Effects of plant growth regulators in heliconia 'Red Opal'[1]

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ABSTRACT

The objective of this study was to evaluate growth regulators with purpose of reducing the size of heliconia 'Red Opal' potted plants. The experiment was carried out in randomized block design with five treatments (trinexapac-ethyl and paclobutrazol at rates of 37.5 and 75.0 mg of active ingredient per pot and control without growth regulator) and five replicates. The treatments were applied 40 days after planting the rhizomes in pots filled with soil. Thirty and 150 days after the growth regulator application, plant height, number of leaves and shoots, petioles length and leaf area were evaluated. One year after planting the rhizomes in pots the number of inflorescence and leaves (leaves, sheathing leaf bases and inflorescences) and rhizomes (rhizomes and roots) dry mass were determined. Trinexapac-ethyl had no differences compared to the control in any of the variables evaluated. Paclobutrazol proved effective in reducing plant height, leaf area and petiole length and increase in number of leaves and shoots but the effect was temporary. Also, it did not affect the inflorescences production and leaves and rhizomes dry mass. Paclobutrazol is efficient to promote height reduction and to increase the number of shoots in heliconia 'Red Opal' potted plants without affect the inflorescence formation but its effects is temporary.

Keywords: trinexapac-ethyl, paclobutrazol, ornamental, potted plants.

RESUMO

Efeitos de reguladores de crescimento em heliconia 'Red Opal'

O objetivo desse estudo foi avaliar reguladores de crescimento para a diminuição do porte da helicônia 'Red Opal' cultivada em vasos. O experimento foi conduzido em delineamento experimental de blocos casualizados com cinco tratamentos (etil-trinexapac e paclobutrazol, nas doses de 37,5 e 75,0 mg por vaso do ingrediente ativo e testemunha sem regulador de crescimento) e cinco repetições. A aplicação dos tratamentos foi feita 40 dias após o plantio de rizomas de helicônia 'Red Opal' em vasos contendo solo. Trinta e 150 dias após a aplicação dos reguladores de crescimento foram avaliadas: altura de plantas, número de folhas e de perfilhos, comprimento de pecíolo e área foliar. Um ano após o plantio foram determinados o número de inflorescências e a produção de massa seca de folhas (folhas, bainhas e inflorescências) e rizomas (rizomas e raízes). A aplicação de etil-trinexapac não resultou em diferenças em relação à testemunha em nenhuma das variáveis avaliadas. A aplicação de paclobutrazol mostrou-se efetiva na diminuição da altura das plantas, da área foliar e do comprimento do pecíolo e aumento no número de folhas e de perfilhos, porém o efeito foi temporário. Também não influenciou na produção de inflorescências e na massa seca de folhas e rizomas. Paclobutrazol foi eficiente em reduzir o porte e aumentar o número de perfilhos de helicônia 'Red Opal' cultivada em vasos sem afetar a formação da inflorescência, mas o efeito foi temporário.

Palavras-chave: etil-trinexapac, paclobutrazol, ornamental, plantas de vaso.

1. INTRODUCTION

Heliconias are tropical herbaceous plants, belonging to Heliconiaceae family, the popularity of these flowers is due to its remarkable inflorescences, with wide range of colors and shapes. Many species of heliconias are already established in the market as a cut flower and plant for landscaping, but still little explored as flowering pot plant.

Currently, a strong trend of floriculture is the cultivation of dwarf plants (SINDIFLORES, 2015) and the development of distribution channels, as self-service type (supermarkets) favors the choice precisely for pot plants and mini products because they are more practical and durable (IBRAFLOR, 2015).

The heliconias cultivated in pots needs a different management to keep them with smaller shape, clustered growth habit suitable for planting in pots. The use of some smaller cultivars, as well as the application of some plant growth regulators, has been evaluated for growing heliconias in pots (TJIA and JIERWIRIYAPANT, 1988).

Growth regulators are synthetic compounds used to obtain plant retardation or growth inhibition. The majority of growth regulators used in ornamental plant culture is inhibitors of gibeberellin (GA) biosynthesis used to control the size of plant, and improve compactness, such as paclobutrazol, which have been used to reduce the growth also in ornamentals as *Dianthus barbatus* x *chinensis* (LENZI et al., 2015); *Hedychium* (CRILEY,

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2005); *Curcuma* spp. (KUEHNY et al., 2005; PINTO et al., 2006); heliconia (JADHAV et al., 2015), cuphea and petunia (AHMAD et al., 2015), oleander (OCHOA et al., 2009) and orchids (WANDERLEY et al., 2014).

Other plant growth regulator, with low potential for bioaccumulation in the environment (MUTLU and KURTULA, 2015), the trinexapac-ethyl is used as an inhibition of internode lengthening, reducing the plant height in turfgrass (COSTA et al., 2010), but studies with ornamental herbaceous are scarce (MUTLU and KURTULA, 2015). The objective of the present study was to evaluate the effects of two growth regulators in heliconia 'Red Opal'.

