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MORPHO-PHYSIOLOGICAL AND FLOWERING BEHAVIOR OF BOUGAINVILLEA CULTIVARS

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ABSTRACT

Mehraj H, Chanda T, Masum Billah AA, Jahan FN, Jamal Uddin AFM (2014) Morpho-physiological and flowering behavior of bougainvillea cultivars. *Int. J. Sustain. Crop Prod.* 9(3), 35-40.

An experiment was conducted on rooftop garden, Department of Horticulture, Sher-e-Bangla Agricultural University, Bangladesh to study the morpho-physiological and flowering behavior of 11 bougainvillea cultivars. All of the plant morpho-physiological and flowering characteristics of bougainvillea varied significantly among the cultivars. However, maximum chlorophyll content (75.5), C_{ref} (22.8 vpm), Q_{leaf} (172.7 µmolm^{-2}s^{-1}), A (14.6 µmolm^{-2}s^{-1}) was found from Mahara Beauty (Pink) but maximum leaf area from James Walker (50.5 cm^2), e_{ref} from Juanita Hatten (55.2 mBar) and g_s from Delta Dawn (Yellow) (0.14 µmolm^{-2}s^{-1}). Maximum number of floret was found from Temple Fire (29.5) but sub floret/floret (92.0) and petaloid bracts/floret (972.7) was found Mahara Beauty (Pink).

Key words: *bougainvillea, morpho-physiological and flowering behavior*

INTRODUCTION

Bougainvillea's growth habit and beautiful showy bracts make it a popular plant for landscapes. The genus bougainvillea plant has a wide variety of behavior and a large flexibility in different agro climatic regions of the world (Suxia *et al.* 2009; Simon *et al.* 2006; Saifuddin *et al.* 2009a and 2009b) that makes it a potential as a new ornamental plant for floriculture. It has 14 species, with three that are horticulturally important: *B. spectabilis* Willdenow, *B. glabra* Choisy, and *B. peruviana* Humboldt and Bonpland. Many crosses among the various species have produced new hybrid species and important horticultural cultivars. Growth and development of plants is a consequence of several physiological processes controlled by environmental conditions and genetic characteristics of each plant species likes availability of solar radiation is one of the factors that most limits the growth and development of plants. All the energy needed to perform photosynthesis, a process that converts atmospheric CO_2 in metabolic energy is derived from solar radiation. The research on physiological and morphological activity of the bougainvillea has not done in Bangladesh yet. Keeping these points in view the current experiment was conducted to study the physiological and morphological behavior of bougainvillea cultivars.

MATERIALS AND METHODS

An experiment was conducted on rooftop garden, Department of Horticulture, Sher-e-Bangla Agricultural University, Bangladesh to study the morpho-physiological and flowering behavior of bougainvillea cultivars. Eleven bougainvillea cultivars *viz.* V_1; Juanita Hatten, V_2; Delta Dawn (Yellow), V_3; Formosa, V_4; Tomato Red, V_5; James Walker, V_6; Temple Fire, V_7; Isla Morada, V_8; Tequila Sunrise, V_9; Miami Pink, V_{10}; Pagoda Orange, and V_{11}; Mahara Beauty (Pink) were used in complete randomized design (CRD) with five replications. One year aged grafted plants were transplanted on pot contained approximate 8 kg soil and @ 2kg well decomposed cowdung. Urea, TSP and MP were also applied @ 20g/pot. Plants were kept on slightly dry conditions between watering. Pruning was done at every 3 months interval after transplanting to prevent to grow too large. This will keep the plant under control and encourage branching without interfering with blooming. The occasional aphid infestation was controlled by hosing off with water. After one and half years of transplanting, data were collected from five plants of each variety. Data were collected on leaf area, chlorophyll content, H_2O references as partial pressure (e_{ref}), CO_2 references (C_{ref}), P.A.R incident on leaf surface (Q_{leaf}), photosynthetic rate (A), stomatal conductance of H_2O (g_s), stomatal resistance to water vapor (r_s), number of floret, number of sub floret/floret, number of petal/floret. Leaf area and chlorophyll content were measured by using CL-202 Leaf Area Meter and SPAD 502 respectively. On the other hand e_{ref}, C_{ref}, Q_{leaf}, A, g_s and r_s were performed by infrared gas analyzer (IRGA) LC pro + Photosynthesis System (ADC bioscientific limited, UK). Variables were measured in every single day interval exactly at 12.30 pm. Mass flow rate setting (Uset) was maintained at 200 in LC pro + Photosynthesis System. For the floral characters 15 cm apical stem were used. All parameters were statistically analyzed by using MSTAT-C program. Mean for all the treatments was calculated and difference between treatments was evaluated by Least Significant Difference (LSD) at the 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Leaf area: Maximum leaf area was observed in V_5 (50.5 cm^2) whereas minimum from V_3 (12.9 cm^2) (Table 1). Leaf area is one of the informative functional traits (Lavorel and Garnier, 2002; Wright *et al.* 2004; Westoby and Wright, 2006; Poorter *et al.* 2009). As it is an indicator of ecophysiological characteristics such as relative growth rate and leaf longevity (Weiher *et al.* 1999; Wright and Westoby, 2002). Leaf size can increase with increasing air temperature and functionally large leaves have thicker boundary layers of air around their surfaces which insulate and decrease water loss through transpiration (Hopkins *et al.* 2008).

