International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(12): 930-933
www.biochemjournal.com
Received: 03-10-2024
Accepted: 07-11-2024

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Effect of plant growth retardants on potted hibiscus

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DOI: https://doi.org/10.33545/26174693.2024.v8.i12l.3351

Abstract
An experiment was conducted to study the effect of plant growth retardants on growth and flowering of potted hibiscus plants grown in pot during 2017-18 and 2018-19. Application of cycocel, alar and paclobutrazol at different concentrations found significant influencing the vegetative growth, flowering parameters and plant pigments of *Hibiscus rosa- sinensis* plants during both the years as compared to untreated plants (control). Reduced plant height, plant spread and minimum leaf area was found in plants treated with 75 ppm paclobutrazol respectively at 15, 30 and 60 days after spraying (DAS). Maximum number of branches, number of leaves, number of flowers per plant, flower diameter, chlorophyll content in leaves and anthocyanin pigment content in flowers were observed with application of 3000 ppm cycocel respectively at 15, 30 and 60 days after spraying (DAS).

Keywords: Hibiscus, cycocel, alar, paclobutrazol, pigments

Introduction
Hibiscus rosa-sinensis (China rose, Chinese hibiscus, rose mallow and shoe black plant) belongs to Malvaceae family. This plant is commonly found throughout the tropics and as a house plant throughout the world. The flower is a colourful trumpet-shaped from white to pink, red, orange, yellow or purple and even in mixed colours with beautiful opening. This plant is highly popular in landscaping and is also now gaining impetus as flowering pot plant especially for Indian tropical and subtropical climate. Plant growth regulators, in ornamental horticulture, are utilized to alter plant growth and influence flower quality and petal pigments (Mangave *et al.*, 2013, Patel *et al.*, 2020) [15, 14]. Use of growth retardants are further known to produce compact and sturdy potted plants (Lodeta *et al.*, 2010; Chopde *et al.*, 2017) [10, 11]. Therefore, this study was conducted to the effect of plant growth retardants on potted hibiscus.

Materials and Methods
The present study was carried out at the ATC of soilless systems, at the Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari-396450, Gujarat during 2017-18 and 2018-19. The experiment was laid out in Completely Randomized Design with three repetations. Uniform plants of *Hibiscus rosa- sinensis* var. Red Double were exposed to foliar spray at different concentrations of chlorocholine chloride i.e, (cycocel) @ 1000, 2000 and 3000ppm, Daminozide (Alar) @ 1000, 2000 and 3000ppm and Paclobutrazol (PBZ) @ 25, 50 and 75ppm after 30 days of planting at 15 days interval twice. Each plant was sprayed with approximately 30 ml of freshly prepared solution. Plants considered as control were not exposed to foliar spray. The data on various vegetative, flowering and pigments were recorded at 15, 30 and 60 days after spraying (DAS). The total chlorophyll content was determined by DMSO (Dimethyl sulphoxide) method of Wellburn (1994) [20] and expressed in mg/g of fresh weight. The statistical analysis was done by adopting pooled analysis with appropriate standard error (S.Em ±) method in each case as suggested by Panse and Sukhatme (1985) [13]. The level of significance was kept at 5% (p<0.05). Data were analyzed using Software program at Statistics department.

Results and Discussion

Vegetative growth parameters

The data presented in Table 1 revealed that application of plant growth retardants significantly influenced vegetative and flowering parameters in *Hibiscus rosa-sinensis* plants. PBZ, cycocel and Alar were highly effective in reducing plant height and leaf area. Minimum plant height at 15 DAS (12.47 and 15.63 cm), 30 DAS (15.70 and 18.03 cm) and 60 DAS (17.30 and 20.43 cm) and minimum leaf area at 15 DAS (2.33 and 2.50 cm^2), 30 DAS (2.50 and 2.63 cm^2) and 60 DAS (2.80 and 2.70 cm^2) were recorded with 75 ppm paclobutrazol (T_{10}) during first and second year.

The reduction in plant height with growth retardant application might be due to inhibitory role of growth retardants on cell division and cell elongation of apical meristematic cells and also on gibberellins synthesis. Leaf area is an important attribute as it has direct relevance with interception of light and photo synthesis and ultimately with overall growth and development. Plant growth retardants generally have the greatest effects on expanding or elongating cells where inhibition of gibberellins synthesis rapidly causes reduction in leaf expansion (Ahmad Nazarudin, 2012) [2].

Plants treated with cycocel at 3000 ppm (T_4) exhibited maximum branches at 15 DAS (2.53 and 2.73), 30 DAS (4.53 and 5.00) and 60 DAS (5.27 and 5.73) with more number of leaves at 15 DAS (25.87 and 33.33), 30 DAS (31.20 and 36.37) and 60 DAS (35.87 and 39.10) during first and second year. It is a well known fact that all the growth retardants can suppress apical dominance, resulting in increased biometric characters like more number of branches and leaves (Sudhagar and Kamalakannan, 2017) [16]. The increase in number of leaves with cycocel and alar treatment may be related to diversion of photosynthates towards the axillary buds and reduction in shoot growth and increase in number of branches per plant (Gyandev, 2006) [4]. These result are in agreement with earlier findings bougainvellia (Abdella and Mohamed, 2012) [1], marigold (Khan *et al.*, 2012) [7] and hibiscus (Ahmad Nazarudin, 2012) [2].

