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EFFECTS OF PLANT GROWTH RETARDANTS ON DEVELOPMENT OF POINSETTIA "CHRISTMAS FEELING" CULTIVAR

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Abstract: The poinsettias were cultivated years ago as medicinal and ornamental plants, too; but in the recent time are in the light of world flower assortment surprising with new shapes and colors in the cold season. The ornamental values of these plants are given by bracts which can have the same size as foliage leaves or even larger. The tendency of floral industry consists in obtaining high quality ornamental plants with superior marketable price. In these regards, the role of plant growth retardants in regulating the growth of poinsettia is important to obtain healthy, compact bushes and extended decoration period. The aim of the paper is to evaluate the effects of plant growth retardants on poinsettia. Five treatments with different retardants were applied as drench or spray. In the experiment four replicates and a total of 144 poinsettias were used. Treatments with paclobutrazol (60 mg/l sprayed), daminozide (2500 mg/l sprayed) and chlormequat chloride (1000 mg/l sprayed), showed the best results in case of marketability.

Keywords: daminozide, drench, *Euphorbia pulcherrima*, paclobutrazol

1. Introduction

Poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch) (sin. *Poinsettia pulcherrima* Willd. ex Klotzsch Graham, *Euphorbia erythrophylla* Bertol.) belongs to the Euphorbiaceae family. It is native in wet, tropical areas and temperate, sub-tropical and tropical climates (Carter, 2002; Niculescu, 2009).

Its ornamental value is given by the modified leaves (bracts) that have the same size as foliage leaves or sometimes even larger. The male and female flowers are forming the cyathia, which is surrounded by bracts. The color of more than 100 cultivars bracts varies between red, pink, white, cream, pale yellow, orange, pale green, and marbled/variegated bracts (Delavie et al., 2004; Schmidt, 2010; Deardorff and Wadsworth, 2016) dominating the red cultivars with 70-75% of world production.

The red color of poinsettia is due to anthocyanins, while the white varieties acquire their color by the anthocyanin content decreasement from vacuoles (Slatnar et al., 2013).

Since the spread of flowering timing, the role of plant growth retardants has increased. Controlling the growth of poinsettias can causes difficulties for growers because without the use of appropriate methods, these plants can grow too tall in greenhouses (Oszkóné et al., 1979; Faust et al., 2001). Influencing stem elongation is critical to successful commercial cultivation, because of the market demands (Lewis et al., 2004). The reduction of stem elongation can be achieved with plant growth retardants (PGR's) (Batelja et al., 2010).

Most growth retardants inhibit the biosynthesis of gibberellin (GA). A very popular growth retardant that inhibits the GA biosynthesis is daminozide (Batelja et al., 2010). Daminozide reduces the size of plant cells, thus shortening the length of the stem. It also inhibits the growth of the apical meristem, causing the plant to branch more and form more flowers on them (Bailey and Whipker, 1998). The treated plants grow strong roots, thus making better use of the soil's water supply and the nutrients. At the same time, daminozide increases chlorophyll production in the treated plant, causing the leaves to turn into a darker green color. Another useful growth retardant is chlormequat-chloride, which also blocks GA biosynthesis in the triazole process (Oszkóné et al., 1979). As a result of CCC treatment, the internode extensions are shortened, and the longitudinal growth of the plant is reduced. The agent accelerates flowering and intensifies the color of true leaves and bracts. By mixing these two materials (daminozide and chlormequat-chloride), the stem elongation was effectively reduced through the synergistic effect of the combination of the two (Oszkóné et al., 1979; Gibson et al., 2003). The biggest problem with using these materials is finding a method that has consistently effective results (Batelja et al., 2010). Another growth inhibitor (paclobutrazol) is also effective on stem elongation but can also reduce the size of bracts too much in case of excessive use (Niu et al., 2002). Paclobutrazol applied at the end of October has the least risk for affecting bract size according to an experiment made with "Freedom Red" poinsettia (Faust et al., 2001). Paclobutrazol (PBZ) has a strong growth inhibitory effect on a wide range of plants, inducing physiological changes including a decrease in gibberellin and sterol biosynthesis, increasing chlorophyll concentration and delaying aging due to increased endogenous cytokine levels (Niu et al., 2002). Maximum reduction in height and size of bracts was obtained when the paclobutrazol treatment was applied immediately after short days (Niu et al., 2002). The use of the agent, 3 weeks after the appearance of the colored bracts, did not affect the plant height and the bract area, regardless of the method or concentration used (Niu et al., 2002).

