Influence of different levels of Ethephon on the growth and flowering of *Euphorbia pulcherrima var.* 'Freedom Red'.

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ABSTRACT

This study was carried out at the experimental farm of Horticultural Department, Faculty of Agriculture., Al-Azhar University, Nasr City, Cairo, Egypt, during the two successive seasons of 2014/2015 and 2015/2016. The effect of ethephon at different the rate on *Euphorbia pulcherrima var.* 'Freedom Red' plants was studied to dwarf their height aiming to produce more compact potted plants. The maximum dwarfing was obtained with ethephon at 1000 ppm, which recorded average height of 22.95 and 23.95 cm/plants for November and December periods, respectively. Furthermore, applying plants with the same ethephon level gave the highest the number of branches, followed by 500 ppm ethephon compared to the other concentrations or the untreated plants (control). The maximum leaves the number was obtained with ethephon treatment of 500 ppm. All concentrations of ethephon delayed the first bract color timing, whereas ethephon treatments at 1000 ppm increased the number of days until the first bract coloring more than other treatments of 300 or 500 ppm and the control. The biggest bracts canopy was observed in the control plants, since it recorded 57.61 cm/canopy. On the other hand, the higher level of ethephon (1000 ppm) led to the lowest bracts canopy.

Keywords: *Euphorbia pulcherrima*, Ethephon, bracts, growth retardants

INTRODUCTION

Floricultural cut flowers and pot plants occupy a major share in the human interesting and accordingly the demand for pot plants has increased (Urenu and Srivastava, 2013). One of these important ornamental pot plants is Poinsettia (*Euphorbia pulcherrima* Willd), which belongs to the family Euphorbiaceae and native to Central America. *E. pulcherrima* is a shrub or small tree, typically reaching a height of 4–6 meters. The plants bear dark green leaves. The colored bracts – which have colors most often flaming red - but can be orange, pale green, cream, pink, white, or marbled. Commonly, poinsettias can grow reaching 3

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meters in high, but for using as pot plants, the plants height should be controlled for the proportional size between container and plants (Megawati, 2009). Under natural conditions, poinsettias usually grow too tall and leggy, which leads to lower-valued products with increasing transport expenses (Sun *et al*., 2011**)**. However, the ability to control the stem elongation of poinsettia is critical in successful commercial cultivation, because market demands often include target plants height (Lewis *et al*., 2004). Hence special attention is required to make short bushy plants match the market specifications mainly with respect to plants height (mostly less than 45cm); therefore, control of stem elongation is a critical step on successful commercial cultivation in poinsettia production (karunananda and peiris, 2010). Plants growth retardants (PGRs) can be an economical option for controlling growth, and to improve the quality and overall appearance of many plants (Asrar *et al*., 2014). Among various plants growth retardants, Ethryl (Ethephon) are well known for production of qualified plants. The aim of this study is to investigate the effect of different levels of Ethephon on the growth and flowering of *Euphorbia pulcherrima* plants to improve the quality of the product enough to meet market quality standards.

MATERIALS AND METHODS

This study was carried out at the experimental farm of Horticultural Department, Faculty of Agriculture., Al-Azhar University, Nasr City, Cairo, Egypt, during the two successive seasons of 2014/2015 and 2015/2016.

Plants material and cultivation:

Rooted cuttings of about 7 cm in height of *Euphorbia pulcherrima var.* 'Freedom Red' were obtained from the Egyptian German Company, Al Sharkia, Egypt. A commercial mixture subs the rate composed of 20% perlite and 80% peat moss v/v was prepared homogeneity before plant's cultivation. The soil pH was adjusted to 6.2 with calcium carbonate. Rooted cuttings were immediately -upon arrival- planted in 20-cm-diameter plastic containers on 22nd June at each season. All plants were grown in a greenhouse of the ran of 63% shading. Pinching was carried after the 14th day (2 weeks) from planting. The plants were watered by drip irrigation when it was needed according to the weather. Agricultural procedures (e.g. fertilization, fungicide and insecticide) were done whenever it was necessary. This experiment focused on examining the effect of different the rate of ethephon [2-chloroethyl phosphonic acid)] at the rate of 0.0, 300, 500 and 1000 ppm. Ethephon treatments were started after 4 weeks from cutting cultivation (2 weeks after pinching) by spraying 30-40 m1 per plant. The spraying soaks both leaves and stems using hand pump sprayer to completely cover the entire plants. These treatments repeated seven times every 14 day intervals among the experimental period. Control plants were sprayed with tap water. All the treatments were applied at afternoon (4.00 pm) whereas temperature was its lower level which led to facilitate absorption of chemicals and to keep moisture longer on the leaf surface due to lack of evaporation.

