Annals of Tropical Research 24(1):23-34

Growth, development and flower quality of poinsettia (*Euphorbia pulcherrima*) as influenced by nutrient level and plant growth regulation method

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ABSTRACT

Quita, D. P. and M. T. Diputado. 2002. Growth, development and flower quality of poinsettia (*Euphorbia pulcherrima*) as influenced by nutrient level and plant growth regulation method. *Ann. Trop. Res.* 24(1):23-34.

Nutrient application, in general, increased plant size and number of leaves per plant and enhanced dry matter production in plant. Low nitrogen to potassium ratio resulted to the production of shorter internodes and with more intense bract color. Plants applied with high N-K ratio were taller, had longer internodes and bigger bracts.

Paclobutrazol application effectively reduced plant height and internode length. Pinching, on the other hand, reduced plant height but did not reduce internode length. It increased number of leaves per plant. Thus, the combination of paclobutrazol application and low N/K ratio feeding regime produced plants of the best quality.

Keywords: poinsettia, nutrient level, growth regulation, flower quality, paclobutrazol, pinching

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INTRODUCTION

The poinsettia, *Euphorbia pulcherrima* L., also called a Christmas star, lobster plant or Mexican flame leaf, is native to Mexico and one of the large number of plants belonging to the family Euphorbia. The showy red, pink or white portions of the plant, popularly referred to as the flower, are modified leaves called bracts (Figure 1). One bract is attached near the base of each cyathium. There are about 20-30 cyathia in each “flower”. In addition, there may be one of the five colored leaves between the green leaves and the bracts, often referred to as transitional bracts.

Poinsettias are photoperiodic and flower in response to change in daylength (Grueber, 1985). Poinsettia initiates and develops “flowers” as the nights become longer than the days.However, flowering in poinsettia can be initiated by an eight-week period of no more than 10 hours of light and no less than 14 hours of total uninterrupted darkness per day and this can be achieved through a high degree of control.

Quality in potted poinsettia plants is characterized by uniform flowering, straight, erect stems, dark green, closely spaced leaves and plant height that is aesthetically balanced with container size. Regulating stem length while maintaining the other characteristics of quality, presents a different challenge to the production of poinsettia plants. Water can be lowered,plants can be pinched and pruned to control stem length, but generally at the expense of reduction in fresh and dry weight, smaller leaves and a delay in maturity. Growth retardants have made it possible to produce potted plants of high quality without the risk of stimulating excessive stem length. On the other hand, nutrient feeding or fertilizer application is one of the most important factors to be considered of poinsettia, not only because nutrients are needed to enable plants to make the maximum growth or produce the best crops (Mac Millan, 1991), but also to improve its flower quality. In general, plants with high N produce a very soft, suitably sized seedlings in a very short time but difficult to handle. Plants with high K produce harder and more compact plants. The ratio of nitrogen, phosphorus and potassium can be altered to meet the desired requirements of the crop for maximum production (Nelson, 1981). This is particularly critical in plants like poinsettia where quality is associated with more robust and sturdy structure.

Fig. 1. The poinsettia plant.

This study was conducted to determine the effect of nutrient level, growth regulation method and the interaction of these two variables on the growth and flower quality of poinsettia.

MATERIALS AND METHODS

Reproduction of Stock Plants

Stem cuttings of about 20 cm long were obtained from healthy poinsettia plants grown in the locality. Disinfected sharp knife was used to cut the stems. Newly cut stems were placed in a basin filled with water to minimize stress.

A combination of garden soil and partially burnt rice hull was used as potting medium. The medium was mixed thoroughly and placed into the pots with a diameter of 25.2 cm. Hot water was poured into the medium to sterilize it.

Before planting, the cuttings were dipped in concentrated ANAA (Alpha naphthalene acetic acid) solution for about one minute to induce early rooting of the cuttings. Three stem cuttings were planted into each pot.

Care and Maintenance of Newly Regenerated Plants

Pots with the newly stocked cuttings were placed in a screenhouse with about 60% shade. Fungicide was applied at a weekly interval to provide protection against fungal contamination. Weeds growing inthe vicinity and in the pots were removed immediately. Watering was done when necessary.

Fertilizer Application and Pinching of the Stock Plant

When new shoots were visible, application of liquid fertilizer consisting of 1 tbsp of urea per gallon of water was done every week until the new shoots were about the size of a pencil. New shoots with eight (8) or more mature leaves were pinched leaving 3 to 4 basal leaves to encourage development of more shoots.

Reproduction of Experimental Plants

Rice hull, charcoal, coco air dust and compost were mixed at a ratio of 1:1:1 (v/v). Two hundred twenty five plastic pots (6" top diameter) were filled up to the brim with the medium. Terminal tip cuttings, 2-3" in length were harvested from the stock plants using a sharp, disinfected knife during early morning. The cuttings were dipped in concentrated ANAA solution for one minute to enhance rooting and planted immediately in the prepared pots with potting medium to a depth of approximately one (1) inch. The newly planted cuttings were provided with one-layer fishnet to give uniform shade.

