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EFFECT OF THE APPLICATION OF GROWTH REGULATORS ON *Peltophorum dubium* (SCIENTIFIC NOTE)[1]

EFEITO DA APLICAÇÃO DE REGULADORES DO CRESCIMENTO EM *Peltophorum dubium* (NOTA CIENTÍFICA)

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ABSTRACT - The objective of this study was to verify changes in the vegetative growth of *Peltophorum dubium* before flowering induced by the application of plant growth regulators. The experimental design was randomized blocks with three replications of four plants/plot. The variables height, stem diameter, chlorophyll content, and peroxidase activity were evaluated. Statistical analysis was performed using SAS. Plant size reduction (73%) was induced by the plant inhibitor paclobutrazol. Plant height growth was stimulated by GA3 (18%). Ethephon caused death of the apical buds.

Keywords: *Peltophorum dubium*; physiology; plant growth regulators.

RESUMO - O trabalho objetivou a aplicação de reguladores vegetais em *Peltophorum dubium* com o intuito de acompanhar as alterações promovidas no desenvolvimento vegetativo antes do florescimento. O delineamento experimental foi blocos casualizados com três repetições de quatro plantas/parcela. Foram avaliadas as variáveis altura, diâmetro do colo, teor de clorofila e atividade da peroxidase. A análise estatística foi realizada pelo programa SAS. Foi verificada redução do porte das plantas (73%) pelo inibidor paclobutrazol. O GA3 estimulou o crescimento em altura das plantas (18%). O ethephon provocou a morte das gemas apicais.

Palavras-chaves: *Peltophorum dubium*; fisiologia; reguladores vegetais.

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1 INTRODUCTION

Peltophorum dubium (Spreng.) Taub., popularly known as canafistula, is a common species in seasonal semideciduous forests, abundant in secondary formations, that begins reproduction at the age of 8 to 12 years (Durigan et al., 2002; Klein et al., 2014; Müller et al., 2016). This plant is widely used in the recovery of degraded areas, in forestation and in landscaping.

One way to promote physiological and biochemical changes in species with a medium life cycle such as in canafistula, in order to reduce the vegetative growth of plants and to anticipate their reproductive stage, is to use substances known as plant growth regulators (Kumar et al., 2011). Plant growth regulators are synthetic compounds essential for the improvement of forest species, to reduce the period preceding flower bud formation and fruit/seed production (Santos et al., 2018).

There is limited information regarding the physiological responses to the addition of plant regulators to *Peltophorum dubium* during vegetative development before flowering.

The most commonly used plant growth regulator in agriculture and forestry is paclobutrazol, a compound that influences biochemical processes in plants. It inhibits the conversion of ent-kaurene to GA12-aldehyde that occurs in the endoplasmic reticulum of the cells, blocking the biosynthesis of gibberellic acid and consequently plant growth (Moraes et al., 2012; Rodrigues, et al., 2016; França et al., 2018).

Gibberellins are species-specific plant hormones that act in various ways and are characterized as tetracyclic diterpenoids (Taiz et al., 2017). In the genus *Pinus*, high concentrations stimulate flowering, while in *Eucalyptus*, low concentrations promote flowering. In addition, gibberellin is associated with stem, leaf and radial growth. It increases plant height significantly via cell and internode elongation (Moraes et al., 2013; Moraes et al., 2014).

Another important substance is ethephon that acts by releasing ethylene into the cytoplasm of plant cells of various organs (Castro et al., 2016), coordinating and regulating many processes in the last stages of plant development. When sprayed in aqueous solution on several plant species, it is readily absorbed through the leaves and translocated within the plant (Joshi e Shukla, 2011), stimulating or inhibiting important steps in plant development.

Therefore, this study presented preliminary results regarding the evaluation of the effects of plant growth regulators on *P. dubium* during the vegetative growth phase.

2 MATERIALS AND METHODS

The experiment was carried out in Botucatu, São Paulo, Brazil on the Faculty of Agricultural Sciences of the Universidade Estadual Paulista "Júlio de Mesquita Filho" - FCA/UNESP at approximately 786 m, latitude 22º51' S and longitude 48º26' W. *P. dubium* seedlings used in the experiment were produced in the nursery of the Department of Forest Science. According to the Koppen classification, the regional climate of Botucatu/SP is Cfa, i.e., warm, temperate (mesothermal) and wet (Alvares et al., 2013).

