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Substrate volumes and application of paclobutrazol for ornamental pepper production

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ABSTRACT

The objective was to evaluate the quality of ornamental pepper seedlings, cultivar Pyramid, in different substrate volumes, with foliar application of paclobutrazol (PBZ).The experiment was carried out at the Mato Grosso do Sul State University - UEMS, in Cassilândia - MS. The experimental design was completely randomized, in a 2 x 2 factorial scheme (growth container x foliar application of PBZ) with four replicates of 36 seedlings each. Plastic trays (cells with a volume of 50 mL) and polystyrene trays (Isopor®, 100 mL cells) were used as containers. The treatments were: polystyrene tray with PBZ application; polystyrene tray without PBZ application; plastic tray with PBZ application and plastic tray without the application of PBZ. Plant height, root length, stem diameter, shoot dry mass, root dry mass, total dry mass, height/stem diameter ratio (H/D), shoot/root ratio (S/R) and Dickson quality index were evaluated. Foliar application of paclobutrazol resulted in robust pepper seedlings with reduced size, suitable and desirable characteristics for ornamental purposes. The polystyrene trays with higher volume cells (100 mL) contributed to the higher quality of ornamental pepper seedlings.

Keywords: *Capsicum frutescens* L., Plant growth regulator, Growth tray.

Volumes de substrato e aplicação de paclobutrazol na produção de pimenteira ornamental

RESUMO

Objetivou-se avaliar a qualidade de mudas de pimenteira ornamental, cultivar Pirâmide, em diferentes volumes de substrato, com aplicações de paclobutrazol (PBZ) via foliar. O experimento foi conduzido na Universidade Estadual de Mato Grosso do Sul – UEMS, na cidade de Cassilândia – MS. O delineamento utilizado foi o inteiramente casualizado, em esquema fatorial 2 x 2 (recipiente de cultivo x aplicação foliar com PBZ) com 4 repetições de 36 mudas cada. Foram utilizados como recipientes bandejas de plástico (células com volume de 50 mL) e de poliestireno (isopor®, células de 100 mL). Os tratamentos foram: bandeja de isopor com a aplicação de PBZ; bandeja de isopor sem aplicação de PBZ; bandeja de plástico com aplicação de PBZ e bandeja de plástico sem a aplicação de PBZ. Foram avaliados o diâmetro do caule, a altura da parte aérea, o comprimento de raiz, a massa seca da parte aérea, a massa seca da raiz, a relação massa seca da parte aérea e massa seca de raiz, a relação altura e diâmetro e o índice de qualidade de Dickson. A aplicação foliar de paclobutrazol resultou em mudas robustas e com tamanho reduzido, características adequadas e desejáveis para fins ornamentais. As bandejas de poliestireno com células de maior volume contribuíram para a qualidade das mudas de pimenteira ornamental.

Palavras-chave: *Capsicum frutescens* L., Regulador vegetal, Bandeja de cultivo.

1. Introduction

The genus Capsicum is important in agribusiness because it contains species that can be used in cooking (Pinto et al., 2013) and in the decoration of environments. Its fruits are consumed *in natura* in the preparation of condiments, in the preparation of sauces, preserves, and others. However, many species are appreciated for their ornamental role, possessing rich variation of fruit colors and small seedling size, guaranteeing space in the ornamental plant market (Carvalho et al., 2006; Melo et al., 2014).

Some studies with ornamental pepper cultivars have shown that the use of protected environments favored the fruiting of the pepper plant (Costa et al., 2017). The cultivar Pyramid of *Capsicum frutescens* has colorful fruits that arouse interest and acceptance by the consumers of ornamental plants. In the seedling formation, this cultivar presented more vigorous plants when compared to the cultivar Etna (Costa et al., 2015). For Tupã Bode Vermelha pepper seedlings, Prado et al. (2016) report that the quality of the seedlings increases with the percentage of humus in the substrate used.

The trays are cultivation containers formed by cells to contain the substrate and support the growth and plant development until the moment of transplantation. Their use has advantages, such as the economy of the substrate, space in the growing environment and labor and reduction of production costs.