THE RECORDED DATA:

I. Vegetative growth: These measurements were recorded at intervals every two weeks (after pinching) –among the of plants growth period until the experiment was ended on (May10th).

1- Plants height (cm): the measurements were estimated from the ground surface to the stem apex

2- The number of shoots (side branches).

II. Flowering growth:

1- The date of first bract coloring (measured as the number of days from cultivation until the first bract coloring was started).

2- The number of coloring leaves /bracts was recorded at intervals every 30 days from the beginning of the first bracts coloring until the end of the experiment (May10th).

3- Canopy diminution (cm) was taken as the average between the length and the width of the canopy. Measurements started after two weeks from the beginning of the first bracts coloring until the end of the experiment.

Statistical analysis: The analysis of variance was performed according to method described by **(Snedecor and Cochran, 1972)**. Computation was done using COSTAT computer package (CoHort software Monterey, California, USA), and means were compared by analysis of variance values (LSD) at 0.05.

RESULTS AND DISCUSSION

I. Vegetative growth:

1-Effect of ethephon on plants height (cm) / plant.

The plants height (cm) was measured at different intervals during the experimental stag every 30 days during the plants growth. The obtained results were presented in Fig. (1 and 2). The mean values of plants height of *Euphorbia pulcherrima var.* 'Freedom Red' was significantly affected by the different treatments of ethephon spraying in the both the seasons. Generally, plants height was decreased linearly in relation to the increase in the concentration of ethephon. The tallest plants in both seasons were recorded from untreated plants (control). The treated plants had different growth the rate due to the concentration application of ethephon. Treating plants by all concentrations of ethephon reduced plants height differently compared with the control. Whereas average of plants height through the first growing season were 54.31, 39.19, 35.72 and 23.52 cm/plants, while they were 49.39, 37.53, 33.69 and 21.2 cm/plants in the second season for ethephon concentration of 0.0, 300, 500 and 1000 ppm respectively. Hence special attention was required to make short bushy poinsettia plants match the market specifications mainly with respect to plants height, mostly less than 45 cm (Karunananda and Peiris; 2010). However, it's well known that November and December is the important period for poinsettia marketing since it is the time of its flowering. Therefore, controlling of plants height at this time of growth is a critical step for

Euphorbia pulcherrima production and marketing. In this point of view our results estimated (November and December) indicated that, the maximum dwarfing was obtained with ethephon at 1000 ppm which recorded an average of 22.95 and 23.95 cm/plants for November and December periods respectively in the first season, while they were 20.40 and 22.40 cm/plants for the same periods in the second season. Low levels of ethephon (300 ppm) had less inhibitory influences on plants height recording 35.50 and 38.25 cm/plants in the first season, while they were 33.05 and 38.30 cm/plants in the 2nd season, respectively. As expected the maximum plants height observed at this certain period (November and December) was in control plants which recorded 57.10 and 63.30 cm/plants in the 1st season while in the 2nd season they recorded 47.85 and 55.51 cm/plants in the same period respectively. The mechanism of reduction occurred in plants height because of growth retardant application appears to be due to its effect in slowing down of cell division and reducing cell expansion (Magnitskiy *et al*., 2006). Karunananda and Peiris (2010) suggested that reduction in height probably was caused by restriction of cell elongation rather than cell division**.** In addition, ethephon is not an anti-gibberellin. It releases ethylene to reduce cellular elongation **(Sun *et al*., 2011).** These results were compatible with other previous research on poinsettia using plants growth retardants which reported by many investigators. (Pérez-López *et al*., 2005 and Sun *et al*., 2011) on *Euphorbia pulcherrima*

