Research Article

Standardization of Growth Retardants for Production of Potted Bougainvillea

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Abstract

This experiment was conducted at Bougainvillea Repository, Division of Floriculture and Landscaping, Indian agricultural research institute, New Delhi. The bougainvillea were planted in 8 inches pots contains cocopeat, perlite and sand in the ratio of 1:1:1 respectively as potting media were used in different combination and growth retardants, viz. ancymidol, uniconazole, paclobutrazol, cycocel, daminozide were applied in the form of foliar spray and were compared with control (Distilled water) and the data were recorded for vegetative and foliar traits. Over a period of 45 and 90 days after planting, it was observed that there was a significant reduction in the plant height, plant spread, shoot length, internode distance, inflorescence length, number of leaves and maximum flower index, number of flowers and number of bract clusters on inflorescence was observed when Parthasarthy bougainvillea plants are sprayed with T6 paclobutrazol at 20 ppm.

Keywords: Bougainvillea, parthasarthy, flower index, cocopeat, vermiculite, sand, perlite,and paclobutrazol

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Introduction

The genus Bougainvillea is a member of Nyctaginaceae family, has 14 species, with horticulturally important species like *Bougainvillea spectabilis*, *Bougainvillea buttiana*, *Bougainvillea glabra*, and *Bougainvillea peruviana* [1]. Bougainvillea is a tropical and subtropical woody evergreen and multipurpose plant used as climber, specimen plant, shrub, topiary, hedge, standard, pot plants, bonsai, ground cover, cascade, arch, pergola etc. [2]. Due to rapid urbanization and concretization less space is available for gardening, and therefore, ornamental plants are placed in indoor to beautify corridors, balconies, large size window boxes, verandah, rooms, and terraces. Major factors that considered bougainvillea is labour oriented for training and pruning makes the industry highly man power intensive and increase the cost on production and such vigorous growing nature of the plants makes unsuitable and uneconomic. Plant growth retardants are the option to reduce the labour intensity and make the plant compact and dwarf with recurrent flowering.

Such growth retardants viz. paclobutrazol, daminozide, and cycocel, are extensively used by the researcher but the detailed study of their doses and intensity of application in bougainvillea is still unknown. Proper pot size is an important factor in bougainvillea to consider, and it must be smaller in size otherwise it is difficult to carry in a big building, apartments, and top, they cover more place and require larger quantity of potting mixture duringrepotting, the most ideal pot size is about 6 to 12 inches, which is handy, useful and cheaper in term of input cost and handling. The studies have also shown that pot plants have positive psychological effects, like indoor air-purification and also provide clean air by absorbing toxic gases.Therefore, in order to use different growth retardants to develop dwarf bougainvillea plants in small containers, this study has been designed to standardize the growth retardants with its different doses. By doing this we can promote the industry for the livelihood of nurserymen and to meet the demand of household's customers.

Materials and Methods

The present experiment was carried out in the bougainvillea garden of International Center of Registration Authority for Bougainvillea, Division of Floriculture and Landscaping, Indian council of agricultural research -Indian Agricultural Research Institute, New Delhi-110012 during 2018-2019.The parthasarthy cuttings were treated with 4000 ppm of IBA prior to planting in polybags with sand medium under net house. Watering was done daily and drenching of polyfeed (19:19:19) @3g/l at 15 days interval were given. Cuttings were allowed to sprout and retained the plants in the net house for about 45 days after which hardening for 15 days was done by keeping plants under open condition. Transplanting of bougainvillea sprouted cuttings to plastic pots having (8 inch length), contains

cocopeat, perlite, sand in the ratio of 1:1:1 respectively as potting media. Thereafter plants were allowed to develop roots and establish firmly for 30 days.

Freshly prepared growth retardant solutions like paclobutrazol and daminozide are water soluble and hence were dissolved in small quantity of distilled water and then volume was made up to spray solution needed. Cycocel and ancymidol are soluble in strong alkali and was dissolved in 1% NaOH solution and then volume made up to spray solution needed with water. Uniconazole is soluble in methanol and hence dissolved in small quantity of methanol and then volume made up to spray solution needed. Each pot sprayed with 30 ml of solution. Were sprayed at 45 and 90 days after planting with treatements.