Some plants are considered more beautiful when they present their diminished size. The control of height can be done with the use of products that inhibit plant growth (Grossi et al., 2005), which may favor seedling production and improve plant quality (Cardoso et al., 2018). Among the plant growth regulators, paclobutrazol (PBZ) is an organic compound that acts on the hormonal balance, inhibiting the biosynthesis of gibberellic acid (Seleguini et al., 2008; Brito et al., 2016).

The root system can absorb PBZ and transported by xylem to other plant organs when applied to the substrate. The PBZ spray on the leaves can reach the meristems after passing through the stomata (Lacerda et al., 2007). Plants under the effect of this inhibitor may present, in addition to the smaller size, more developed roots. These characteristics confer, in addition to a more exotic look, a greater rusticity to the vegetable, making it resistant to stress due to water deficiency and more adapted to explore the substrate in obtaining water and nutrients (Santos et al., 2018).

In commercial seedlings, management with the use of suitable containers and the control of vegetative growth with the use of plant growth regulators may be an alternative to obtain high-quality plants. The objective of this study was to evaluate the production of ornamental pepper plants with the use of trays composed of cells with different volumes and foliar applications of PBZ in a protected environment.

2. Material and Methods

The experiment was carried out in an experimental area of the Mato Grosso do Sul State University (UEMS), in Cassilândia - MS, from March 20th to May 20th, 2017. The region is located at an altitude of 516 m, longitude of - 51º44'03 "and latitude -19º06'48" (CASSILÂNDIA-A742 automatic station).The climate of this region, according to Köppen, is tropical with a dry season.

The seedlings were produced under the protected greenhouse type, 18.0mx 8.0mx 4.0m (144 m^2), covered with a low density polyethylene film (LDPE) of 150 microns, light diffuser, anti-drip , sealed zenith opening with 30%, with side and front monofilament screen of 30% shading and aluminized reflecting screen LuxiNet 42/50 under the LDPE film. It had internal metallic desks of 1.40m wide x 3.50m long x 0.80m high, irrigation system by suspended micro sprinkler with emitters NETAFIM SPINNET of 70 liters per hour, concrete wall of 0.35m height in the perimeter of the module and floor covered by gravel stone.

The containers used were: plastic trays (72 cells with a volume of 50 mL each) and polystyrene trays (Isopor®, 72 cells with a volume of 100 mL each). The substrate used was prepared with 50% soil, 30% vermiculite, and 20% tanned bovine manure. The trays were uniformly filled with the substrate, and two seeds were seeded per cell; after thinning, one seedling per cell remained. The seedlings were irrigated daily, twice a day if necessary: one in the morning and one in the afternoon. The physical-chemical analysis of the soil is described in Table 1.

The 0.005% PBZ solution (50 mg L^{-1}) was prepared with deionized water, and the PBZ source used was the commercial product Cultar 250 SC®. The foliar application was carried out with the use of a manual sprayer (flow rate of 200 mL m^{-2}) at 32 and 42 days after sowing (DAS).

At 60 days after sowing (DAS), the plant height (PH) was measured in centimeters, using a graduated ruler. The height measurement was performed from the base of the stem to the insertion of the last leaf. Root length (RL), measured in centimeters using a graduated ruler, was considered from the base to the end of the main root. A digital caliper was used with measurements in millimeters to evaluate the stem diameter (SD).

To evaluate the accumulation of plant dry mass, the plant was separated into shoot part and root, which were taken to forced circulation air oven at 65ºC, to be dried until reaching the constant mass.

Table 1. Substrate chemical analysis. Cassilândia – MS, UEMS, 2017.

P (mel)	K	Ca	Mg	SB	CEC	V
mg dm^{-3}		---------- $cmol_c$ dm^{-3} ----------				%
75.30	0.54	2.20	2.00	4.74	6.74	70.3
pH ($CaCl_2$)	OM	B	Cu	Fe	Mn	Zn
	g dm^{-3}		---------- mg dm^{-3} ----------			
5.6	26.60	0.66	0.80	104.00	37.80	6.40

OM= Organic Matter. mel=MelichExtractor. SB = Sum of Bases. V = Base saturation.