In the production of potted plants, a number of growth regulators can be used to adjust the size of the plant and this can be especially helpful after using excessive growth retardants (Runkle et al., 2005). Gibberellic acids have a growth-promoting effect and cytokinin's have a cell division-enhancing and branching-stimulating effect. By using growth regulators, leaf yellowing can be prevented, the size, number and lifespan of the flower can be increased (Runkle et al., 2005).

The aim of the experiment was to evaluate the effects of plant growth retardants on poinsettias. In addition, another desire of this research was to develop a cultivation technology that results in healthy and attractive plants which meets the market demands.

2. Materials and methods

The experiment was performed in a tunnel-based greenhouse with a double inflated foil cover in Transylvanian region. The height of the greenhouse was 5 meters, and the ventilation was provided by an automated roof ventilator. The cultivation tables were 2 m wide and 22 m long, on which the plants were irrigated constantly, the moisture and humidity was ensured (75% average air humidity, 20°C average temperature). The heating of the greenhouse was operated by a central heating system implemented through a pipe system under the tables. Monofactorial experiments were set with six different treatments applied with four replicates on six plants/treatment. In case of each replicates 6 plants did not receive any treatment and were kept as control (**Table 1.**). In the experiment a total of 144 cuttings were used belonging to the "*Christmas Feeling*" variety, purchased from the German company Elsner PAC Vertriebsgesellschaft mbH. The plants arrived on July 11. Potting up took place on July 12. To eliminate the possibility of infections various pesticides (Actara 25 WG, Dimilin 25 WP and Topsin 500 SC) were used. The method and time of application of the growth retardants are summarized in **Table 2.**

Table 1. Different treatments applied in the experiment

Experimental variants	Commercial name	Active ingredient (according to label)	Observations
V1 (control)	-	-	-
V2	Alar + Cycocel	daminozide and chlormequat (DAM + CCC)	used one time
V3	Bonzi	paclobutrazol (PBZ 10 mg/l)	used one time marked with D1
V4	Bonzi	paclobutrazol (PBZ 1 mg/l)	used two times marked with D2
V5	Bonzi	paclobutrazol (PBZ 60 mg/l)	used one time marked with S1
V6	Bonzi	paclobutrazol (PBZ 30 mg/l)	used two times marked with S2

Table 2. Growth retardants used in the experiment

Application time	**Method of application**	**Dosage**
17. Aug	Spray-first time	S1: 60 mg/l
17. Aug	Spray-first time	S2: 30 mg/l
29. Aug	Spray-second time	S2: 30 mg/l
17. Aug	Drench-first time	D1: 10 mg/l
17. Aug	Drench-first time	D2: 1 mg/l.
29. Aug	Drench-second time	D2: 1 mg/l
17. Aug	Spray-first time	DAM+CCC -2500 mg/l +1000 mg/l

Abbreviations: DAM + CCC - daminozide and chlormequat

Overall, the plants were examined at five different times (August, September, October and two times in December) and the following parameters were determined: plant height (cm), red bracts number, bracts length and width, total number of shoots, and the EC value. The recorded data concerning the influence of different growth regulators on development of *Poinsettia* "Christmas Feeling" cultivar was statistically interpreted with the Mann-Whitney test, worked out as average values per variant.

3. Results and discussion

The plant height and the bract area of poinsettias sprayed with paclobutrazol 60 mg/l (S1) were significantly different from the control plants, they were more marketable. Plants sprayed with DAM+CCC and PBZ 30 mg/l x 2 were near the same height with the plants treated with PBZ 60 mg/l treatment, no significant differences were found. The significantly lowest plant heights (**Fig. 1./ Fig. 3.**) were measured in case of paclobutrazol 10 mg/l and 1 mg/l drenched.

