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EFFECT OF GROWTH RETARDANTS ON THE VEGETATIVE GROWTH, FLOWERING AND YIELD OF HELICONIA (*HELICONIA PSITTACORUM*) VAR. RED TORCH UNDER 50 PER CENT SHADE NET CONDITION

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ABSTRACT

An investigation was carried out to study the effect of plant growth retardants on the growth, flowering and yield of heliconia (*Heliconia psittacorum)* var. Red Torch under 50 per cent green shade net condition during 2012-2013. The experimental results revealed that among all growth retardants, paclobutrazol @ 300 ppm drastically suppressed plant height (24.86 cm, 25.95 cm, 27.20 cm and 49.60 cm) at 3, 6, 9 and 12 MAP, respectively and it was at par with 150 ppm paclobutrazol and followed by TIBA @ 30 ppm. Other vegetative parameters like leaves per plant (4.60, 6.20, 4.66 and 4.33 at 3, 6, 9 and 12 MAP, respectively), sucker per clump (6.13, 12.20 and 15.86 at 6, 9 and 12 MAP, respectively) and leaf area (477.73 cm^2 at 12 MAP) were found maximum in MH @ 50 ppm. Minimum days to flowering (147.20), maximum flowering duration (55.40 days), number of bracts and florets (4.60 and 12.06, respectively), rachis and stalk length (15.41 cm and 110.98 cm, respectively), spikes per clump (4.46) and vase life (13.33 days) was also found in the same treatment. It can be concluded that MH @ 50 ppm proved to be the best treatment for obtaining higher yield of good quality flowers

INTRODUCTION

Heliconia is a newly identified, herbaceous, perennial, tropical, rhizomatous plant which belongs to family Heliconiaceae and member of a large taxonomic category Zingiberales. It rises from banana like clump. The importance of heliconia as an ornamental is due to its strikingly elegant cut flowers, which originally is a colored flashy bract. It is an important specialty cut flower and is gaining popularity as commercial cut flower due to the diversity in their colour and form, unusual inflorescence and long lasting vase life. Its brilliant colours, exotic form, long straight peduncles (both erect and hanging) and good post harvest life make it an outstanding flower for the florist trade. In India, West Godavari district of Andhra Pradesh, Kerala, Karnataka, Assam and other North-Eastern states are the major producers. This new high value flower crop can assure sizable income to farmers with minimum investment and care.

Presently, heliconia is not very popular among growers because it takes long duration between planting and flowering while farmers need early return. This problem can be overcome by using various growth regulators, especially growth retardants which are synthetic compounds and used to retard the shoot length of the plant without evoking phyto toxic effects. This has been achieved by reducing the cell elongation and by lowering the rate of cell division and thus regulating the plant height physiologically. Most of the available growth retardants are anti gibberellins, as they inhibit the growth of active gibberellins and can thus be used to reduce unwanted shoot elongation (Singh, 2004). Certain plant growth retardants like CCC, MH, TIBA, Paclobutrazol, etc. have known to reduce the plant height and increase production in African marigold (Sunitha, 2006), salvia (Kumar *et al*., 2012) and mango (Srilatha *et al*., 2015).

As most of species and varieties of heliconia have more height often with extensive rhizomatous growth. Eventually, because of extensive growth habit, it requires more area for growth which is commercially very difficult to grow for production and also requires more days to flowering. However, research on producing profuse and early flowering in heliconia by using plant growth retardant has not been worked out yet in our country. Therefore, this experiment was designed to induce early flowering and better yield and quality of heliconia var. 'Red Torch' under 50 per cent shade net condition.

MATERIALS AND METHODS

The experiment was conducted at Floriculture Research Farm, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India. The healthy, uniform sized sprouted rhizomes of heliconia var. Red Torch with 12-15 cm height's auxiliary buds, free from insect pest and disease were planted on raised beds under 50 per cent green shade net house condition. The row to row and plant to plant distances were 1.0 m and 0.8 m, respectively where the row orientation was in North–South direction. There were nine growth retardant treatments laid out in randomized block design (RBD) with three replications. The treatments contained different concentrations of each of cycocel (100 and 200 ppm), maleic hydrazide (25 and 50 ppm), tri iodo benzoic acid (15 and 30 ppm) and paclobutrazol (150 and 300 ppm) along with control (water drenching). Different growth retardants were dissolved in small quantity of 0.1 N NaOH, then mixed with water and poured within 25 cm periphery around the plant. Irrigation was avoided before and after the retardant application. Drenching of growth retardants was done three times at 10 days interval after 30 days of planting. The data with regard to various vegetative growth characteristics *viz*., plant height, number of leaves and suckers per plant were recorded at 3, 6, 9 and 12 months after planting (MAP) while leaf area was recorded at 12 MAP. Overall presentability of spike was measured on visual basis with respect to number of bracts, rachis length, stalk length and general appearance. The vase life of cut flower was recorded as per the method suggested by Halevy and Mayak (1979). The vase life of flower was assessing daily by calculating the days taken for the symptoms of wilting.