Shoot dry mass (SDM), and root dry mass (RDM) were measured with the aid of an analytical balance and the results presented in grams (g). From these data, the total dry mass (TDM), the height/stem diameter ratio (H/D), the shoot/root ratio (S/R) and the Dickson quality index (DQI) were calculated.

The experimental design was completely randomized in a 2 x 2 factorial scheme (containers x PBZ application), with four replications of 36 seedlings. The data were submitted to analysis of variance (F test), and the means were compared by Student's t-test, at 5% probability (Banzatto and Kronka, 2006; Ferreira, 2011).

3. Results and Discussion

The seedlings produced in polystyrene trays showed higher shoot height (SH), stem diameter (SD) and root length (RL) (Table 2), and the larger volume of the cells influenced these results. Containers with a greater amount of substrate favor the growth of the embryonic axis; the consequences are demonstrated in the tallest seedlings. Results like the present study were found for beet seedlings, comparing trays of different volumes, and in those with higher volume, there was the availability of nutrients, water and physical space more adequate for root development (Oliveira et al., 2012).

The seedlings submitted to foliar application of PBZ had lower plant height and stem diameter (Table 2), which may have occurred due to inhibition of gibberellic acid biosynthesis by PBZ, causing inhibition in the elongation and cell division, resulting in compact seedlings. This result is like that observed in tomato seedlings, in which the foliar application of PBZ resulted in the reduction of seedling height (Seleguini et al., 2013). The influence of PBZ on the root system growth of ornamental pepper plants was not observed (Table 2), different from that observed in tomato seedlings, in which the increase in PBZ concentration increased the dry mass of the root system (Seleguini et al., 2013).

The seedlings produced in plastic trays with 50 mL of substrate had the lowest values of shoot dry mass (MSPA), dry mass of the root system (MSSR) and total dry mass (MST) when compared to seedlings of polystyrene trays, with 100 ml of substrate (Table 2). The cells with greater volume have higher availability of nutrients, water, and space for the accumulation of mass, providing seedlings with higher accumulation of dry mass. Similar results were found in beet seedlings, in which the highest volume of the substrate provided seedlings with a higher dry mass of the root system, height, and root length (Oliveira et al., 2012). It should be noted that in the growth of cauliflower, those plants that, in the seedling phase were produced in trays with cells of larger volume, had a higher mean mass of 'head' (Godoy and Cardoso, 2005). The seedlings that received PBZ application had the lowest masses (Table 2) due to the effect of the product on reducing plant growth. These results agree with those obtained in soybean, where the application of PBZ resulted in plants with lower fresh mass and dry mass seven days after application (Cruciol et al., 2014). In Vetiver (*Chrysopogon zizanioides*), the application of different doses of PBZ via substrate resulted in seedlings with lower dry mass production of the root system, regardless of the doses applied (Blank et al., 2009).

These results contrast with those reported by Seleguini et al. (2013): in tomato seedlings, using PBZ at concentrations of 0, 50 and 100 mg L^{-1} and two application methods (seed treatment and seedling irrigation). These authors report that application through irrigation provided seedlings with a higher root dry mass when compared to seedlings treated by imbibition. They observed that there was a linear increase in the root system dry mass as the concentration of PBZ increased: the accumulation of RSDM was higher than the control when the concentration of 100 mg L^{-1} was used.

The containers used did not influence the height/stem diameter ratio (H/D). However, the seedlings that received PBZ application had the lowest H/D (Table 3). This variable indicates the balance of growth and relates these two variables to a single index, and the lowest values indicate robust changes. The use of PBZ to increase the robustness of seedlings was also observed by Santos et al. (2018) in different clones of eucalyptus hybrids.