Chlorophyll content: Chlorophyll content showed a significant variation among the cultivars. V_{11} provided the maximum (75.5%) chlorophyll while minimum from V_6 (48.2%) (Table 1). Ehsan *et al.* (2008) and Troughton (1970) also found the variations in the characteristics of cultivars which may be due to differences in their genetic constitution. Genotype and environment interactions play a major role in influencing growth and development of plants and high leaf biomass coupled with the high chlorophyll content might have enhanced its rate of photosynthesis (Mulder and Bijma, 2005). On the other hand, reduced levels of leaf chlorophyll content per unit leaf area in crops may be of advantage in the search for higher yields. Possible reasons include better light distribution in the crop canopy and less photochemical damage to leaves absorbing more light energy than required for maximum photosynthesis. Reduced chlorophyll may also reduce the heat load at the top of canopy, reducing water requirements to cool leaves. Chloroplasts are nutrient rich and reducing their number may increase available nutrients for plant growth and development (Hamblin *et al.* 2014).

H_2O references as partial pressure (e_{ref}): Maximum e_{ref} was found from V_1 (55.2 mBar) whereas minimum from V_4 (47.5 mBar) (Table 1).

CO_2 references (C_{ref}): Maximum C_{ref} was provided by V_{11} (22.8 vpm) followed by V_{10} (22.6 vpm) whereas minimum from V_1 (20.6 vpm) (Table 1). RuBPco (ribulose-1,5-bisphosphate carboxylase) activity was reduced in the high-CO_2 grown leaves but there were no apparent differences in other two Calvin cycle enzymes (Besford 1990). Loss of RuBPco protein may be a factor associated with accelerated fall in Pmax (light-saturated rate of photosynthesis) and in contrast to acclimation to high light, acclimation to high CO_2 does not usually involve an increase in photosynthetic machinery (Besford 1993).

P.A.R incident on leaf surface (Q_{leaf}): Maximum Q_{leaf} was obtained from V_{11} (172.7 µmolm^{-2}s^{-1}) followed by V_{10} (149.6 µmolm^{-2}s^{-1}) whereas minimum from V_2 (87.5 µmolm^{-2}s^{-1}) (Table 1). With increasing photosynthetically active radiation (PAR) chloroplast stroma becomes more alkaline that leads to the activation of Rubisco, and an increase in ATP and NADPH production, therefore to an increase in photosynthetic CO_2 assimilation (A). The intensity of photosynthesis process varies depending on the light radiation received at the leaves surface, which depends of the position of the leaves in the plant. Radiation drives photosynthesis. At high irradiance, photosynthesis becomes light-saturated and is limited by the carboxylation rate, which is governed by some combination of CO_2 diffusion into the leaf and carboxylation capacity (Atwell *et al.* 1999).