Flowering characters

Foliar application of cycocel at 3000 ppm (T_4) recorded maximum number of flowers per plant at 15 DAS (6.20 and 6.57), 30 DAS (6.80 and 6.93) and 60 DAS (7.13 and 7.20), flower per branch at 15 DAS (2.40 and 2.53), 30 DAS (2.67 and 2.83) and 60 DAS (2.80 and 2.97) with maximum diameter of flower at 15 DAS (5.30 and 6.33 cm), 30 DAS (5.80 and 6.70 cm) and 60 DAS (6.13 and 6.90 cm) during first and second year.

Increase in number of flowers with the application of cycocel could be attributed to increased mobilization of biomass to flowers from the source. Kumar *et al.* (2006) [8] also found beneficial effect of growth retardants compared to growth promoters in terms of the translocation of photo-assimilates towards developing reproductive parts. The increase in flower size may be due to higher food reserves as a result of increased number of leaves and plant spread as well as high chlorophyll content. The production of big sized flowers due to growth retardants might be due to the indirect effect of more number of laterals, increased number of leaves with thick texture as stimulated and developed by the influence of such chemicals (Sudhagar and Kamalakannan, 2017) [16].

Pigments

Plants sprayed with cycocel at 3000 ppm (T_4) recorded significantly maximum chlorophyll content in leaves at 15 DAS (16.67 and 18.77 mg/g), 30 DAS (18.80 and 20.73 mg/g) and 60 DAS (20.37 and 22.20 mg/g) and maximum anthocynin in flower at 15 DAS (13.13 and 14.03 mg/g), 30 DAS (15.63 and 17.23 mg/g) and 60 DAS (16.20 and 19.20 mg/g) during first and second year.

The effect of cycocel in increasing total chlorophyll contents may be due to reduction in cell size resulting in dense cytoplasm in the cells. Increase of chlorophyll content in growth retardant treated leaves was due to smaller cells and thus more concentrated chlorophyll inside the reduced cell volume as explained earlier (Thakur *et al.*, 2006 and Lodeta *et al.*, 2010) [18, 10]. Cycocel is directly related to the formation of bioactive compounds, since it potentiates photosynthetic process and contributes to higher production of primary carbohydrates, that when in high concentration in plant, promotes activation of secondary metabolic pathways, responsible for the synthesis of anthocyanin substances. Further, results are in conformity with earlier reports in hibiscus (Ahmad Nazarudin, 2012) [2], bogainvellia (Abdella and Mohamed, 2012) [1] and chrysanthemum (Kazaz *et al.*, 2010 and Kahar, 2008) [6, 5] and marigold (Sunayana *et al.*, 2017) [17].

From the present study it may be concluded that foliar application of 3000 ppm cycocel or alar at 30 days after planting in hibiscus plants, at 15 days interval can be efficiently used to develop improved plant architecture with regard to more branching, leaves and flower parameters along with reduced plant height in *Hibiscus rosa-sinensis* as a pot plant.

Table 1: Effect of plant growth retardants on vegetative growth parameters of potted hibiscus

Treatments	Plant height (cm)						Leaf area (cm^2)					
	2017-18			2018-19			2017-18			2018-19		
	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS
T_1 – Control (water)	18.10	23.23	28.10	20.50	24.33	29.27	9.60	10.00	10.20	9.83	11.00	12.20
T_2 – CCC 1000 ppm	17.20	21.00	25.67	19.60	22.50	27.40	12.60	12.80	13.10	13.00	14.43	14.47
T_3 –CCC 2000 ppm	16.43	20.30	25.43	18.87	21.80	25.80	13.67	13.77	14.83	14.50	15.63	15.87
T_4 – CCC 3000 ppm	16.07	20.03	25.00	18.30	21.37	25.27	14.20	14.33	15.13	15.57	16.77	17.43
T_5 – Alar 1000 ppm	17.13	21.60	26.73	19.37	22.60	27.50	11.80	12.07	13.37	12.97	14.33	14.40
T_6 – Alar 2000 ppm	16.73	21.40	26.50	19.27	22.40	27.30	12.10	12.37	13.47	13.33	14.57	14.73
T_7 – Alar 3000 ppm	16.50	21.30	26.33	19.10	22.20	27.20	12.30	12.50	14.10	13.77	14.90	14.97
T_8 – PBZ 25 ppm	14.37	16.27	18.67	16.30	18.77	21.13	3.70	3.90	4.23	4.77	5.60	5.70
T_9 – PBZ 50 ppm	13.60	16.07	18.30	15.90	18.20	20.93	3.03	3.10	3.50	3.20	3.60	3.77
T_{10} - PBZ 75 ppm	12.47	15.70	17.30	15.63	18.03	20.43	2.33	2.50	2.80	2.50	2.63	2.70
S.Em.±	0.26	0.27	0.23	0.11	0.13	0.12	0.07	0.07	0.24	0.10	0.10	0.14
C.D. at 5%	0.77	0.78	0.69	0.33	0.40	0.34	0.20	0.21	0.71	0.29	0.30	0.40
C.V.%	2.85	2.34	1.71	1.07	1.11	0.80	1.24	1.27	3.99	1.67	1.58	2.04