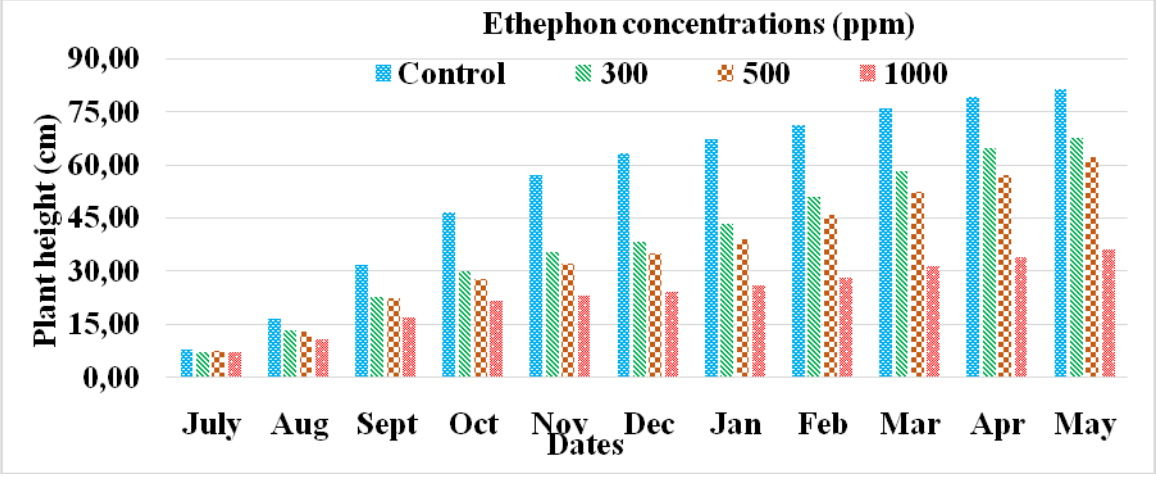

Fig (1). Effect of ethephon concentrations on the monthly average of plants height of *Euphorbia pulcherrima* *var.* 'Freedom Red' during the first season of (2014/2015).

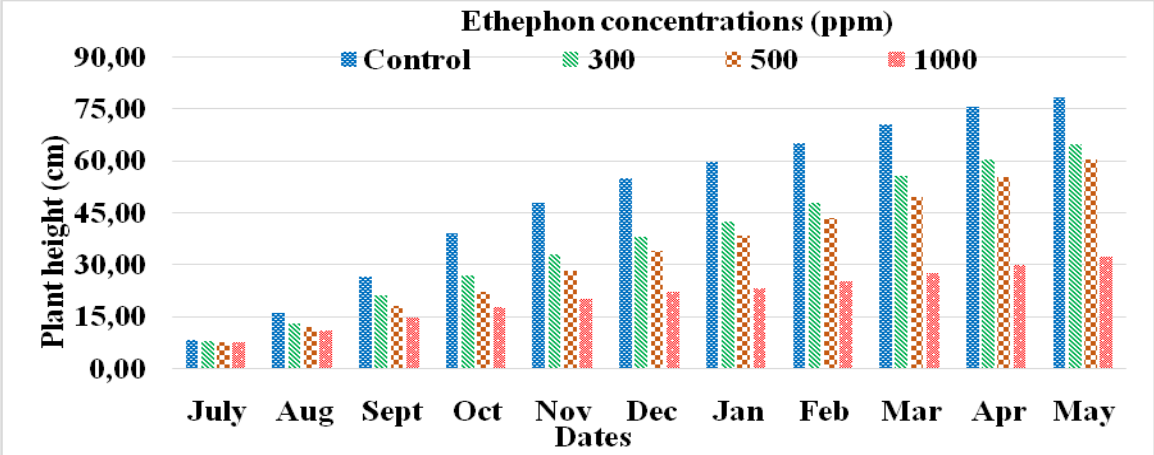

Fig (2). Effect of ethephon concentrations on the monthly average of plants height of *Euphorbia pulcherrima var.* 'Freedom Red' during the second season of (2015/2016).