For the shoot/root ratio (S/R), it was observed that the seedlings of the plastic tray had the lowest result. This index did not differ with the PBZ application. The Dickson quality index (DQI), was higher in the seedlings coming from the polystyrene tray. The DQI values did not differ with the PBZ application.

Table 2. Plant height (PH), root length (RL), stem diameter (SD), shoot dry mass (SDM), root dry mass (RDM) and total dry mass (TDM) of ornamental pepper seedlings grown in different containers and the presence or absence of PBZ foliar application. Cassilândia - MS, 2017.

Cell volume	PH	RL	SD	SDM	RDM	TDM
	--------- cm ---------		mm	-------- g seedling^{-1} ---------		
50 mL	3.90 b	9.22 b	1.85 b	0.87 b	0.67 b	1.54 b
100 mL	5.04 a	12.28 a	2.25 a	1.63 a	1.08 a	2.71 a
Foliar application						
PBZ	3.95 b	10.57 a	1.97 b	1.05 b	0.77 b	1.82 b
Water	4.98 a	10.94 a	2.12 a	1.44 a	0.98 a	2.43 a
C.V. (%)	6.7	3.54	5.44	17.39	17.43	16.26

Means followed by the same letter, in the columns, between each studied factor do not differ among themselves by the t-test (LSD) at 5% probability.

Table 3. Height/stem diameter ratio (H/D), shoot/root ratio (S/R) and Dickson quality index (DQI) of ornamental pepper seedlings grown in different containers and the presence or absence of PBZ foliar application. Cassilândia - MS, 2017.

Cell volume	H/D	S/R	DQI
50 mL	2.10 a	1.28 b	0.45 b
100 mL	2.24 a	1.51 a	0.72 a
Foliar application			
PBZ	2.01 b	1.33 a	0.54 a
Water	2.33 a	1.46 a	0.63 a
C.V. (%)	6.1	10.31	16.35

Means followed by the same letter, in the columns, between each studied factor do not differ among themselves by the t-test (LSD) at 5% probability.

The small stem diameter summed up to a shoot with high values is characteristic of seedlings susceptible to 'lodging' being considered fragile. This imbalance of structures can also be observed in etiolated seedlings, with excessive growth (Seleguini et al., 2013). These characteristics are undesirable because they allow less uniformity of the stand due to plant mortality. So, the appropriate vegetables are those having the architecture with enough stem diameter to support the aerial part.

In this study, it is possible to divide the results into two types: growth variables, grouping the results of shoot height, stem diameter, root length, and dry mass; and the biometric indexes, composed by the relation of growth variables. These indexes are useful because they demonstrate the quality of the seedlings; they are height/stem diameter ratio, shoot/root ratio, and Dickson quality index. Both the growth variables and biometric indexes show that the seedlings produced in the tray with the greatest volume, besides presenting higher growth in height, also have higher quality, being considered robust and with greater chances of survival after transplantation.

According to the growth variables, the foliar application of the PBZ inhibited the growth of the seedlings without reducing the development of the root system. Biometric indexes (S/R and DQI) indicate that the use of this inhibitor provided similar quality seedlings without their application. According to the values obtained in the H/D ratio, the use of PBZ resulted in more robust seedlings, being indicated for seedlings of *Capsicum frutescens* L., which are destined for ornamental purposes.

4. Conclusions

Foliar application of paclobutrazol resulted in robust pepper seedlings with reduced size, suitable and desirable characteristics for ornamental purposes.

The polystyrene trays with higher volume cells (100 mL) contributed to the higher quality of ornamental pepper seedlings.

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Bibliographic References

Banzatto, D.A., Kronka, S.N., 2006. Experimentação Agrícola, quarta ed. Jaboticabal, Funep.

Blank, A.F., Paula, J.W., Arrigoni-Blank, M.F., Moreira, M.A., 2009. Utilização de paclobutrazol em vetiver na produção de mudas e seu efeito em plantas no campo. Horticultura Brasileira, 27, 425-430.

Brito, C.L.L., Matsumoto, S.N., Santos, J.L., Gonçalves, D.N., Ribeiro, A.F.F., 2016. Efeito do paclobutrazol no desenvolvimento de plantas de girassol ornamental. Revista de Ciências Agrárias, 39, 153-160.

