EFFECTS OF PLANT GROWTH REGULATORS AND PHYSIOLOGICAL STRESSES ON THE GROWTH OF *BOUGAINVILLEA* SPP.

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ABSTRACT

This study was aimed to investigate the effects of physiological stresses such as pruning, shading, phloemic stress and plant hormones such as gibberellic acid (GA_3) and naphthalene acetic acid (NAA) on the growth, development and flowering process of bougainvillea plants. The plants (*Bougainvillea glabra* and *Bougainvillea spectabilis*) were grown under prevailing conditions (temperature 21-32°C, maximum PAR 2100 µE m^{-2} s^{-1} and relative humidity of 60-90%) using completely randomized design. Field experiments as well as biochemical analysis were carried out at the Plant Physiology Garden and the Plant Physiology Laboratory, Institute of Biological Sciences, University of Malaya. Results on frequent pruning of *Bougainvillea glabra* plants gave the highest quantum yield, chlorophyll *a* and *b*, and maximum flower initiation per plant compared to those of non-pruning plants. Though the sugar content in pruned plants decreased, probably due to the prolonged vegetative phase, flowering process continues and developed new flower shoots. Minimum branch (14.43 gm) fresh weight and low potassium content were observed in complete pruning plants.

The present study discovered that different shading treatments (2100 ± 200, 1470 ± 200, 1050 ± 200 and 525 ± 200 µE m^{-2} s^{-1}) have great effects on flower initiation, longevity, leaf chlorophyll and sugar content and plant quality in *Bougainvillea glabra*. Light shading more than 1470 ± 200 µE m^{-2} s^{-1} has led to inhibit flower initiation completely and the high light intensity that resulted in increased sugar and chlorophyll content may be attributed to stimulation of flower initiation and in turn to the deceleration of flower abscission.

The effect of GA_3, phloemic stress and combined treatment of GA_3 and phloemic stress on flower blooming, expansion, development and longevity in *Bougainvillea spectabilis* was also analyzed. The results showed that the bract size and shape were both increased by 40%

in 100 ppm GA_3. Blooming was three days earlier in 100 ppm GA_3 treated plants than those in the control. Longevity of flowers was increased by four days in phloemic stress and two days in combined treatment of 100 ppm GA_3 and phloemic stress than those in control. Finally, longevity was found to be almost ten days longer in NAA (100 ppm) than those in both control and GA_3 treatments in *Bougainvillea spectabilis*. The prolonging effect of low concentrations of NAA (100 ppm) at the initial budding stages was more effective compared to its application at other stages of development and at higher concentrations (150 ppm NAA). Maximum bract weight and shoot length were observed in the GA_3 and GA_3 combined with NAA treated flowers. The above findings have given a better understanding of the effects of hormones and physiological stresses on the growth and development of the bougainvillea flower and its longevity. Hence, it is suggested that these physiological and hormonal stresses can be used to maintain better plant growth and flower longevity.

ABSTRAK

Kajian ini bertujuan untuk menyiasat kesan tekanan fisiologi seperti pemangkasan, teduhan, tekanan floemik dan hormon tumbuhan seperti GA_3, dan NAA, kepada proses pertumbuhan, perkembangan dan pembungaan pada tumbuhan Bougainvillea. Tumbuhan (*Bougainvillea glabra* dan *Bougainvillea spectabilis*) telah ditanam di bawah keadaan normal (suhu 21-32°C, PAR maksimum 2100 µE m^{-2} s^{-1} dan kelembapan bandingan 60-90%) menggunakan kaedah Rekabentuk Rawak Lengkap (CRD). Kajian lapangan serta analisis biokimia dijalankan di Taman Fisiologi Tumbuhan dan Makmal Fisiologi Tumbuhan, Institut Sains Biologi, Universiti Malaya. Keputusan menunjukkan pemangkasan *Bougainvillea glabra* secara kerap membawa kepada penghasilan maksimum pada 'quantum yield', klorofil *a* dan *b*, dan percambahan bunga yang maksima bagi setiap tumbuhan jika dibandingkan dengan tumbuhan yang tidak dipangkas. Walaupun kandungan gula pada tumbuhan yang dipangkas menurun, berkemungkinan disebabkan oleh fasa vegetatif berpanjangan, proses pembungaan berterusan dan menghasilkan kuntum bunga baru . Berat dahan segar minimum (14.43 gm) dan kandungan Kalium yang rendah diperhatikan pada tumbuhan yang dipangkas sepenuhnya.