2- Effect of ethephon on the number of branches/ plant.

The results in Table (1) show that, using of ethephon gave a significantly different response in the number of branches. It was shown from data in Table (1) that, the number of branches increased by spraying ethephon in both seasons. This trend was gradually augmented as levels of ethephon were increased. Moreover, it can be noticed that branching of the treated and untreated plants was not affected during the period of from September until March, However the number of branches/plants still constant among this growing period. A slight increase in the number of branches was observed started from April with the growth development until the end of the experiment (May). The promoter effect occurred in branching rates may be due to the environmental condition since the temperature begins to increase gradually from April.

Table (1): Effect of ethephon concentrations on the monthly averages of the branch the number of *Euphorbia pulcherrima var.* 'Freedom Red' during seasons of 2014/2015 and 2015/2016.

Average branch the number /plant

1st season

Treatments	**Concentration**	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	6.8	6.87	6.93	6.93	6.93	6.93	6.93	6.93	6.93	7.00	7.00	6.93
	300 ppm	6.87	6.94	7.07	7.07	7.07	7.07	7.07	7.07	7.07	7.08	7.08	7.04
	500 ppm	6.87	7.13	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.58	7.58	7.36
	1000 ppm	6.8	7.38	7.90	8.07	8.07	8.07	8.07	8.07	8.07	8.36	8.36	7.93
LSD 0.05		0.46	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.40	0.40	

2nd season

Treatments	**Concentration**	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	6.67	7.11	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.33	7.33	7.20
	300 ppm	6.69	7.05	7.36	7.36	7.36	7.36	7.36	7.36	7.36	7.39	7.39	7.28
	500 ppm	6.89	7.24	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.89	7.89	7.65
	1000 ppm	6.75	7.81	8.19	8.19	8.19	8.19	8.19	8.19	8.19	8.39	8.39	8.06
LSD 0.05		0.94	0.45	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.22	0.22	

The minimum the number of branches in both seasons was recorded in the untreated plants (control). The higher the rate of application of ethephon at 1000 ppm gave the highest values of a number of branches followed by ethephon at the rate of 500 ppm compared to the other concentrations, and the untreated plants (control). The monthly averages of a number of branches/plants through the marketing period of (November) were 6.93, 7.07, 7.40 and 8.07 branches/plants for ethephon concentration of 0.0, 300, 500 and 1000 ppm at the same period respectively. This trend holds true in the same period for ethephon treatments at the second season (Table 1). During the growing period of the first season, the same trend was occurred, whereas the

main averages were 6.93, 7.04, 7.36 and 7.93 branches/plants for ethephon at the rate of 0.0, 300, 500 and 1000 ppm respectively. This trend was the same through the second season (Table 1). Promotion in the number of branches due to the treatments of ethephon more than untreated plants is mainly attributed to the inhibitory effect of these growth regulators in the cell division in the apical bud, which subsequently might have stopped the growth of the main axis and resulted in more lateral production (Prashanth *et al.,* 2006; Di Benedetto and Molinari 2007). In addition, plants growth retardants activated lateral buds to grow and fill in with more the number branches (Benjawan *et al.*, 2007). The increase in the number of branches could be due to inhibition in the auxin activity in the apical bud because of the application of growth inhibitors since they act as anti-auxin. These treatments intern suppressed the apical dominance, thereby diverting the polar transport of auxins towards the basal nodes leading to increase branching the rate (Dole and Wilkins, 1999; Reddy, 2005). The promotive effect of ethephon on the number of branches was reported by Abbas *et al.* (2007) on *Rosa damascene.*

II. Flowering growth:

1-Effect of ethephon on first bracts coloring time by days.

Data tabulated in Table (2) show that, there is a clear considerable significant difference in the number of days from cutting cultivation time until the first bract coloring start due to spraying plants with the different levels of ethephon in the both seasons, all different concentrations of ethephon were used, delayed first bract color timing, whereas ethephon at 1000 ppm gave the maximum the number of days calculated from cutting plan

Table (2): Effect of ethephon concentrations on timing of first bracts coloring (days after cultivation) of *Euphorbia pulcherrima var.* 'Freedom Red' during 2014/2015 and 2015/2016 seasons.