Cardoso, E.D., Costa, E., Binotti, F.F.S., Batista, T.B., 2018. Chemical agents and shading levels for the production of pepper seedlings. Engenharia Agrícola, 38, 450-456.

Carvalho, S.I.C., Bianchetti, L.B., Ribeiro, C.S.C., Lopes, C.A., 2006. Pimentas do gênero Capsicumno Brasil, Embrapa Hortaliças, 27.

Costa, E., Prado, J.C.L., Cardoso, E.D., Binotti, F.F.S., 2015. Substrate from vermiculite and cattle manure for ornamental pepper seedling production. Horticultura Brasileira, 33, 163-167.

Costa, E., Santo, T.L.E., Batista, T.B., Curi, T.M.R.C., 2017. Diferentes tipos de ambiente protegido e substratos na produção de pimenteiras. Horticultura Brasileira, 35, 458-466.

Cruciol, G.C.D., Koyanagui, M.T., Batista, T.B., Binotti, F.F.S., Costa, M.L.N., 2014. Aplicação de ácido giberélico e paclobutrazol na cultura da soja. Revista de Agricultura Neotropical, 1, 72-79.

Ferreira, D.F., 2011. Sisvar: um sistema computacional de análise estatística. Revista Ciência e Agrotecnologia, 35, 1039-1042.

Godoy, M.C., Cardoso, A.I.I., 2005. Produtividade da couve-flor em função da idade de transplantio das mudas produzidas e tamanhos de células na bandeja. Horticultura Brasileira, 23, 837-840.

Grossi, J.A.S., Moraes, P.J., Tinoco, S.A., Barbosa, J.G., Finger, F.L., Cecon, P.R., 2005. Effects of paclobutrazol on growth and fruiting characteristics of cv. Pitanga ornamental Pepper. Acta Horticulturae, 1, 333-336.

Lacerda, C.F., Enéas Filho, J., Pinheiro, C.B., 2007. Fisiologia vegetal. Universidade Federal do Ceará, Fortaleza-CE, 332 p.

Melo, L.F., Gomes, R.L.F., Silva, V.B., Monteiro, E.R., Lopes, A.C.A., Peron, A.P., 2014. Potencial ornamental de acessos de pimenta. Ciência Rural, 44, 2010-2015.

Oliveira, L.C., Costa, E., Cortelassi, J.A.S., Rodrigues, E.T., 2012. Formation of beetroot seedlings in different protected environments, substrates and containers in Aquidauana region, state of Mato Grosso do Sul, Brazil. Engenharia Agrícola, 32, 415-422.

Pinto, C.M.F., Pinto, C.L.O., Donzeles, S.M.L., 2013. Pimenta Capsicum: propriedades químicas, nutricionais, farmacológicas e medicinais e seu potencial para o agronegócio. Revista Brasileira de Agropecuária Sustentável, 3, 108-120.

Prado, J.L., Costa, E., Cardoso, E.D., Binotti, F.F.S., 2016. Proporções de húmus para a formação de mudas de pimenteira. Amazonian Journal of Agricultural and Environmental Sciences, 59, 339-344.

Santos, S.M.S., Matsumoto, S.N., Silva, R.A., Oliveira, L.S., Viana, A.E.S., 2018. Modulation of the initial growth of Eucalyptus clones using paclobutrazol: when smaller is better. Australian Journal of Crop Science, 12, 610-616.

Seleguini, A., Faria Júnior, M.J.A., Benett, K.S.S., Lemos, O.L., Seno, S., 2013. Estratégias para produção de mudas de tomateiro utilizando paclobutrazol. Semina, 34, 539-548.

Seleguini, A., Faria Júnior, M.J.A.F., Silva, K.S., Seno, S., Lemos, O.L., 2008. Uso do paclobutrazol na produção de mudas de tomateiro de crescimento indeterminado. Horticultura Brasileira, 26, 272-276.