The data on various observations were recorded during the course of investigation were statistically analyzed by randomized block design (RBD) as suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Vegetative growth characters like change in plant height and number of leaves at 3, 6, 9 and 12 months after planting are shown in Table 1 which indicates that among the various treatments, paclobutrazol had a considerable influence on reduction of plant height. Most pronounced plant height inhibition was observed with the drenching of paclobutrazol @ 300 ppm (T_8), which was at par with paclobutrazol @ 150 ppm (T_7) and followed by TIBA @ 30 ppm where plant was minimized at optimum level at all duration, except 6 MAP while control recorded maximum plant height. Plant height can be influenced by type and concentration of growth retardants (Daniel, 1986). The difference in plant height with the type and concentration of growth retardants may be due to their different mode of action in inhibiting plant growth regulators particularly gibberellins and auxins as explained by Warner and Erwin (2003). At low concentrations, growth retardants typically reduce cell elongation, whereas at high concentrations the reduction is increased due to a retard cell division (Grossman, 1992). The drastically retarded growth with application of paclobutrazol @ 150 and 300 ppm may be due to its very high concentrations, which has more inhibitory role on cell division and cell elongation of apical meristematic cells and also on gibberellins synthesis. Similar results were found in annual carnation (Foley and Keever, 1991) and marigold (Latimer, 1991) when plants treated with paclobutrazol. Growth reduction in plants when treated with TIBA @ 30 ppm may be due to antiauxin activity, disturbed carbohydrate metabolism, inhibition of cell division and elongation of apical meristem.

However, significantly maximum number of leaves at 3, 6, 9 and 12 MAP (Table 1) and number of suckers per clump at 6, 9 and 12 MAP (Table 2) were recorded with the application of MH @ 50 ppm (T_4). It may be related to diversion of photosynthates towards the axillary buds and reduction in shoot growth and inhibition of apical dominance caused by auxin (Gnyandev, 2006) and stimulation of the growth of apical meristematic cells, which would have triggered the reproductive shoots.

Maximum leaf area at 12 MAP was also found with the application of MH @ 50 ppm which was at par with CCC@100 ppm (T_1) and MH @ 25 ppm (T_3) (Table 2) which might be due to emergence and exploitation of leaves which is pivotal for overall growth and development in plant and may also be due to inhibition of gibberellins synthesis, which stimulates maximum leaf expansion. Similar results were found in crossandra (Venkatesan *et al*., 2004) and dahlia (Khan and Tewari, 2003).

The data obtained from the effect of plant growth retardants on flowering and quality characters of heliconia variety Red Torch are presented in Table 3. The present investigation showed that minimum days to flowering were recorded with

Table 1: Effect of plant growth retardants on vegetative growth of heliconia var. Red Torch

Treatment	Plant height (cm)				Number of leaves per clump			
	3 MAP	6 MAP	9 MAP	12 MAP	3 MAP	6 MAP	9 MAP	12 MAP
T_1 – CCC @ 100 ppm	70.43	102.44	152.93	154.73	4.26	5.80	4.60	3.93
T_2 – CCC @ 200 ppm	68.60	99.067	145.86	145.73	4.20	5.73	4.43	3.66
T_3 – MH @ 25 ppm	67.26	101.56	145.24	144.93	4.23	5.76	4.46	3.90
T_4 – MH @ 50 ppm	60.40	97.78	138.13	141.13	4.60	6.20	4.66	4.33
T_5 – TIBA @ 15 ppm	60.46	105.16	139.56	144.86	3.80	5.26	4.10	3.53
T_6 – TIBA @ 30 ppm	59.53	103.15	133.46	140.26	4.16	5.60	4.20	3.86
T_7 – PCB @ 150 ppm	25.73	26.76	28.40	54.33	2.33	2.40	2.86	3.06
T_8 – PCB @ 300 ppm	24.86	25.95	27.20	49.60	2.93	3.33	3.20	3.10
T_9 – Control	73.20	117.40	163.93	159.46	3.53	4.80	4.00	3.33
S.Em. ±	3.35	5.49	7.30	5.77	0.24	0.33	0.20	0.24
C.D. at 5 %	10.06	16.47	21.89	17.32	0.73	1.01	0.60	0.74
C.V.%	10.24	10.99	10.59	7.93	11.28	11.67	8.55	11.82

Table 2. Effect of plant growth retardants on vegetative growth of heliconia var. Red Torch.