Timing of first bracts coloring (days after cultivation)			
Treatments	**Concentration**	**1st season (2014/2015)**	**2nd season (2015/2016)**
Ethephon	0.0 ppm	118.1	122
	300 ppm	121.7	124.8
	500 ppm	124.9	126.6
	1000 ppm	128.7	133
LSD 0.05		3.36	3.87

Then ethephon treatments at 500 and 300 ppm gave afterword as they recorded (124.9 and 121.7 days respectively) in 1st season compared with (126.6 and 124.8 days respectively) in the 2nd

season. In spite of the foliar spray application of ethephon delayed the bract coloring development, but the plants were still of commercially acceptable quality, except those treated with ethephon at the rate of 1000 ppm when we considered the the number of bracts/plants mentioned in (Table 2). Ethephon sprays delayed first bract color due to some side effects, such as phytotoxicity that delayed of bract color development (Sun *et al*. 2011). The promoter effect of ethephon on time of the first bract coloring was reported by Sun *et al*. (2011).

2- Effect of ethephon on the number of color leaves (bracts)/ plant.

The number of color leaves (bracts)/ plants were recorded through the period (from 26 Oct to May) every 30 days during the two successive seasons. Significant differences were observed among the results of bract's counting due to ethephon treatments in various levels (Table 3). Ethephon the rate have a clear effect on the mean values of the number of color leaves (bracts) of *Euphorbia pulcherrima var.* 'Freedom Red' during both seasons. Among the growing season, the higher level of ethephon (1000 ppm) recorded minimum the number of color leaves compared to the other concentrations and the control. Plants treated with ethephon at the rate of 300 ppm produced slightly less the number of color leaves per plants at the different measuring intervals.

Table (3): Effect of ethephon concentrations on the monthly averages the number of color leaves of *Euphorbia pulcherrima var.* 'Freedom Red' during seasons of 2014/2015 and 2015/2016.

Average the number of color leaves /plant

1st season

Treatments	Concentration	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	22.5	74.4	148.1	173.5	184.4	161.0	120.9	89.2	121.7
	300 ppm	16.7	75.4	154.5	176.5	191.1	166.5	126.4	101.8	126.1
	500 ppm	15.5	68.5	153.9	185.1	201.6	181.2	127.0	107.9	130.1
	1000 ppm	8.4	35.1	127.6	167.1	182.0	161.8	109.5	88.2	109.9
LSD 0.05		2.15	9.19	10.34	10.66	11.64	7.04	5.53	12.90	

2nd season

Treatments	Concentration	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	21.0	73.5	130.6	162.6	181.3	154.0	109.8	85.9	114.8
	300 ppm	22.1	72.2	143.6	168.3	184.6	159.5	114.0	99.8	120.5
	500 ppm	17.0	71.6	143.9	177.8	198.3	172.1	115.7	109.1	125.7
	1000 ppm	11.0	32.7	110.8	159.0	172.6	147.6	94.9	77.6	100.8
LSD 0.05		2.96	8.00	7.42	10.32	6.66	4.37	6.89	10.47	

Plants treated with ethephon concentration of 500 ppm produced the highest the number of leaves compared to the other ethephon treated plants and the control. In contrast plants treated with ethephon the rate of 1000 ppm tended to reduce their number of leaves significantly to be less

than the untreated plant. In addition, the number of color leaves (bracts) was increased gradually reaching its maximum in February and then it deceased constantly reaching the minimum value at the end of the experiment (May). This decline in the number of bracts may be due to the high level of temperature and the longest day length occurred at this late period of plants growth (late spring and early summer) which in turn induced the bract senescence. The main averages the number of color leaves calculated among the whole growing stage during the first season were 121.7, 126.1, 130.1 and 109.9 color leaves/plant, while they were 114.8, 120.5, 125.7 and 100.8 color leaves/plants in the second season by using ethephon concentrations at 0.0, 300, 500 and 1000 ppm respectively Table (3). In the marketing time (November and December) results indicated that in the first season, treating plants with the high the rate of ethephon (1000 ppm) was not suitable for producing the commercially quality the number of bracts since it produced the lowest the number of bracts because of the falling of these leaves were much early and vigor. The minimum amount of color leaves/plants was due to ethephon treatment of 1000 ppm recording 35.1 and 127.6 color leaves/plants in the marketing period (November and December) at the first season, while it was 32.7 and 110.8 color leaves/plants for the same periods in the second season compared with other treatments and the control (Table 3). These results are in harmony with those obtained by Araghi *et al.,* (2013).