T_1 : Ancymidol 25ppm; T_2 : Ancymidol 50ppm; T_3 : Uniconazole 5ppm; T_4 : Uniconazole 10ppm
T_5 : Paclobutrazol 10ppm; T_6 : Paclobutrazol 20ppm; T_7 : Cycocel 500ppm
T_8 : Cycocel 1000ppm; T_9 : Daminozide 750ppm; T_{10} : Daminozide 1000ppm
T_{11} : Control (Without Hormones)

Based on previous studies, the plant growth retardants were applied either in the form of soil foliar spray or drench application and the quantity of solution used per pot was 125 ml and 200 ml, re Maleic hydrazide is recommended as a foliar spray for the temporary growth inhibition of various trees, shrubs and grasses. Similarly, B-9 (daminozide) is also applied as a foliar spray because it is highly mobile in the plant and will rapidly move from the point of application to all parts of the plant, but if it is applied to the substrate, it breaks down rapidly, however, paclobutrazol can be applied both in the form of drench or foliar spray because it moves in the xylem and slows down vegetative growth by inhibiting gibberellin biosynthesis. The experiment was laid out in Randomized Complete block design (RCBD), with 11 treatments, three replications and three plants per replication. Observations were recorded at 45days and 90 days after planting for the vegetative parameters like plant height, percentage increase in plant height, plant spread,number of branches, shoot length, internodal length,number of leaves per plant,number of flowers, inflorescence length, number of bract clusters on inflorescence, bract length, bract widthwhile observations for qualitative traits like growth index (Average plant height+ plant spread/2), flower index (rating scale; 1.00=none, 2.00 = slight, 3.00= some, 4.00=moderate, 5.00=heavy), form index (rating scale 1.00=poor, 2.00= fair, 3.00= good, 4.00= excellent) and number of structural branches (> 15 cm in length),The data were subjected to analysis by using CRD at 5% level of significance.

Results and Discussion

The potted plants of Parthasarthy which are sprayed with T_6 paclobutrazol at 20ppm showed that there was a significant reduction in the plant height, plant spread, shoot length, internode distance, inflorescence length, number of leaves and maximum flower index, number of flowers and number of bract clusters on inflorescence.

Vegetative paramters

The results show in **Table 1** plant height at 45 days and 90 days after planting showed significant difference among the different treatments, minimum plant height was recorded in treatment (T_6) (25.05 cm), maximum plant height was recorded in control treatment (T_{11}) (36.87cm) and minimum plant height was recorded in treatment (T_6) (25.63 cm) followed by treatment (T_7) (28.74 cm) and maximum plant height was recorded in control treatment (T_{11}) (39.73 cm) respectively compared to other treatments.

Plant spread at 45 days and 90 days after planting shows significant difference among the different treatments, minimum plant spread was recorded in treatment (T_6) (13.49 cm), maximum plant spread was recorded in control treatment (T_{11}) (33.13cm) and compared to other treatments and minimum plant spread was recorded in treatment (T_6) (14.60 cm) followed by treatment (T_{10}) (18.88 cm) and maximum plant spread was recorded in treatment (T_{11}) (35.78 cm) respectively compared to other treatments.

Maximum number of branches was recorded in treatment (T_6) (4.40) and minimum number of branches was recorded in treatment (T_{11}) (1.85) and maximum number of branches was recorded in treatment (T_6) (4.73) followed by treatment (T_{10}) (3.59) and minimum number of branches was recorded in treatment (T_{11}) (2.33) and compared to other treatments. Number of branches at 45 days and 90 days after planting respectievely shows significant difference among the different treatments.

Table 1 Effect of growth retardants on vegetative growth of Bougainvillea var. Parthasarthy

Treatments	Plant height (cm) at 45 DAP	Plant height (cm) at 90 DAP	Plant spread (cm) at 45 DAP	Plant spread (cm) at 90 DAP	Number of branches at 45 DAP	Number of branches at 90 DAP	Shoot length (cm) at 45 DAP	Shoot length (cm) at 90 DAP
T_1	30.72	32.00	17.44	19.19	2.78	3.33	19.94	21.12
T_2	29.97	31.48	19.40	20.50	2.67	3.22	20.70	21.93
T_3	31.17	32.56	21.79	23.03	2.63	3.11	19.88	20.55
T_4	32.44	33.93	19.73	20.52	2.44	3.11	19.90	20.94
T_5	28.76	29.93	18.66	19.66	2.56	3.33	18.10	19.02
T_6	25.05	25.63	13.49	14.60	4.40	4.73	11.63	12.71
T_7	28.74	30.20	21.27	22.33	2.66	3.26	18.69	19.65
T_8	30.33	31.70	23.22	24.51	2.44	3.70	20.72	21.76
T_9	28.89	30.31	19.52	20.40	2.56	3.41	18.62	19.44
T_{10}	29.24	30.60	17.53	18.88	2.33	3.59	17.72	19.64
T_{11}	36.87	39.73	33.13	35.78	1.85	2.33	25.58	27.95
Mean	1.16	1.26	2.03	1.99	0.26	0.23	1.42	1.49
C.D.	2.43	2.63	4.25	4.16	0.55	0.48	2.98	3.12

Minimum shoot length was recorded in treatment (T_6) (11.63 cm) and maximum shoot length was recorded in treatment (T_{11}) (25.58 cm) and minimum shoot length in treatment (T_6) (12.71 cm) followed by treatment (T_5) (19.02 cm) and maximum shoot length was recorded in treatment (T_{11}) (27.95 cm) compared to other treatments. Shoot length at 45 days and 90 days after planting respectively shows significant difference among the different treatments.