Treatment	Number of suckers per clump				Leaf area (cm^2)
	3 MAP	6 MAP	9 MAP	12 MAP	12 MAP
T_1 – CCC @ 100 ppm	2.00	6.10	11.73	15.40	458.98
T_2 – CCC @ 200 ppm	1.87	6.00	10.13	14.13	397.20
T_3 – MH @ 25 ppm	1.90	6.03	11.33	15.20	441.51
T_4 – MH @ 50 ppm	2.03	6.13	12.20	15.86	477.73
T_5 – TIBA @ 15 ppm	1.63	4.66	9.00	12.60	373.28
T_6 – TIBA @ 30 ppm	1.80	5.06	10.00	13.26	367.33
T_7 – PCB @ 150 ppm	1.40	3.86	6.13	6.73	150.50
T_8 – PCB @ 300 ppm	1.60	4.20	6.73	7.13	152.03
T_9 – Control	1.27	4.46	8.06	11.06	371.18
S.Em±	0.16	0.35	0.63	0.72	22.96
C.D. at 5 %	NS	1.06	1.89	2.16	68.84
C.V.%	16.70	11.94	11.54	10.11	11.22

Table 3. Effect of plant growth retardants on flowering parameters of heliconia (*Heliconia psittacorum*) var. Red Torch

Treatment	Days toflowering	Flowering duration (days)	Number of bracts per rachis	Number of florets per bract	Rachis length (cm)	Stalk length (cm)
T_1 – CCC @ 100 ppm	149.86 (12.25)	53.33 (7.33)	4.53 (2.24)	11.53 (3.46)	15.23 (3.96)	98.44 (9.93)
T_2 – CCC @ 200 ppm	159.73 (12.65)	47.07 (6.89)	4.46 (2.23)	10.66 (3.34)	14.90 (3.92)	90.66 (9.54)
T_3 – MH @ 25 ppm	151.66 (12.32)	53.20 (7.30)	4.50 (2.24)	11.27 (3.42)	15.00 (3.93)	92.26 (9.61)
T_4 – MH @ 50 ppm	147.20 (12.14)	55.40 (7.47)	4.60 (2.26)	12.06 (3.54)	15.41 (3.98)	110.98 (10.55)
T_5 – TIBA @ 15 ppm	175.66 (13.26)	46.60 (6.86)	4.40 (2.21)	10.33 (3.28)	14.83 (3.91)	85.68 (9.27)
T_6 – TIBA @ 30 ppm	188.06 (13.70)	45.20 (6.75)	4.00 (2.12)	10.00 (3.24)	13.66 (3.75)	84.71 (9.21)
T_7 – PCB @ 150 ppm	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_8 – PCB @ 300 ppm	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_9 – Control	197.20 (14.05)	38.40 (6.23)	3.93 (2.11)	9.93(3.22)	13.48 (3.73)	71.61 (8.47)
S.Em.±	0.34	0.16	0.031	0.076	0.099	0.26
C.D. at 5 %	1.04	0.48	0.094	0.228	0.29	0.77
C.V.%	5.94	5.03	2.92	4.75	5.41	5.96

* Data in parenthesis are square root transformed value

Table 4: Effect of plant growth retardants on yield, overall present ability and vase life of heliconia (*Heliconia psittacorum*) var. Red Torch.