Photosynthetic rate (A): Maximum photosynthetic rate was obtained from V_{11} (14.6 µmolm^{-2}s^{-1}) followed by V_{10} (10.7 µmolm^{-2}s^{-1}) while minimum from V_1 (2.6 µmolm^{-2}s^{-1}) (Table 1). Photosynthetic rate was varied among the genotype (Sasaki and Ishii, 1992) in chilli (Mehraj *et al.* 2014) and the higher biomass productivity might be due to the higher photosynthetic rate (Horie *et al*. 2003). Photosynthesis is limited by the rate of electron transport which is in turn limited by the amount of available light. With further increase in light photosynthesis becomes CO_2 limited until where the curve reaches a light saturation point, where A is not responding to further increases in PAR level, and is limited by the carboxylation capacity of Rubisco or by triose phosphate metabolism (Long *et al.* 1996).

Stomatal conductance of H_2O (g_s): Maximum stomatal conductance of H_2O (g_s) was obtained from V_2 (0.14 µmolm^{-2}s^{-1}) followed by V_6 (0.13 µmolm^{-2}s^{-1}) while minimum from V_9 and V_{10} (0.08 µmolm^{-2}s^{-1}) (Table 2). The difference in stomatal conductance perhaps maintains the physiological coherence, leaf age or due to a slower growth rate. That is why in a vegetative stage, leaf exhibited low stomatal conductance and the stomatal conductance was directly connected to age and position of leaf in a plant (Nabi *et al.* 2000). With the increase of leaf age, the stomatal conductance had improved up to a certain value which was differed from plant species to species. In the case of complete and partial pruning, stomatal conductance increased rapidly beyond the second month of observation. It was also referred that leaves from the younger branch or middle age had a higher rate of photosynthesis and high stomatal conductance than the leaves of older branches (Nabi *et al.* 2000; Poni and Intrieri, 1996). The stomata are not only the entry route for gas exchanges for CO_2 but also the outflow of water in vapor form, from the inside to the outside of the leaf. In order to absorb CO_2 from the outside, the plant inexorably loses water and when this loss decreases, it also restricts the intake of CO_2 (Kelly and Jose, 2013).

Stomatal resistance to water vapor (r_s): Maximum stomatal resistance to water vapor (r_s) was found from V_9 and V_{10} (12.5 µmolm^{-2}s^{-1}) followed by V_4 and V_8 (11.4 µmolm^{-2}s^{-1}) whereas minimum from V_2 (7.1 µmolm^{-2}s^{-1}) (Table 2).

Number of floret: The number of floret was varied significantly among the cultivars. The maximum number of floret was observed from V_6 (29.5) followed by V_{10} (28.6) while minimum from V_5 (9.5) (Table 2).

Number of sub floret: Maximum number of sub floret was observed from V_{11} (92.0) which was statistically similar with V_{10} (87.9) whereas minimum from V_3 (74.9) (Table 2).

Number of* petaloid bracts*/floret: Number of petaloid bracts/floret was varied significantly among the cultivars. Maximum number of petaloid bracts/floret was found from V_{11} (972.2) followed by V_{10} (388.6) whereas minimum from V_6 (9.5) which was statistically similar with V_3, and V_9 (9.6) (Table 2).

The flowering pattern was represented on the Plate 1 using the apical stem. From the current experiment it was observed that V_1 to V_9 represented the single floret flower whereas V_{10} and V_{11} represented the double floret flower (Plate 2) that's why V_{10} and V_{11} was given the numerous number of petaloid/bracts.

Table 1. Response of bougainvillea cultivars on some morpho-physiological traits [X]