The lowest plant height was observed in the treatment involving paclobutrazol as a foliar spray at 20 ppm. Plant growth retardants cause delay in cell division and elongation of plant aerial parts by inhibiting gibberellins biosynthesis, so there by resulting in decreased plant height, internodal length and vegetative growth [3] in bougainvillea variety Mahara.

Growth retardants inhibit the cell division and cell elongation from tissues in shoot and regulate plant height physiologically without any formative effect. The paclobutrazol functions by retarding cytochrome P-450, which mediates oxidative demethylation reactions containing those which are necessary for the synthesis of ergosterol and the conversion of kaurene to kaurenoic acid in the biosynthesis pathway of gibberellin [4]. The gibberellins biosynthesis is blocked, cell division continues but the new cells have do not elongate results in shoots with the same or more number of leaves but the compressed internodes [5]. Due to this function paclobutrazol has been used to reduce the plant height of the potted plants particularly ornamentals plants like *Dieffenbachia maculate, philodendron scandensoxycardium* and *scheffler arboricola* [6], *Ficus benjamina*, *Zebrina pendula* and *plectranthus australis* [7, 8] and also in *Hibiscus rosa-sinensis* [9].

Least internodal length was observed with foliar spray of paclobutrazol at 20 ppm and results were coherent with the [10] who observed the paclobutrazol is known to reduce the stem elongation by inhibiting the GA biosynthesis. In the present study, the internodal length was reduced by application of growth retardants leading to dwarfing of the plant. This is due to shortening of the internodal length and elimination of apical dominance [11]. Similar retardation of plant height has been reported in Chrysanthemum morifolium [12, 13], Dianthus caryophyllus [14] and Tagetus erecta [15].

According to [16], the major biochemical effect of the paclobutrazol is suppression of gibberellin biosynthesis by inhibiting the oxidation of kaurene to kaurenoic acid in in gibberellin biosynthesis pathway resulting in decreased cell division and expansion. The direct consequences in morphological is a reduction in vegetative growth. This explains the greater reduction in plant height in bougainvillea was observed in the present study.

The results show in **Table 2** minimum internodal length was recorded in treatment (T_6) (0.94 cm), maximum internodal length was recorded in treatment (T_{11}) (2.35 cm) and minimum internodal length was recorded in treatment (T_6) (1.07 cm) followed by treatment (T_5) (1.31 cm) and maximum internodal length was recorded in treatment (T_{11}) (2.46 cm) compared to other treatments. Internodal length at 45 days 90 days after planting shows significant difference among the different treatments.

Table 2 Effect of growth retardants on vegetative growth of Bougainvillea var. Parthasarthy

Treatments	Inter nodal length (cm) at 45 DAP	Inter nodal length (cm) at 90 DAP	Number of leaves at 45 DAP	Number of leaves at 90 DAP	% Increase in plant height at 90 days after planting	No. of structural branches at 90 days after planting	Growth index at 90 days after planting	Form index at 90 days after planting
T1	1.41	1.45	62.33	72.85	4.16	1.55	25.59	2.56
T2	1.41	1.54	68.92	80.23	5.08	1.43	25.99	2.11
T3	1.17	1.31	62.99	73.98	4.49	1.40	27.80	2.33
T4	1.66	1.81	71.39	84.65	4.59	2.74	27.23	2.11
T5	1.43	1.58	48.39	58.25	4.10	1.44	24.80	1.67
T6	0.94	1.07	36.39	44.48	2.34	1.00	20.12	2.22
T7	1.56	1.58	67.43	76.85	5.05	1.59	26.26	2.00
T8	1.60	1.68	68.50	79.03	4.47	1.43	28.11	2.67
T9	1.60	1.81	61.30	71.38	4.93	1.33	25.36	1.89
T10	1.29	1.41	68.04	78.15	4.63	1.40	24.74	1.78
T11	2.35	2.46	118.20	128.24	7.77	1.22	37.76	2.11
Mean	0.15	0.14	4.68	4.16	0.43	0.13	1.36	0.36
C.D.	0.32	0.30	9.77	8.70	0.90	0.28	2.84	0.75

Minimum number of leaves was recorded in treatment (T_6) (36.39), maximum number of leaves was recorded in treatment (T_{11}) (118.20) and minimum number of leaves was recorded in treatment T_6 (44.48) followed by treatment T_5 (58.25) and maximum number of leaves was recorded in treatment T_{11} (128.24) compared to other treatments, number of leaves at 45 days and 90 days after planting respectievely, shows significant difference among the different treatments.Minimum percentage increase in plant height was recorded in treatment (T_6) (2.34%) followed by treatment (T_5) (4.10%) and maximum percentage increase in plant height was recorded in treatment (T_{11}) (7.77%) and compared to other treatments, the percentage increase in plant height at 90 days after planting shows significant difference among the different treatments.