The experiment was arranged in a randomized block design with three replications, four plant rows per plot plus one control treatment, resulting a total of 120 plants. The pots used in the experiment were filled with a medium-textured red latosol, with the following macro- and micronutrient concentrations, according to the soil chemical analysis: pH (CaCl2): 4.2; organic matter (g dm-3): 10.0; P (mg dm-3) 1.0; H + Al (mmolc dm-3): 37.0; K (mmolc dm-3): 0.1; Ca (mmolc dm-3) 6.0; Mg (mmolc dm-3): 0.0; Al (mmolc dm-3): 2.0; SB (mmolc dm-3): 8.0; CEC (mmolc dm-3): 45.0; V (%): 18.0; S (mmolc dm-3): 6.0; B (mg dm-3): 0.12; Cu (mg dm-3): 0.2; Fe (mg dm-3): 31.0; Mn (mg dm-3): 0.2; and Zn (mg dm-3): 0.0.

The soil in the pots was fertilized as recommended, based on the following chemical analysis: limestone at a rate of 2.0 t-ha-1 (30.0 g pot-1), 20 g ammonium sulfate (4 N g pot-1), 22.4 g triple superphosphate (9.18 P2O5 g pot-1), 4.96 g potassium chloride (2.98 K2O g pot-1), 1.76 g boric acid (0.3 B g pot-1) and 2.25 g zinc sulfate (0.45 Zn g pot-1), and of this total, 10% was applied at planting and the rest after three months.

Plant growth regulators were first applied to six-month-old plants. Paclobutrazol was diluted in 300 mL water and applied to the soil according to the treatments described below; gibberellic acid and ethephon were applied 6 times at intervals of 20 days by foliar spray, at doses of 40 mL of solution per plant in each pot.

The treatments consisted of paclobutrazol (PBZ) in concentrations of 100 mg L^{-1}, 200 mg L^{-1} and 300 L^{-1} mg, gibberellic acid (GA3) at 30 mg L^{-1}, 60 mg L^{-1} and 90 mg L^{-1}; ethephon (ETH) at 100 mg L^{-1}, 200 mg L^{-1} and 300 mg L^{-1}, and the control with water only.

The following variables were determined: a) plant height (cm); b) stem diameter (mm); c) chlorophyll content, measured indirectly as described by Uesugi et al. (2015), with a chlorophyll meter (SPAD-502), to calculate the SPAD index. Readings were made between 8 and 11 in the morning, at four points of the leaf (two points on each side) of each plant, and preferring the leaves in the middle third of the plants (Minolta, 1982); and d) peroxidase activity by Allain et al. (1974) methodology.

The statistical analysis was performed with software SAS, in which the means were compared by the Tukey test at 5% probability.

3 RESULTS AND DISCUSSION

The results showed significant effects ($p < 0.05$) of the various treatments on the study variables (Table 1).

The values of the coefficient of experimental variation (CV%) ranged from 4.5% to 6.4% for the studied traits, indicating good experimental accuracy (Garcia, 1989; Resende and Duarte, 2007). High sensitivity of canafistula to the inhibitor was observed for the paclobutrazol treatment, reducing plant growth by 73% when compared with the control treatment (Table 2).

The reduction in the gibberellin concentration in plant tissues promoted by paclobutrazol affects the processes of cell division and elongation. Consequently, the morphological effect on the plant is a growth reduction in terms of plant height (Salisbury and Ross, 2013).

Table 1. Summary of the analysis of variance and coefficients of variation of height (cm), root collar diameter (mm), chlorophyll content (SPAD), and peroxidase activity (µmoles H2O2 decomp. g. mf-1.min-1) in 12-month-old *Peltophorum dubium* treated with various plant growth regulators.

Tabela 1. Resumo da análise de variância e coeficientes de variação de altura (cm), diâmetro do colo (mm), teor de clorofila (SPAD) e atividade da peroxidase (µmoles H2O2 decomp. g. mf-1.min-1) em plantas com 12 meses de *Peltophorum dubium* tratadas com diferentes biorreguladores de crescimento.