2. MATERIALS AND METHODS

The experiment was carried out at the Embrapa Tropical Agroindustry Experimental Field, located in Pacajus-CE, Brazil. The region has a tropical climate and average temperatures of 26 to 28 °C and average rainfall of 791.4 mm per year.

The study was set in randomized blocks with five treatments (two growth regulators at rates of 37.5 and 75.0 mg of active ingredient per pot (5 L capacity) and a treatment without growth regulator application) and five replicates. Each experimental unit consisted of four pots, totaling 100 plants. Growth regulators used were trinexapac-ethyl (250 g L^{-1}) and paclobutrazol (250 g L^{-1}).

Heliconia 'Red Opal' rhizomes were selected and cleaned; the roots were removed and after washing in distillated water they were air dried for 24 hours. Rhizomes were planted in pots filled with soil and slow control fertilizer. Plants were grown in a greenhouse with black shade cloth of 50% transmittance. The pots were spaced with 1.0 m and the irrigation was done daily through a drip irrigation system.

Forty days after planting the rhizomes a single application of about 50 mL of growth regulator solution was done at the apical meristem of plants. Before the application of growth regulators plants presented 43.7±4.0 cm height; 7.1±1.2 leaves and 1.0±0.4 shoot.

Thirty days after the application of growth regulators (DAA), plant height, number of leaves and shoots and petiole length were obtained. Leaf area was estimated by multiplying by 0.4 the product of length and width of leaves (FARIAS et al., 2013). At 150 DAA, plant height and number of shoots were determined. The inflorescence number and leaves, sheathing leaf bases, inflorescences, rhizomes and roots dry mass were obtained at 325 DAA (or 365 days after planting). Hereinafter, leaves, sheathing leaf bases and inflorescences and rhizomes and roots dry mass will be referred to as leaves and rhizomes dry mass, respectively. The increase in growth was calculated by subtracting the initial values (day zero) from those obtained in the evaluation at 30 and 150 days after the growth regulators application.

Data were subjected to analysis of variance (ANOVA) and the means were compared using Tukey test at 5% level of significance.

3. RESULTS AND DISCUSSION

Treatments with trinexapac-ethyl at any concentration tested showed no differences compared to control in any of the variables evaluated (Tables 1, 2, 3 and 4). This growth regulator is often used successfully in plant size reduction as turfgrasses, but the application of the product once may not be sufficient for a slow growing plant as heliconia, once its half-lives of a few hours to few days in plants and in soil (MUTLU and KURTULA, 2015).

Table 1. Increase in height, shoots and leaves number of heliconia 'Red Opal', 30 days after the growth regulator application

Treatments	Rates	Increase[1]		
		Height	Leaves number	Shoots number
	mg per pot	cm		
Control	0	23.1 a[2]	3.7 b	1.3 b
Trinexapac-ethyl	37.5	22.2 a	2.5 b	1.1 b
Trinexapac-ethyl	75.0	22.9 a	3.6 b	1.2 b
Paclobutrazol	37.5	4.6 b	9.3 a	2.9 a
Paclobutrazol	75.0	1.6 b	11.3 a	3.0 a
		F Test[3]		
Treatments		18.23**	18.04**	17.41**
Blocks		3.64*	1.45^{ns}	1.88^{ns}
C.V. (%)		38.0	34.2	27.9

[1] Increase: value at 30 days after the growth regulator application minus the value at day zero

[2] Means followed by the same letter in the column did not differ by Tukey Test (P<0.05)

[3] ^{ns}; ** e *: not significant; significant at 0.01 and 0.05 probability levels, respectively

At 30 days after application (DAA), paclobutrazol rates were effective in reducing plant height and increasing the leaves and shoots number (Table 1). During the first 30-day evaluation, plants treated with paclobutrazol grew only 6.9 and 19.9% (75.0 and 37.5 mg per pot of active ingredient, respectively) of the control plants. Besides that, plants treated with paclobutrazol presented nearly three times more leaves as the control (Figure 1). Jadhav et al. (2015) observed a significant reduction in height of heliconia 'Red Torch' plants treated with paclobutrazol drenches (applied three times at 10 days interval after 30 days of planting), with a greatest effect on the concentration of 300 ppm, but there was no increase in the number of shoots. Greater paclobutrazol concentrations have inhibitory role on cell division and elongation of apical meristematic cells and on gibberellins synthesis (JADHAV et al., 2015).

Figure 1. Heliconia "Red Opal" plants at 30 days after application with paclobutrazol: A) Control, B) 37,5 mg per pot of active ingredient and C) 75,0 mg per pot of active ingredient.

Powell and Neilson (1991) have also observed height reduction in *Heliconia psittacorum* 'Fireflash' using paclobutrazol drenches (up to 1.0 mg per pot of active ingredient). Paclobutrazol, uniconizole and ancymidol drenches were effective to control the height of *Heliconia psittacorum* 'Golden Torch', but flowering was delayed and at the higher concentration of the growth regulators (0.5; 0.25 and 2.0 mg per pot of active ingredient, respectively) and flowers production were inhibited (TJIA and JIERWIRIYAPANT, 1988). These authors reinforce the fact that growth regulators application should be enough to reduce their height but not enough to cause delay in flowering.