Variety [Y]	Leaf area (cm^2)		SPAD reading (Chlorophyll %)		e_{ref}		C_{ref} (vpm)		Q_{leaf} ($\mu molm^{-2}s^{-1}$)		A ($\mu molm^{-2}s^{-1}$)	
V_1	32.1	e	56.3	e	55.2	a	20.6	g	108.5	g	2.6	i
V_2	17.4	h	56.9	d	54.6	b	21.4	f	87.5	j	5.8	f
V_3	12.9	j	52.2	g	48.2	j	21.6	f	90.6	i	8.5	d
V_4	15.4	i	53.1	f	47.5	k	22.5	bc	103.6	h	5.8	f
V_5	50.5	a	60.1	c	48.7	h	21.9	e	121.5	f	6.1	e
V_6	17.4	h	48.2	i	49.1	f	22.1	de	144.5	c	5.3	g
V_7	33.2	d	48.9	h	51.3	d	22.3	cd	134.6	d	3.7	h
V_8	41.1	c	60.1	c	50.7	e	22.5	bc	129.7	e	9.8	c
V_9	17.9	g	56.9	d	49.0	g	22.5	bc	134.6	d	14.6	a
V_{10}	25.0	f	71.3	b	52.0	c	22.6	ab	149.6	b	10.7	b
V_{11}	41.5	b	75.5	a	48.5	i	22.8	a	172.7	a	9.7	c
LSD0.05	0.2		0.3		0.1		0.3		0.3		0.3	
CV%	0.5		5.6		8.3		0.7		0.1		1.9	

[X] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

[Y] V_1; Juanita Hatten, V_2; Delta Dawn (Yellow), V_3; Formosa, V_4; Tomato Red, V_5; James Walker, V_6; Temple Fire, V_7; Isla Morada, V_8; Tequila Sunrise, V_9; Miami Pink, V_{10}; Pagoda Orange, and V_{11}; Mahara Beauty (Pink)

Table 2. Response of bougainvillea cultivars on some morpho-physiological traits and flowering behaviour[X]

Variety [Y]	g_s ($\mu molm^{-2}s^{-1}$)		r_s ($m^2s^{-1}mol^{-1}$)		Number of floret		Number sub floret/floret		Number of petaloid bracts/floret	
V_1	0.12	c	8.3	e	20.5	e	75.2	c	21.5	d
V_2	0.14	a	7.1	g	11.5	h	72.2	c	12.5	e
V_3	0.10	e	10.0	c	17.6	g	74.9	c	9.6	f
V_4	0.09	f	11.1	b	18.6	f	76.6	c	21.6	d
V_5	0.11	d	9.1	d	9.5	i	72.9	c	12.5	e
V_6	0.13	b	7.7	f	29.5	a	78.9	c	9.5	f
V_7	0.10	e	10.0	c	21.6	d	78.2	c	70.6	c
V_8	0.09	f	11.1	b	24.7	c	80.0	bc	21.7	d
V_9	0.08	g	12.5	a	18.6	f	75.2	c	9.6	f
V_{10}	0.08	g	12.5	a	28.6	b	87.9	ab	388.6	b
V_{11}	0.10	e	10.0	c	20.7	e	92.0	a	972.7	a
LSD0.05	0.001		0.1		0.3		8.3		0.3	
CV%	9.7		9.3		0.7		6.2		3.1	

[X] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

[Y] V_1; Juanita Hatten, V_2; Delta Dawn (Yellow), V_3; Formosa, V_4; Tomato Red, V_5; James Walker, V_6; Temple Fire, V_7; Isla Morada, V_8; Tequila Sunrise, V_9; Miami Pink, V_{10}; Pagoda Orange, and V_{11}; Mahara Beauty (Pink)

Plate 1. Flowering pattern of 11 bougainvillea cultivars

Here,

V_1; Juanita Hatten, V_2; Delta Dawn (Yellow), V_3; Formosa, V_4; Tomato Red, V_5; James Walker, V_6; Temple Fire, V_7; Isla Morada, V_8; Tequila Sunrise, V_9; Miami Pink, V_{10}; Pagoda Orange, and V_{11}; Mahara Beauty (Pink)

V_1 V_2 V_3 V_4

V_5 V_6 V_7 V_8

V_9 V_{10} V_{11}

Plate 2. Variation of petaloid bracts of 11 bougainvillea cultivars

Here,

V_1; Juanita Hatten, V_2; Delta Dawn (Yellow), V_3; Formosa, V_4; Tomato Red, V_5; James Walker, V_6; Temple Fire, V_7; Isla Morada, V_8; Tequila Sunrise, V_9; Miami Pink, V_{10}; Pagoda Orange, and V_{11}; Mahara Beauty (Pink)

CONCLUSION

The bougainvillea cultivars showed wide ranges of variation in morphological, physiological and flowering behavior.

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