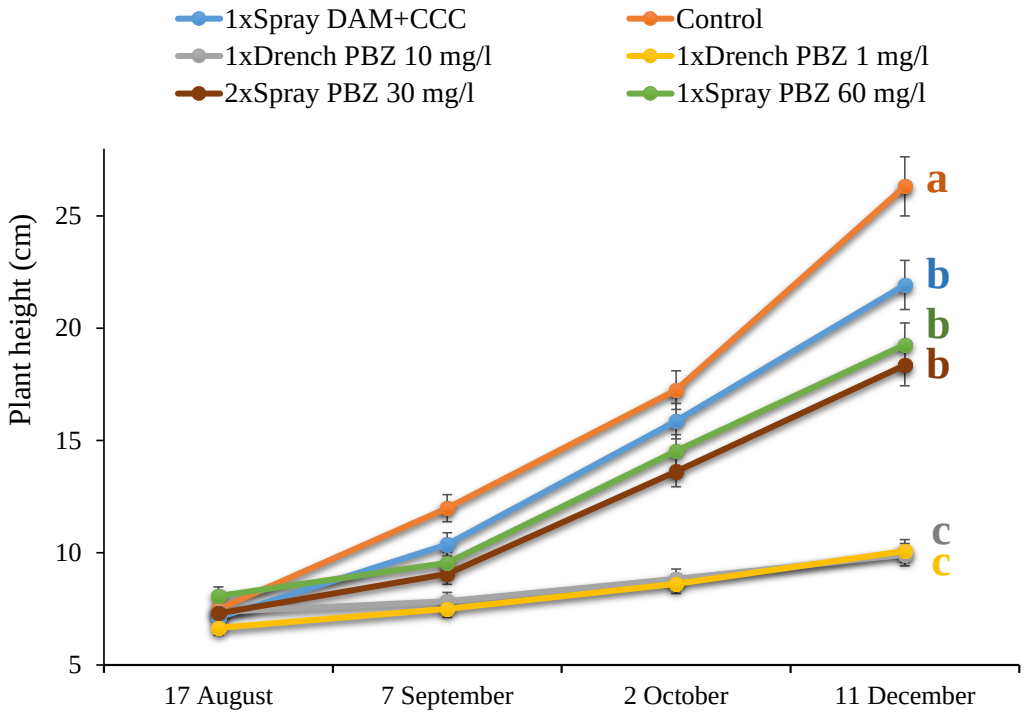

Fig. 1. Plant height at different measurement times and under different treatments. (Mann-Whitney test $p<0.05$). Different letters means statistical significant differences.

In case of the number of red bracts no significant differences were found between the control plants and the sprayed ones with PBZ (60 mg/l and 30 mg/l) and DAM+CCC. The lowest result was obtained with the PBZ 10 mg/l treatment which significantly differed from the other treatments. The poinsettias treated with PBZ 60 mg/l where the most marketable after visual examination because of the number of red bracts, the size of these bracts and the size of the plants (**Fig. 2. / Fig. 3. / Fig. 4.**).

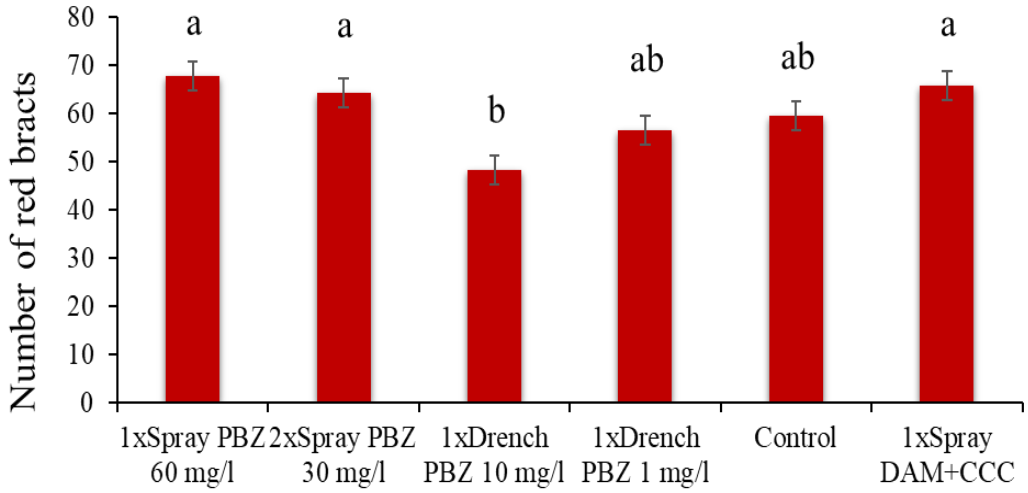

Fig. 2. Number of red bracts under different treatments (Mann-Whitney test $p<0.05$). Different letters means statistical significant differences.

