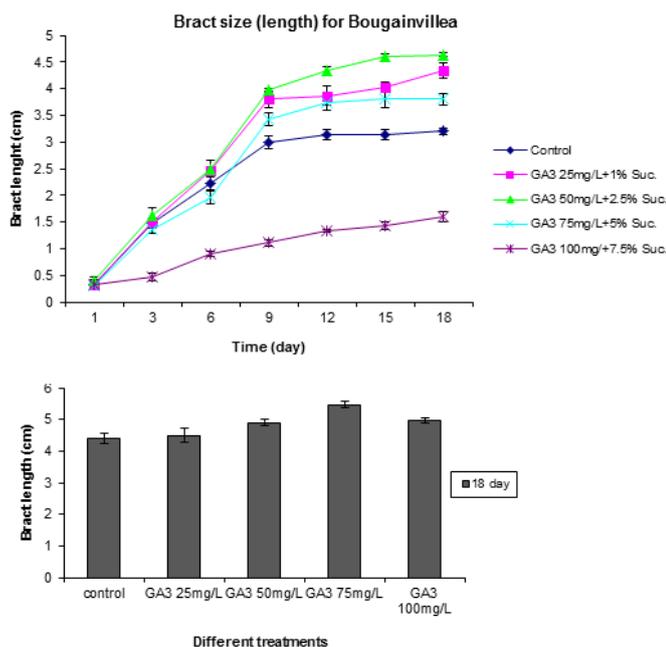


Fig. 4: Bract length as affected by different treatments of GA3

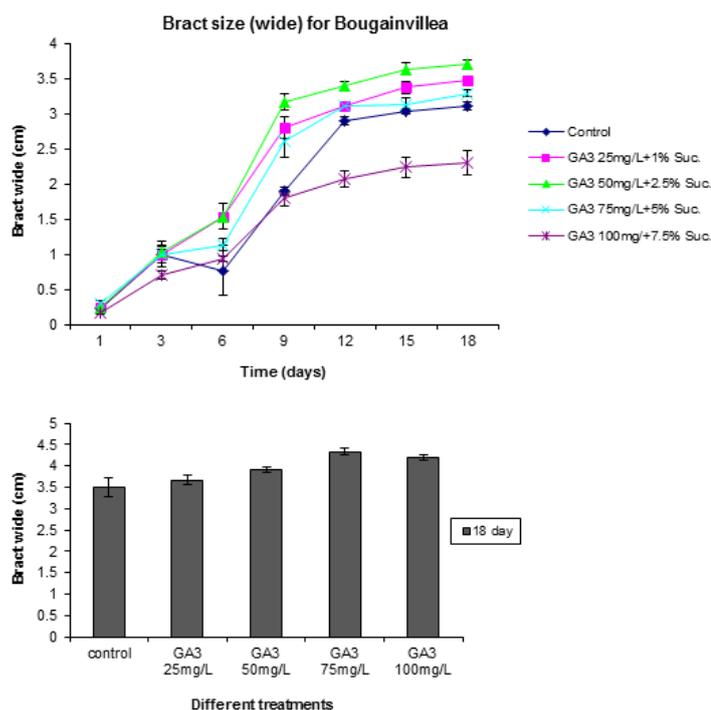


Fig.5: The effect of GA₃ application on bract wide of Bougainvillea

The widest bract was observed at treatment GA₃ 25 mg/L and 1% sucrose. Moderate bract sizes were observed at 50 mg/L GA₃ plus 2.5% sucrose and 75 mg/L of GA₃ plus 5% sucrose. Lowest bract size was observed at concentration 100 mg/L of GA₃ plus 7.5% sucrose. Opposite pattern of bract size was observed at only GA₃ treatment. Increase in GA₃

concentration increased the bract size. 100 mg/L of GA₃ give the biggest bract size, while 25 mg/L of GA₃ give the smallest bract size. Saifuddin *et al.*, (2009) suggested the 100ppm of sucrose is the most effective concentration than 150 ppm sucrose to promote bract size (wide).

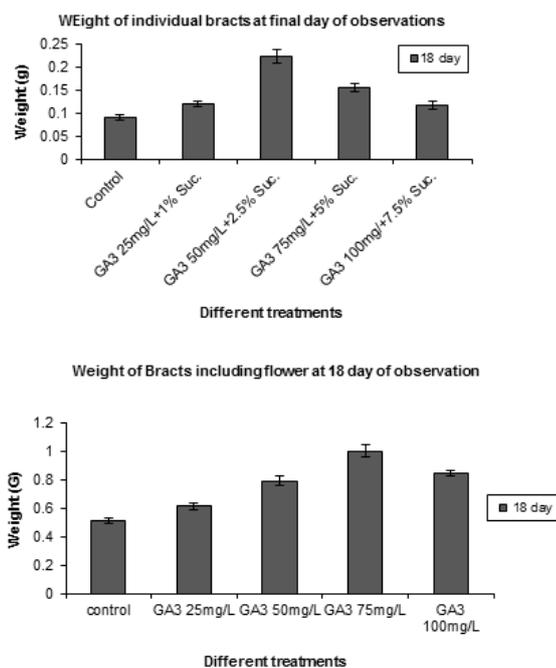


Fig. 6: The effect of GA₃ treatments on individual bract weight of Bougainvillea

It is shown that 50 mg/L of GA₃ with addition of 2.5% sucrose result in highest weight of individual bract compared to other treatments. 25 mg/L of GA₃ with 1% sucrose result in lowest weight of individual bract. Under GA₃ treatments, 75 mg/L yield the highest weight of individual bract, and 25 mg/L of GA₃ lead to lowest individual bract size. Saifuddin *et al.* (2009) demonstrated that the application of GA₃ was able to promote maximum bract weight in his previous study. Moneruzzaman *et al.* (2013) reported that application of Triaccontanol increased the quality of Bougainvillea flower. It can be related that 75 mg/L of GA₃ is the optimum concentration to stimulate maximum bract weight of Bougainvillea flower.

Conclusion:

Lower concentration of GA₃ and sucrose (25 mg/L GA₃ + 1% sucrose or 50 mg/L GA₃ + 2.5% sucrose) is required to stimulate maximum number of buds, blooming rate, shoot elongation, bract length, bract wide, and bract weight. However, higher concentration of GA₃ (75 mg/L or 100 mg/L) is required to stimulate shoot elongation, bract length, bract wide and bract weight while lower concentration of GA₃ (25 mg/L) is required to stimulate maximum number of buds and blooming rate of the flowers. We can conclude that combination of lower concentration of GA₃ and sucrose is more effective than sole usage of GA₃ in stimulating flowering behavior of Bougainvillea. Rao and Mohan Ram (1982) suggest that GA₃ is the stimulating factor while sucrose is the limiting factor which both is critically required at optimum amount to complete flower opening.

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