Experimental Design and Treatments

A two-factorial experiment in randomized complete block design (RCBD) with three replications was used. Nutrient level served as Factor A while growth regulation method served as Factor B. Each replicate had five sample plants. The treatments were as follows:

Factor A: NPK level (ppm N, P and K)

L_0 - Control

L_1 - 200-200-200

L_2 - 300-300-300
L_3 - 200-200-300
L_4 - 300-200-200

Factor B: Method of Growth Regulation
G_0 - Control
G_1 - Paclobutrazol Application
G_2 - Pinching

Preparation and Application of Fertilizers

Urea [$CO(NH_2)2$-45% N] was used as source of nitrogen, potassium phosphate (KH_2PO_4 - 22.8% P) for phosphorus, and potassium chloride (KCl - 60% K) for potassium. The different fertilizer materials were prepared based on the treatments. Application was done twice a week at the rate of 50 ml per pot. Fertilizer application started right after planting and was stopped two weeks before the termination of the study.

Application of Plant Growth Regulator and Pinching

Paclobutrazol (Cultar) was applied once at a concentration of 0.40 ml per liter of water (McDaniel, 1986). This was done at the beginning of bud initiation and was applied using a hand sprayer. Pinching as another growth regulation method was done when the plants were 36 days old. This was done by removing the terminal end of the experimental plants leaving 5 to 6 functional leaves.

Inducing Early Flowering of the Plants

To enhance early bract development, short day was simulated by covering the entire area with black sacks at 5:00 p.m. up to 7:00 a.m. the following day. This was done every day for four weeks.

Care and Maintenance of the Plants

Weeds growing in the area were removed regularly. Insect pests and diseases were closely monitored and controlled. Watering was done when necessary.

Laboratory Analysis of Potting Medium

A representative sample of the medium was set aside for initial analysis of N, P and K content. The same medium was gathered after the termination of the study from the different treatments. The samples were air-dried, pulverized, sieved and submitted to the Soils Research, Testing and Plant Analysis Laboratory of the Dept. of Agronomy and Soil Science, LSU, Visca, Baybay, Leyte for the analysis of total N, extractable P and exchangeable K.

RESULTS AND DISCUSSION

Nutrient Status of Growing Medium

Table 1 shows the nutrient status of the soil in terms of nitrogen, phosphorus and potassium contents before and after cropping. The nitrogen level and potassium contents dropped slightly in all media regardless of fertilizer and growth regulation treatments. The phosphorus level, on the other hand, increased by more than 50% and this may be due to the applied phosphorus, which may have not been utilized by the plant. The unexpected similar increase in phosphorus level in the unfertilized pots may have been due to error in sampling or analysis.

Plant Height and Internode Length

One of the important attributes of poinsettia plants is being compact, i.e., plants have short internodes. It was found in this study that plant height and internode length significantly varied with different fertilizer treatments and plant growth regulation methods (Table 2). The shortest plants with the shortest internodes were those applied with 200-200-300 ppm N, P and K (L_3). This was followed by the control plants (L_0) and those applied with 200-200-200 ppm N, P and K (L_1). Plants that were given 300-300-300 (L_2) and 300-200-200 ppm N, P and K (L_4) produced the tallest plants. These findings agree with Nelson (1981) who stated that high amount of potassium relative

Table 1. Initial and final contents of N, P and K in the potting medium of poinsettia as affected by nutrient level and plant growth regulation method

Treatment	Total N (%)	Available P (ppm)	Exch. K (ppm)
		Initial Determination	
	0.76	0.09	0.18
		Final Determination	
Nutrient Level (ppm N, P, K)			
L_0 - Control	0.72	0.14	0.16
L_1 - 200-200-200	0.75	0.15	0.16
L_2 - 300-200-300	0.75	0.13	0.14
L_3 - 200-200-300	0.74	0.16	0.15
L_4 - 300-200-200	0.73	0.14	0.15
Growth Regulation Method			
G0 - Control	0.73	0.15	0.14
G1 - Paclobutrazol app'n	0.75	0.15	0.15
G2 - Pinching	0.75	0.14	0.16

Table 2. Plant height, internode length, leaf size and number of leaves produced per plant as influenced by nutrient level and plant growth regulation method

Treatments	Plant Height (cm)	Internode Length (cm)	Leaf Length (cm)	No. of Leaves/plt.
Nutrient Level (ppm N, P, and K)				
L0 - Control	33.83c	3.14b	22.94	10.74b
L1 - 200-200-200	36.30b	3.32ab	25.43	13.63a
L2 - 300-200-300	40.67a	3.69a	25.07	13.41a
L3 - 200-200-300	28.46d	2.60c	22.58	12.37a
L4 - 300-200-200	42.73a	3.70a	26.92	13.74a
Growth Regulation Method				
G0 - Control	42.68a	3.83a	26.98a	12.69b
G1 - Paclobutrazol app'n	32.29c	2.52b	24.34ab	11.56c
G2 - Pinching	34.12b	3.51a	22.46b	14.09a
CV (%)	6.29	16.02	19.16	11.08

Treatment means in the same column within a subgroup having a common letter designation or those without letter designation are not significantly different from each other based on DMRT (5% level) to that of nitrogen produces shorter and sturdier plants. High amount of nitrogen, on the other hand, causes plants to grow rapidly resulting in high proportion of succulent and fleshy plant tissue (Ecke *et al.*, 1990).