Kajian terkini turut menemui bahawa rawatan teduhan yang berbeza ((2100 ± 200, 1470 ± 200, 1050 ± 200 dan 525 ± 200 µE m^{-2} s^{-1}) mempunyai kesan yang lebih ketara kepada pembentukan bunga, kelanjutan usia, kandungan klofil daun dan gula serta kualiti tumbuhan pada *Bougainvillea glabra*. Teduhan daripada cahaya yang lebih daripada 30% telah menyekat sepenuhnya percambahan bunga dan keamatan cahaya yang tinggi yang membawa kepada peningkatan kandungan gula dan klorofil berkemungkinan menyebabkan rangsangan terhadap percambahan bunga dan sebaliknya pula melambatkan 'flower abscission'. Kesan 'gibberellic acid', tekanan floemik dan kombinasi GA_3 dan tekanan

floemik kepada pengembangan, pembesaran, perkembangan dan peningkatan hayat *Bougainvillea spectabilis* turut dikaji. Keputusan menunjukkan peningkatkan panjang saiz kelopak dan bentuk sebanyak 40% pada 100 ppm GA_3. Pengembangan adalah tiga hari lebih awal pada tumbuhan yang dirawat 100 ppm GA_3 berbanding kawalan. Pemanjangan hayat bunga dengan tekanan floemik menunjukkan peningkatan selama empat hari manakala peningkatan dua hari diperhati dengan penggabungan 100 ppm GA_3 bersama tekanan floemik berbanding kawalan.

Akhirnya, pemanjangan hayat *Bougainvillea spectabilis* didapati hampir sepuluh hari lebih lama pada NAA jika dibandingkan pada ke dua-dua kawalan dan rawatan menggunakan GA_3. Kesan pemanjangan hayat dengan konsentrasi NAA yang rendah pada fasa permulaan putik adalah lebih efektif berbanding aplikasi pada fasa perkembangan yang lain dan pada konsentrasi yang tinggi. Berat maksimum 'bract' dan panjang pucuk diperhati pada GA_3 dan gabungan GA_3 bersama bunga yang dirawat dengan NAA. Penemuan di atas telah memberi satu pemahaman lebih baik mengenai kesan hormon dan tekanan fisiologi pada pertumbuhan dan perkembangan bunga dan kelanjutan usia bougainvillea. Justeru itu, di cadangkan bahawa tekanan fisiologi dan hormon ini boleh digunakan untuk mengekalkan pertumbuhan yang baik dan pemanjangan hayat bunga.

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ABBREVIATIONS

ACC	1-Aminocyclopropen-1-Carboxylic Acid
ATP	Adenosine Triphosphate
cm	Centimetre
CO_2	Carbon dioxide
CRD	Completely Randomized Design
CW	Cool White
DMRT	Duncan Multiple Range Test
DW	Dry Weight
EBS	Early Bolting in Short Days
ETR	Electron Transport Rates
FBC	Flower Blooming Cycle
Fig	Figure
Fm	Higher Fluorescence
Fo	Lower Fluorescence
FW	Fresh Weight
GA	Gibberelic acid
gm	Gram
GRO	Gro- Lux
LCP	Light compensation points.
LSD	Least Significant Difference
NAA	Naphthalene Acetic Acid
NADPH	Nicotinamide Adenine Dinucleotide Phosphate
NH_4^+	Ammonium Ion
NPQ	Nonphotochemical Quenching
PAR	Photosynthetically Active Radiation
PFT	Phytochrome Flowering Time
PGRS	Plant Growth Regulatory Substances
PPFD	Photosynthetic Photon Flux Density
PPM	Part per Million
PS	Photosystem
RWC	Relative Water Content

SI	Surface Irradiance
STS	Silver Thiosulfate
Ts	Total Soluble Sugar
TW	Turgid Weight
VB	Visible Bud
WS	Wide Spectrum