Despite the increase in number of leaves, leaf area was significantly reduced in plants treated with paclobutrazol at 75 mg of active ingredient per pot, a 27% decrease compared to the control (Table 2). Plants treated with paclobutrazol rates showed shorter petiole length, from 27.3 to 45.5% in relation to the control. These plants presented a very pronounced reduction in the petiole length and they lost the typical musoid architecture and became rosette aspect. At the lower paclobutrazol concentration (37.5 mg per pot of active ingredient) a less pronounced effect was found and as a result, more harmonious plant was obtained.

Table 2. Leaf area and petiole length of heliconia 'Red Opal', 30 days after the growth regulators application

Treatments	Rates	Leaf area	Petiole length
	mg per pot	cm^2 per plant	cm
Control	0	2102 a[1]	5.5 a
Trinexapac-ethyl	37.5	1848 ab	6.4 a
Trinexapac-ethyl	75.0	1802 ab	6.7 a
Paclobutrazol	37.5	1706 ab	1.5 b
Paclobutrazol	75.0	1526 b	2.5 b
		F Test[2]	
Treatments		3.14*	28.72**
Blocks		6.10**	0.72^{ns}
C.V. (%)		14.78	22.87

[1] Means followed by the same letter in the column did not differ by Tukey Test (P<0.05)
[2] ns; ** e *: not significant; significant at 0.01 and 0.05 probability levels, respectively

No differences were found in the plant height at 150 DAA (Table 3), which means that paclobutrazol has a temporary effect and that the application should be continued for continuing effects. As it was observed earlier (30 DAA), plants treated with paclobutrazol showed about 1.8 shoot more than the control and those with trinexapac-ethyl (Table 1). This ratio was maintained in the evaluation four months later (150 DAA), support the finding that the effect of paclobutrazol was temporary (Table 3).

Table 3. Increase in height and shoots number of heliconia 'Red Opal', 150 days after the growth regulators application

Treatment	Rates	Increase[1]	
		Height	Shoots number
	mg per pot	cm	
Control	0	71.0 a[1]	7.5 b
Trinexapac-ethyl	37.5	70.8 a	7.6 b
Trinexapac-ethyl	75.0	72.1 a	7.4 b
Paclobutrazol	37.5	75.5 a	9.2 a
Paclobutrazol	75.0	68.6 a	9.4 a
		F Test[2]	
Treatments		0.33^{ns}	13.82**
Blocks		3.58*	9.43**
C.V. (%)		13.59	8.84

[1] Increase: value at 150 days after the growth regulator application minus the value at day zero
[2] Means followed by the same letter in the column did not differ by Tukey Test (P<0.05)
[3] ns; ** e *: not significant; significant at 0.01 and 0.05 probability levels, respectively

Although the paclobutrazol rates have increased the shoots number (Tables 1 and 3) they did not increase the number of inflorescences (Table 4). In fact, several studies have shown the negative influence of paclobutrazol on the heliconia flowering. Jadhav et al. (2015) found that paclobutrazol drenches application at 150 and 300 ppm resulted in inhibition of heliconia flowering. *Heliconia psittacorum* 'Fireflash' treated with paclobutrazol drenches at 1.0 mg per pot (active ingredient) did not flower (POWELL and NEILSON, 1991).

At 325 DAA no differences were found in the leaves and rhizomes dry mass in plants treated with growth regulators and the control (Table 4). According to Lever (1986), paclobutrazol has direct effect on vegetative growth reduction, thus change in partition of assimilates to favor reproductive growth is likely to happen.

Table 4. Inflorescences number, leaves and rhizomes dry mass production of heliconia 'Red Opal', 325 days after the growth regulators application

Treatment	Rates	Inflorescences number	Dry mass	
			Leaves	Rhizomes
	mg per pot		g per plant	
Control	0	1.9 a[1]	155.4 a	260.4 a
Trinexapac-ethyl	37.5	2.5 a	158.0 a	277.0 a
Trinexapac-ethyl	75.0	1.5 a	133.8 a	233.6 a
Paclobutrazol	37.5	2.8 a	163.8 a	309.4 a
Paclobutrazol	75.0	2.1 a	127.4 a	374.6 a
		F Test[2]		
Treatments		1.48^{ns}	2.52^{ns}	0.77^{ns}
Blocks		4.19*	3.04*	0.27^{ns}
C.V. (%)		44.35	15.32	47.31

[1] Means followed by the same letter in the column did not differ by Tukey Test (P<0.05)
[2] ns; ** e *: not significant; significant at 0.01 and 0.05 probability levels, respectively

These results suggest the use of pablobutrazol to heliconia 'Red Opal' to growth control and to increase the number of shoots. Further research is needed to evaluate frequency of paclobutrazol application to ensure the long-lasting effects.

4. CONCLUSION

Paclobutrazol is efficient to promote height reduction and to increase the number of shoots in heliconia 'Red Opal' potted plants without affect the inflorescence formation but its effects is temporary.

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