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Gibberellic Acid and Physiological Stress's Impact on the Bract Growth, Longevity and Phytochemical Content of Bougainvillea: A Medicinal Plant

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ABSTRACT

The study was conducted to evaluate the effect of gibberellic acid ($GA_3$100 ppm) and physiological stress represented by phloem cut on Bougainvillea bract growth, longevity and phytochemical (chlorophyll and carotene) content. The results showed that total number of bract was higher in phloem cut and GA_3 100 ppm than in control treatment. The highest bract length was found in 100 ppm GA_3 treatment. Bract longevity was found almost 3 days longer for phloem cut and two days longer in 100 ppm GA_3 than in water control. The effect of bract weight was significantly higher in 100 ppm GA_3 and phloem cut than in water control. Phytochemical content like chlorophyll represented by SPAD was the highest in phloem cut stress. Moreover, chlorophyll fluorescence yield was found higher (Fm and Fv) in phloem cut stress and 100 ppm GA3 than in control. Quantum yield (Fv/Fm) was found 0.90 in phloem cut stress followed by 0.89 and 0.85 in the 100 ppm GA3 and control. Phytochemical content Carotene or carotenoid content was found higher in the 100 ppm GA3 phloem cut than in control. Therefore, results suggest that gibberellic acid and physiological stress represented by phloem tissue cut were effective for bract enlargement, longevity and increase of the phytochemical content like chlorophyll and carotene as medicinal value.

INTRODUCTION

Bougainvillea flowering plant is usually grown in tropical and subtropical zones and is enriched with different varieties having attractive color for environmental benefits and shades (Grodon, B., 2002). Lim (2014) reported that bougainvillea flowers were edible, it was used fresh and gave feeling of refreshment. It was used in salads and drinks including tea for coughs. All parts of plant including roots and mostly flowers were used in forms of infusions. It is most commonly used as a tea for cough, sore throat, flu (Adam, 2015). Longevity or vase life was an important factor in consumer preference and considerable research had been carried out on the causes of senescence (Reid et al., 1983; Menguc & Usta, 1994). William (2004) stated that beta-carotene boosts skin health. He also reported that a possible mechanism for beta-carotene's action against skin damage from exposure to sunlight has been a new finding.

Gibberellins are well known plant growth hormones differ considerably in their mode of actions (Saunder, 1991). GA_3 is well known for the bolting effect in plants. Ogale (2000) reported that GA_3 induced changes in flower (*Portulaca grandiflora*) color from crimson red (CR) to complete white. GA_3 application increased petiole length and leaf area of the strawberry plants in most treatments. It reduced the time needed for inflorescence emergence, accelerated flowering and increased the number of flower buds and open flowers in most growing conditions (Khan and Chaudhry, 2006). In addition, the application of gibberellic acid (GA_3) has the potential to control growth and flowering and induce earliness. The other growth regulating substances that mechanism of action may be related to that of sugar also affect on flowering. Hossain et al. (2006) reported that flower bud percent was a higher when bark phloem stress was applied due to flowering was closely related to starch content and girdling increases leaf sugar content. It has been reported that sucrose might affect vase life of some plant species as well as sucrose extended vase life of rose (Kuiper et al., 1995) and also extended vase life of gladiolus (Marousky, 1971). Jose (1997) found less vegetative growth in all the treatments of ringing (girdling). Hossain et al. (2004) reported that starch content in the bark was higher in samples when it was taken from the upper part of the bark phloem stress.

There are few literatures are available regarding this research. That is why our interest has grown to develop the bract size and weight of bougainvillea and develop its quality such as longevity and phytochemical content like chlorophyll and carotene by applying GA_3 (100ppm) and phloem cut stress in bark.

MATERIALS AND METHODS

Plant Material

The experimental site was in the Plant Physiology Garden, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia. Seven-year-old Bougainvillea plants were selected in this experiment. Total of nine branches were selected. Three branches were used for each treatment. The plant was 1.5 m of height and canopy length was 3.0 m.

Treatment Setting

Physiological stress represented by phloem cut in the bark was done by using a small sharp knife removing 2 cm length and 3 cm width bark (Fig. 1). The phloem cut was applied 20 cm away from shoot apex in a branch. There were three replications used for phloem cut, three for GA3 100 ppm and three for control (no phloem cut in bark). GA3 100 ppm was applied using micro spray method by small syringe.

Data Collection

Total bract number, bract longevity, weight, bract length were measured weekly.

Chlorophyll fluorescence yield measurements

The chlorophyll fluorescence yield was measured by Hansatech Plant Efficiency Analyser. Leaf was attached to the leaf clip and kept in dark place for 30-45 minutes to maintain dark adaptation. Then, the leaf clip oriented with the containing shutter plate. When light shine was applied on to the leaf, the fluorescence signal was counted for 3 second and observed fluorescence yield or photosynthetic yield. It was represented by Fo, Fm, Fv and Fv/Fm (fluorescence yield). Where, Fo = Lower fluorescence, Fm = Higher fluorescence, Fv = Relative variable fluorescence (Fm- Fo). Temperature = 27 ºC, Time range = 10µs- 3 sec (Fig.1).

Phytochemical (Chlorophyll) content measurements

Phytochemical like chlorophyll content was measured by chlorophyll meter SPAD-502, Minolta Co. Japan which represented by SPAD value. The leaf was inserted into the meter and measured SPAD value 5 times from different spot of a single leaf.

Determination of carotene content

The phytochemical like carotene content of the leaves was determined using the methods described by Hendry and Price (1993).