Table 2: Effect of plant growth retardants on vegetative growth parameters of potted hibiscus

Treatments	Number of branches per plant						Number of leaves per plant					
	2017-18			2018-19			2017-18			2018-19		
	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60DAS	15 DAS	30 DAS	60 DAS
T_1 – Control (water)	1.27	2.73	2.80	1.33	2.87	3.30	12.60	14.70	16.47	14.60	16.53	19.37
T_2 – CCC 1000 ppm	1.87	3.27	3.37	1.87	4.37	4.90	20.40	22.40	28.30	23.57	25.57	32.43
T_3 –CCC 2000 ppm	2.27	3.87	4.70	2.47	4.60	5.27	25.00	30.23	33.50	30.43	34.47	37.47
T_4 – CCC 3000 ppm	2.53	4.53	5.27	2.73	5.00	5.73	25.87	31.20	35.87	33.33	36.37	39.10
T_5 – Alar 1000 ppm	2.00	3.50	3.73	2.00	3.73	3.87	20.20	24.30	28.53	24.43	26.43	30.23
T_6 – Alar 2000 ppm	2.13	3.67	3.97	2.20	3.77	4.13	21.93	25.33	28.80	27.57	29.93	32.27
T_7 – Alar 3000 ppm	2.33	3.80	4.00	2.53	3.90	4.17	23.13	26.30	30.53	28.80	31.87	34.37
T_8 – PBZ 25 ppm	1.67	3.03	3.00	1.73	3.37	3.90	17.27	20.27	24.43	21.30	23.37	25.23
T_9 – PBZ 50 ppm	1.73	3.23	3.20	1.73	3.40	4.03	17.36	20.40	24.67	21.40	23.57	25.40
T_{10} - PBZ 75 ppm	1.87	3.17	3.27	1.93	3.47	4.03	17.53	20.70	25.80	21.83	24.23	26.20
S.Em.±	0.07	0.20	0.15	0.08	0.17	0.23	0.10	0.11	0.08	0.08	0.08	0.13
C.D. at 5%	0.21	0.61	0.44	0.23	0.50	0.68	0.30	0.33	0.23	0.26	0.24	0.39
C.V.%	6.43	10.23	6.97	6.65	7.58	9.27	0.87	0.83	0.50	0.63	0.51	0.76

Table 3: Effect of plant growth retardants on flowering characters of potted hibiscus

Treatments	Number of flowers per plant						Flower diameter (cm)					
	2017-18			2018-19			2017-18			2018-19		
	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS	15 DAS	30 DAS	60 DAS
T_1 –Control (water)	4.30	4.47	4.57	4.67	4.83	5.20	4.23	4.53	4.97	4.47	5.10	5.30
T_2 –CCC 1000 ppm	4.90	5.07	5.17	5.00	5.23	5.60	4.37	4.93	5.40	4.83	5.27	5.53
T_3 –CCC 2000 ppm	5.93	6.20	6.87	6.07	6.47	6.93	5.00	5.47	5.90	5.13	6.00	6.20
T_4 –CCC 3000 ppm	6.20	6.80	7.13	6.57	6.93	7.20	5.30	5.80	6.13	6.33	6.70	6.90
T_5 – Alar 1000 ppm	5.00	5.17	5.23	5.27	5.57	5.73	4.40	4.97	5.37	4.87	5.27	5.57
T_6 – Alar 2000 ppm	5.13	5.37	5.53	5.50	5.90	6.00	4.50	4.77	5.17	4.70	5.30	5.70
T_7 – Alar 3000 ppm	5.40	5.97	6.30	5.90	6.13	6.50	4.73	5.23	5.50	5.07	5.50	5.87
S.Em.±	0.07	0.12	0.06	0.07	0.09	0.09	0.17	0.17	0.21	0.28	0.15	0.13
C.D. at 5%	0.22	0.36	0.19	0.21	0.28	0.29	0.52	0.52	0.64	0.85	0.47	0.40
C.V.%	2.34	3.69	1.83	2.18	2.73	2.72	6.40	5.88	6.65	9.60	4.86	3.92

Note: No flowering was observed in PBZ treated Plants

Conclusion

The study concludes that the foliar application of growth retardants, particularly cycocel at 3000 ppm, significantly influenced the vegetative and flowering parameters of *Hibiscus rosa-sinensis* plants. Paclobutrazol (75 ppm) was most effective in reducing plant height and leaf area, while cycocel promoted increased branching, leaf production, and flower yield. The growth retardants also enhanced chlorophyll and anthocyanin content, contributing to improved photosynthetic efficiency and flower pigmentation. Overall, cycocel and alar, applied at regular intervals, can effectively regulate plant growth, resulting in compact, well-branched plants with larger flowers, making them suitable for ornamental pot cultivation.

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