3-Effect of ethephon on the average of bract canopy size.

From the presentation of data in Table (4), it appears that, bracts canopy of *Euphorbia pulcherrima var.* 'Freedom Red' size estimated as average between length and wide of the canopy was significantly affected by using different levels of ethephon during both seasons. It is obvious that, all levels of ethephon (300, 500 and 1000 ppm) led to a significant decrease in bracts canopy size as compared to the untreated plants in both seasons.

The biggest bracts canopy was observed with control plants since it was 57.61 cm/canopy. On the other hand, the higher level of ethephon at the rate of 1000 ppm led to the lowest bracts canopy with values of 42.65 cm/canopy. The lower concentrations of ethephon at the rate of 300 and 500 ppm recorded higher values of 49.51 and 46.59 cm/canopy, respectively during the 1st season (Table 4). In addition, there was a gradual increase in the bracts canopy size started from time of bracts coloring appearance and extended until February and then it decreased constantly during March and April reaching the maximum decline on May at both the experimental seasons. This decline is due to the deterioration of the bracts leaves during this time which was marked in falling of the bracts leaves. In the marketing time (November and December) results reveal that, the maximum of bracts canopy size was observed with control, which recorded 59.85 and 64.74 cm/canopy during this period respectively, in the first season, while they were 44.21 and 49.90 cm/canopy during this period respectively in the second season. Ethephon at the rate of 300, 500 and 1000 ppm recorded 50.18, 46.73 and 40.52 cm/canopy respectively during November while they were 54.10, 50.77 and 44.23 cm/canopy respectively, during December in the first season. This

trend holds true in the second season results. This relative reduction in average of canopy bract diameters occurred in plants by spraying ethephon may be due to growth inhibitors effect on producing more compact tissue and the restriction of cell elongation rather than cell division and this in turn decreased leaves area as compared to the untreated plants.

Table (4): Effect of ethephon concentrations on the monthly average on the bract canopy of *Euphorbia pulcherrima var.* 'Freedom Red' during seasons of 2014/2015 and 2015/2016.

Average bracts canopy (cm/plant)										
1st season										
Treatments	**Concentration**	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	48.00	59.85	64.74	63.22	60.21	57.49	54.92	52.50	57.61
	300 ppm	40.39	50.18	54.10	55.12	54.44	49.69	46.84	45.33	49.51
	500 ppm	38.44	46.73	50.77	52.72	51.43	46.44	43.95	42.28	46.59
	1000 ppm	33.02	40.52	44.23	46.79	48.68	44.43	41.89	41.61	42.65
LSD 0.05		2.89	2.62	1.25	1.24	1.07	2.42	2.13	1.46	
2nd season										
Treatments	**Concentration**	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean
Ethephon	0.0 ppm	39.00	44.21	49.90	53.93	59.36	58.03	52.63	48.22	50.66
	300 ppm	38.22	43.11	48.70	53.21	57.41	52.57	43.73	38.11	46.88
	500 ppm	34.08	39.32	44.94	47.65	52.75	48.60	40.10	35.69	42.89
	1000 ppm	31.68	35.61	41.15	44.30	49.10	45.32	36.08	33.33	39.57
LSD 0.05		2.55	1.56	1.74	2.98	3.24	2.35	2.69	2.48	

The inhibitors effect of ethephon on bract canopy diameter was reported by many investigators., Lewis *et al*. (2004) Pérez-López *et al*. (2005) and Sun *et al*. (2011) on *Euphorbia pulcherrima*.

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