Statistical analysis

Treatments were set following completely randomized design (CRD). Three replicates were used for each treatment. LSD test was employed for the data analysis.

RESULTS AND DISCUSSION

Table 1. Bract number/branch was showed of bougainvillea plant as affected by different treatments. Mean ± SE (n=3).

Treatment	Bract no/branch	Bract length (mm)	Bract longevity (Day)	Bract weight (g)
Control	16.1±0.01	27.4±0.01	22.5±0.44	0.20±0.01
GA3 100 ppm	23.2±0.01	49.5±0.01	24.4±0.47	0.55±0.01
Phloem cut	25.0±0.01	30.2±0.01	25.8±0.56	0.29±0.01

Total number of bract was higher in phloem cut and GA3 100 ppm than in control treatment (Table 1).

The highest bract length was found in 100 ppm GA_3 treatment (Table 1). Bract longevity was found almost 3 days longer for phloem cut and two days longer in 100 ppm GA_3. than in water control (Table 1). The effect of bract weight in 100 ppm GA_3 was significantly higher than in water control (Table 1).

Table 2. Measurement of chlorophyll fluorescence intensity (yield) of leaves on different experiments branches

Treatment	Phytochemical as Chlorophyll by SPAD unit	Phytochemical yield as Chlorophyll fluorescence		Quantum Yield (Fv/Fm)	Phytochemical content as carotene (µg/gfw)
		Fm	Fv		
Control	50.0b	1450c	1255c	0.85b	0.90b
GA3 100 ppm	46.3b	1555b	1430b	0.89a	1.50a
Phloem cut	53.2a	2010a	1740a	0.90a	1.30a

Fo = Lower florescence, Fm = Higher fluorescence, Fv = Relative variable fluorescence (Fm – Fo). SE (n=3). Time range: 2ms-3sec. Means followed by the common letters are not significantly different at the 5%level by Least Significant different test (LSDT).

The phytochemical like chlorophyll represented by SPAD was the highest in phloem cut stress. Moreover, chlorophyll fluorescence (yield) was found higher (Fm and Fv) in phloem cut stress and 100 ppm GA3 than in control (Table 2). Quantum yield (Fv/Fm) was found 0.90 in phloem cut stress followed by 0.89 and 0.85 in the 100 ppm GA3 and control (Table 2). Phytochemical like carotene or carotenoid content was found higher in the 100 ppm GA3 phloem cut than in control. Fig. 1 shows the treatment setting technique, chlorophyll inflorescence measurement and higher bract size enlargement in the phloem cut stress and 100 ppm GA3 than in control Strong logarithmic correlation was found between the quantum yield and treatments (Fig. 2).

Phloem cut by knife Chlorophyll inflorescence measurement Bract size

Fig. 1. Photograph shows the treatment setting technique, chlorophyll inflorescence measurement and higher bract size enlargement

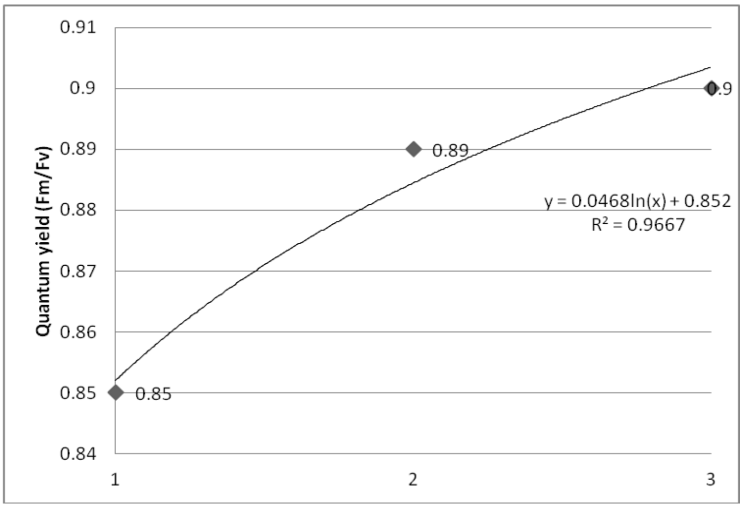

Fig. 2. Correlation between the quantum yield and treatments

1= Control, 2= GA3 100 ppm, 3= Phloem cut stress

In present study, it was found that bract number/branch, longevity, size and weight were greater in 100 ppm GA_3 and phloem cut stress than the control treatment. General concept is while bract size is bigger then the longevity will be shorter. GA_3 showed positive effect on bract size expansion and weight but not on bract longevity and number. This might be due to carbohydrate availability from leaf to bract. Bract longevity was prolonged by phloem cut stress. Mataa, et al. (1998) reported that sufficient carbohydrates and nutrients were deposited on the above portion of phloem cut stress. Corr and Widmer (1987) reported that in callas, GA_3 had been used to increase total shoot number, flowering shoot number and also increased the number of shoots with more than one flower. Brokking and Chon (2002) observed that plants treated with GA_3 also induced earlier flowering and with a lower flower number. This is similar to our results. Arakawa et al. (1997) found that flowering of Fuji apple was significantly increased by phloem cut stress and also in peach (Hossain et al. 2004, Hossain et al. 2006).

CONCLUSION

It can be concluded that that total number of bract and longevity were higher in phloem cut and GA_3 100 ppm than in control treatment. The highest bract length and weight was found in 100 ppm GA_3 treatment. Phytochemical content like chlorophyll content and chlorophyll fluorescence yield were the highest in phloem cut stress. Moreover, carotene content was found higher in the 100 ppm GA3 and phloem cut stress than in control.

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