Treatment	Spikes per clump per year (No)	Overall presentability of spike (out of 10 score)	Vase life (days)
T_1 – CCC @ 100 ppm	3.93 (2.10)	9	13.00 (3.67)
T_2 – CCC @ 200 ppm	3.46 (1.99)	7.5	12.00 (3.53)
T_3 – MH @ 25 ppm	3.7 (2.05)	7.5	12.33 (3.58)
T_4 – MH @ 50 ppm	4.46 (2.22)	10	13.33 (3.71)
T_5 – TIBA @ 15 ppm	2.83 (1.82)	6.5	11.33 (3.43)
T_6 – TIBA @ 30 ppm	2.73(1.79)	5.5	11.00 (3.38)
T_7 – PCB @ 150 ppm	0.00 (0.71)	-	0.00 (0.71)
T_8 – PCB @ 300 ppm	0.0 (0.71)	-	0.00 (0.71)
T_9 – Control	2.33 (1.68)	5	8.33 (2.97)
S.Em±	0.03	-	0.05
C.D. at 5 %	0.09	-	0.15
C.V.%	3.16	-	3.23

Data in parenthesis are square root transformed value

the drenching of MH @ 50 ppm (T_4), which was at par with T_1, T_3 and T_2. However, maximum days to flowering were observed in control group T_9. These results may be due to the fact that plants treated with growth retardants have built up sufficient food reserves at initial stages due to suppression of apical dominance, increased number of leaves and mobility of photosynthates from source to sink. This reserve food has been utilized for reproductive purpose with a restriction on vegetative growth which decreases days to flowering. These results were in close agreement with Dutta *et al.* (1993) in chrysanthemum and Kumar and Kumar (2004) in balsam. The longest duration of spike was registered by the application of maleic hydrazide @ 50 ppm (T_4), which was at par with T_1 and T_3 (Table 3). Application of maleic hydrazide and cycocel enhance the chlorophyll content of leaves which helps to increase the functional life of the source for a longer period leading to improve partitioning efficiency and productivity (Kashid *et al.*, 2010). They also improved the longevity by maintaining the level of chlorophyll, protein and RNA content of leaf at higher level for a longer duration and suppress the senescence (Kar *et al.*, 1989).

Significantly maximum number of bracts per rachis was found in MH @ 50 ppm which was at par with T_1 treatment. Moreover, maximum number of florets in lower bract was also found with the same treatment which was followed by T_1, T_3 and T_2 treatments (Table 3). The plants treated with maleic hydrazide and cycocel have built up sufficient food reserves due to reduction in plant height with increasing number of leaves which resulted in higher production of photosynthates. The quick mobilization of these photosynthates from leaves (source) to flowers (sink) increases number of bracts per spike and florets per bracts (Joshi and Reddy, 2006). The maximum rachis length with longest stalk was found with the application of MH @ 50 ppm. This result was on par with T_1, T_3, T_2, T_5 and T_6 in case of rachis length, whereas stalk length was at par with T_1 treatment (Table 3). Enhancement of rachis and stalk length might be due to increase in the number of bracts. This enlargement is caused by drawing of photosynthates to the flower as a consequence of intensification of the sink. Further, other scientists have reported suppression in vegetative parameters with the application of growth retardants but not on flowering parameters (Lee and Suh, 2005; Anburani and Ananth, 2008; Saikia and Talukdar, 1998; Kazaz *et al.,* 2010 and Khan and Tewari, 2003).

Yield is the functional result of growth parameters of the plant like plant height, number of leaves and number of suckers. It is also very important attribute which attract attention of farmers for commercial cultivation. Data presented in Table 4 show that the maximum number of spikes per clump was significantly higher with the application of MH @ 50 ppm (T_4), which was followed by CCC @ 100 ppm (T_1). Moreover, current study showed that paclobutrazol @ 150 and 300 ppm did not produce flowering and suppressed growth drastically due to very high concentration while minimum number of spikes per clump was found in control (T_9). This has also been confirmed by Kumar *et al.* (2012), they reported that the pre harvest application of maleic hydrazide at 100 ppm resulted in the maximum number of branches and number of flower per plant in cut rose cv. First Red. This might be due to the suppression of apical dominance resulted in increasing number of leaves per plant, leaf area and number of sucker per clump which ultimately increased number of flowers per plant. It was also due to increased mobilization of biomass to flowers from sources in leaves. On the basis of visual analysis, the best quality of flowers was observed in heliconia var. Red Torch with application of MH @ 50 ppm where this treatment got the highest score followed by CCC @ 100 ppm. It was due to the maximum number of bracts, rachis length, stalk length and its bright appearance. Application of maleic hydrazide @ 50 ppm also increased vase life of heliconia spike (Table 4). Increased vase life might be due to reduced physiological weight loss. Restricted respiration due to inhibitory action of growth retardants might have increased the vase life. It also might be due to the maximum number of bracts, florets and longest stalk. Similar findings were also obtained by Dutta *et al.* (1993) and Talukdar and Paswan (1997) in chrysanthemum.

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