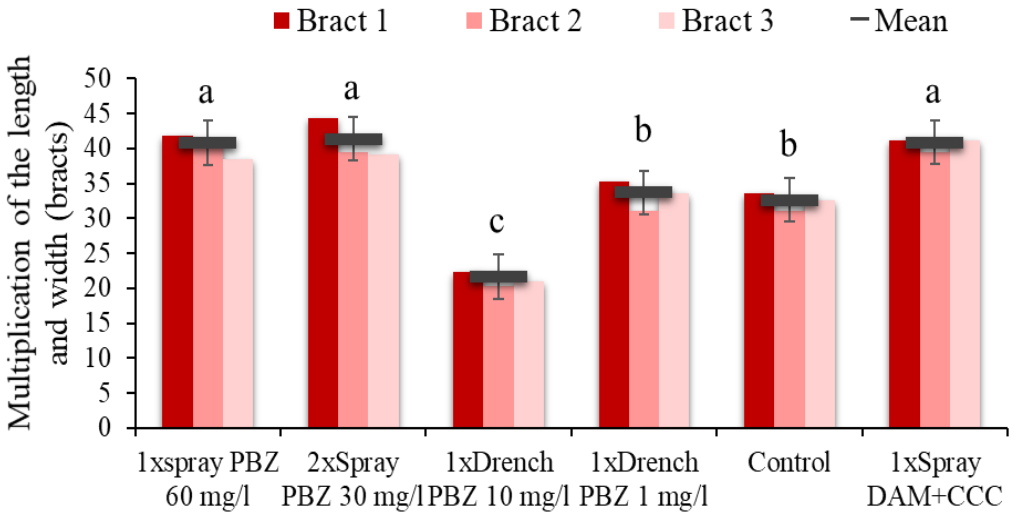

Fig. 3. Multiplication of the length and width of the three largest bract from each treatment (Mann-Whitney test $p<0.05$). Different letters means statistical significant differences.

The multiplication of the length and width of 3 selected bracts (the largest bracts) from each treatment were measured. Statistical differences were found between the sprayed plants with PBZ (60mg/l and 30mg/l) and the control plants. The lowest result was obtained with the drench of PBZ 10 mg/l which statistically differed from all treatments. The result of the DAM+CCC treatment was nearly the same as the PBZ treatment. The best result was obtained with the PBZ 60 mg/l treatment (**Fig. 2. / Fig. 3. / Fig. 4.**).

Treatments with PBZ 60 mg/l and daminozide and chlormequat chloride at concentration of 2500 mg/l: 1000 mg/l showed the best results in case of marketability. Same results were found in another two experiment made with poinsettia "Freedom Red" and "Freedom" (Faust et al., 2001; Niu et al., 2002).

All growth retardant treatments decreased the height of poinsettias and the anthesis was delayed by the daminozide and chlormequat chloride (DAM+CCC) treatment (Bailey and Miller, 1991).

The drenched plants with paclobutrazol 10 mg/l and paclobutrazol 1 mg/l excessively stopped the longitudinal growth of poinsettias and drastically reduced the height, bract size and internodes-length (Faust et al., 2001). These plants may have an increased rate of botrytis infection because of the reduction of height, bract area and compact size. The final plant height was around 5.5 cm shorter for DAM+CCC treatments, compared to the control, and varied between 7.5 and 15 cm in case of paclobutrazol treatments. According to Lewis et al., (2004) the obtained results were the same.

The combination of chlormequat chloride and daminozide treatment did not cause phytotoxic symptoms on poinsettias, neither when they were drenched or sprayed, which coincides with the results of the experiment made by Batelja et al. (2010).

Fig. 4. Poinsettias treated with different PGR's at the end of the experiment.

Conclusions

Altogether, it can be concluded that treatments with PBZ 60 mg/l and daminozide and chlormequat chloride at concentration of 2500 mg/l: 1000 mg/l showed the best results in case of marketability. The combination of chlormequat chloride and daminozide treatment did not cause phytotoxic symptoms on poinsettias, neither when they were drenched or sprayed. According to these it can be stated that the right cultivation technology and well-timed plant protection interventions, poinsettia can be successfully grown in the Transylvanian region in greenhouse conditions.

Conflict of interest

The authors declare that there are no conflicts of interest related to this article.

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