Number of structural branches at 90 days after planting shows significant difference among the different treatments, minimum number of structural branches was recorded in treatment (T_6) (1.00) followed by treatment (T_{11}) (1.22) and maximum number of structural branches was recorded in treatment (T_4) (2.74) and compared to other treatments.Minimum growth index was recorded in treatment (T_6) (20.12) followed by treatment (T_{10}) (24.74) and maximum growth index was recorded in treatment (T_{11}) (37.76) and compared to other treatments. Growth index at 45 days after planting shows significant difference among the different treatments.Form index at 45 days after planting shows non-significant difference among the different treatments. Minimum form index was recorded in treatment (T_5) (1.67) and maximum form index is recorded in treatment (T_8) (2.67) and compared to other treatments.

Flowering paramters

The results show in **Table 3** number of flowers at 90 days after planting shows significant difference among the different treatments, maximum number of flowers was recorded in treatment (T_6) (23.87) and minimum number of flowers is recorded in treatment (T_{11}) (2.67) and compared to other treatments.Minimum inflorescence length was recorded in treatment (T_6) (1.11 cm) followed by treatment (T_1) (1.28 cm) and maximum inflorescence length is recorded in treatment (T_{11}) (2.49 cm).

Maximum number of bract cluster on inflorescence was recorded in treatment (T_6) (10.51) followed by treatment (T_8) (4.88) and minimum number of bract cluster on inflorescence is recorded in treatment (T_{11}) (1.40) and compared to other treatments. Number of bract cluster on inflorescence at 90 days after planting shows significant difference among the different treatments.Bract length at 90 days after planting shows significant difference among the different treatments. Maximum bract length was recorded in treatment (T_2) (3.85 cm) and minimum bract length is recorded in treatment (T_{11}) (1.84 cm) and compared to other treatments.

Maximum bract width was recorded in treatment (T_2) (2.22 cm) followed by treatment (T_{10}) (2.19 cm) and minimum bract width is recorded in treatment (T_{11}) (1.30 cm) and compared to other treatments. Bract width at 90 days after planting shows significant difference among the different treatments.

Important flowering characteristics namely, flower index, number of flowers, inflorescence length, number of bract cluster on inflorescence, bract length, bract width are discussed here. These parameters had been significantly influenced upon application of plant growth retardants. Maximum number of flowers, number of bract cluster on inflorescence was observed in foliar spray application of paclobutrazol at 20 ppm. The most favourable feature of

paclobutrazol is the inhibition of vegetative growth fallowed by change in the pattern of distribution in photosynthetic products thereby, diverting them towards reproductive growth and the formation of more number of flower buds [17].

The decreased bract length and bract width in Parthasarthy variety of bougainvillea was seen with foliar application of paclobutrazol at 20 ppm and this may be due to reduced gibberellin biosynthesis leading to limited expansion of cells [18].

Table 3 Effect of growth retardants on flowering growth of Bougainvillea var. Parthasarthy

Treatments	No. of flowers at 90 days after planting	Inflorescence length at 90 days after planting	No. of bract cluster on inflorescence at 90 days after planting	Bract length at 90 days after planting	Bract width at 90 days after planting
T1	11.45	1.28	4.73	2.54	2.07
T2	6.89	2.12	4.30	3.85	2.22
T3	8.74	2.11	4.11	2.89	1.86
T4	5.00	2.10	3.37	2.73	1.83
T5	17.85	2.07	4.72	2.59	1.96
T6	23.87	1.11	10.51	3.18	1.80
T7	13.56	2.28	4.39	3.01	2.01
T8	9.16	1.97	4.88	2.87	1.89
T9	12.87	2.35	3.77	2.85	2.02
T10	13.97	2.03	3.75	2.61	2.19
T11	2.67	2.49	1.40	1.84	1.30
Mean	1.92	0.14	0.93	0.29	0.14
C.D.	4.01	0.31	1.94	0.60	0.29

Figure 1 Rooted cuttings of Parthasarthy Experimental field view

T_6- 20ppm (Paclobutrazol)

Control- T_{11}(Distilled Water)

Figure 2 Influence of growth retardant on Bougainvillea var. Parthasarthy pot plant

Conclusion

On thebasis of present study, it can be concluded that in order to obtain potted bougainvillea Parthasarthy plants for rigorous and recurrent bloom, the effective growth retardant is paclobutrazol at 20 ppm, by use of this growth retardant there is a gradual reduction in vegetative growth which cause dwarf growth and increasing flower production and are most suitable for pot production of bougainvillea.

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