SV	DF	Height (cm)	Diameter (mm)	Chlorophyll (index SPAD)	Peroxidase (µmoles)
Treat.	9	2696.9**	72.42**	129.3**	0.074**
Rep.	2	25.8	1.62	32.0	0.009
Error	18	14.5	0.48	3.7	0.001
CV%		6.4	4.5	4.8	4.7

***Significant at $p < 0.05$ by the F test.*

Table 2. Plant height (cm), stem diameter (mm), chlorophyll content (SPAD) and peroxidase activity (µmoles H2O2 decomp. g. mf-1.min-1) in 12-month-old *Peltophorum dubium* plants treated with various plant growth regulators.

Tabela 2. Altura da planta (cm), diâmetro do caule (mm), teor de clorofila (SPAD) e atividade da peroxidase (µmoles H2O2 decomp. g. mf-1.min-1) em plantas com 12 meses de *Peltophorum dubium* tratadas com diferentes biorreguladores de crescimento.

Treatments	Height (cm)	Diameter (mm)	Chlorophyll (index SPAD)	Peroxidase (µmoles)
Control (T1)	75b	21.8a	37b	0.47d
PBZ = 100 mg L-¹	21d	8.3c	51a	0.43d
PBZ = 200 mg L-¹	20d	9.4c	52a	0.33e
PBZ = 300 mg L-¹	20d	7.2c	56a	0.43d
GA3 = 30 mg L-¹	87.6a	19.4b	39b	0.59c
GA3 = 60 mg L-¹	96.0a	18.5b	41b	0.66b
GA3 = 90 mg L-¹	93.6a	17.0b	32c	0.68b
Ethephon = 100 mg L-¹	62.3c	18.5b	41b	0.70b
Ethephon = 200 mg L-¹	64.7c	17.8b	42b	0.82a
Ethephon = 300 mg L-¹	61.7c	17.8b	43b	0.43d
General mean	60.3	15.6	43.1	0.56

Means followed by the same letter in the column do not differ significantly by the Tukey test at ($p < 0.05$) error probability.

The applications of gibberellic acid on canafistula plants increased height growth by 18%, suggesting that this plant growth regulator modulates height growth in plants.

In Joinville, Santa Catarina, Althaus-Ottmann et al. (2008) studied *Hemerocallis hybrida* under various GA3 concentrations in the summer, autumn and winter, without finding any significant answers regarding the growth in response to the application of the plant growth regulator; this suggested that different species respond differently to the exogenous application of these products. The main changes promoted by GA3 in canafistula were the elongation of internodes. This is in line with other results reported in the literature for several plant species (Silk and Jones, 1975; Moraes et al., 2013).

In addition to reducing the height of the plant, ethephon induced the death of apical buds and reduced the development of lateral buds. Gibberellic acid induced leaf bleaching, modifying the chlorophyll content. This confirmed findings of Adams et al. (1996), who studied sunflowers treated with gibberellic acid, and obtained plants with light green color. The amounts of chlorophyll a, chlorophyll b, chlorophyll a + b, and total carotenoid content depends primarily on the applied plant growth regulator rate (Mansouri et al., 2011). A reduction in chlorophyll content in response to GA3 application was reported for several crop plants, e.g., peach (Monge et al., 1994), rice (Yim et al., 1997) and pea (Bora and Sarma, 2006).

Peroxidase activity was affected by the intermediate treatment of 200 mgL-¹ of paclobutrazol, while the reduction in growth was the same as that following the three paclobutrazol treatments. (Table 2).

This result disagrees with that of Denna and Alexander (1975), who stated that peroxidase production is inversely proportional to plant growth. Peroxidase activity varies with the tissue type and developmental stage of plants, and is inversely proportional to plant growth. This enzyme system was used as marker to study the hormonal control and growth processes of plants.

According to Siegel (1993), peroxidase activity might increase in plants subjected to various types of stress. With application of plant growth regulators at various concentrations in the treatments, we obtained values of peroxidase

activity of 0.33 µmoles for the application with inhibitor paclobutrazol up to 0.82 µmoles under the effect of ethephon.

4 CONCLUSIONS

Plant growth regulators proved to be an alternative in the management of canafistula, because the application of gibberellic acid reinforced plant development and paclobutrazol was effective as a growth inhibitor.

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