Paclobutrazol application also reduced plant height and internode length. This confirms the report of McDaniel (1986) and Wilkinson and Richards (1987). Pinching also reduced plant height,however, this was more because of shoot tip removal rather than shortening of internodes. Hartley (1992) pointed out that the right timing of pinching is necessary. Pinching too near the "flower" initiation date may not make enough growth before "flower" initiation, whereas pinching too advanced of the flower initiation date may result in plant that is too tall.

Leaf Size, Leaf Number and Plant Dry Weight

The different nutrient levels did not significantly affect leaf size but significantly affected the number of leaves produced per plant. The increased number of leaves in the fertilized plants relative to the control was comparable among the different nutrient levels. Pinching reduced leaf length relative to the control and this was due to the production of lateral branches which competed with leaves as sinks of assimilates. Reduction of leaf length in paclobutrazol-treated plants relative to the control was not significant. The chemical may have resulted to stunted plant growth but not leaf growth.

The number of leaves produced per plant was higher in fertilized plants than in non-fertilized ones. The number of leaves did not vary significantly among fertilized plants. Pinched plants produced more leaves compared to that of the control and with those treated with paclobutrazol. Increased number of leaves in pinched plants was a result of the production of lateral branches due to the arrest of apical dominance after pinching. In plants applied with paclobutrazol reduced leaf production could be due to overall reduction in plant size.

Plants applied with fertilizer regardless of level and N-K ratio substantially increased the dry weight of shoots and roots relative to the unfertilized plants (Table 3). Among the fertilizer levels, L_3 resulted in the least shoot growth of plants although statistically comparable with the L_1 and L_2.Plants under L_4 produced the most shoot dry matter although not significantly different with those under L_1 and L_2.In general, plants supplied with high N level relative to

Table 3. Dry matter produciton and shoot-to-root ratio of potted poinsettia as affected by nutrient level and plant growth regulation method

Treatments	Shoot Dry Wt. (g/plt.)	Root Dry Wt. (g/plt.)	Shoot/Root Ratio
Nutrient level (ppm N, P and K)			
L0 - Control	19.83c	1.02	20.41
L1 - 200-200-200	29.58ab	1.45	20.35
L2 - 300-200-300	30.44ab	1.44	21.37
L3 - 200-200-300	26.96b	1.43	18.74
L4 - 300-200-200	33.44a	1.43	23.94
Growth Regulation Method			
G0 - Control	28.78	1.34	21.72
G1 - Paclobutrazol app'n	26.90	1.31	20.15
G2 - Pinching	28.68	1.41	21.02
CV (%)	6.29	17.35	21.18

K produced greater shoot dry matter. According to Larson (1988) and Hartley (1992), plants given ample amounts of nutrients, particularly N, will have enhanced dry matter accumulation.

The root to shoot ratio was unaffected by nutrient level and plant growth regulation indicating that this parameter in poinsettia plant is a stable character.

The interaction effects between nutrient level and plant growth regulation on leaf size, number of leaves per plant,plant dry weight and root to shoot ratio were not significant.

Bract Development

Significant variations among plants under different nutrient levels in terms of days from visible bud formation to full bract development, bract size and plant quality (Table 4) were observed. The control plants and those under L1 and L4 formed bracts 2-3 days later than those under L3 indicating that plants with high K (300 ppm) level relative to N had reached maturity earlier. Delayed bract development in plants under high N relative to K level could be due to the tendency of plants to stay vegetative when supplied with high N level.

Table 4. Plant quality rating of poinsettia as affected by the interaction between nutrient level and plant growth regulation method

Nutrient Level (ppm N, P and K)	Plant Quality Rating G_0	G_1	G_2
L_0 - ontrol	2.13f	2.36f	2.16f
L_1 - 200-200-200	3.22de	4.10b	3.27de
L_2 - 300-200-300	3.93bc	4.34ab	3.45cd
L_3 - 200-200-300	4.21b	4.75a	4.23b
L_4 - 300-200-200	4.09b	4.36ab	4.20b
CV (%)	2.64	12.38	4.42

G_0 - without growth retardant
G_1 - with Paclobutrazol
G^2 - pinched

Undernourishment, as in the case of control plants, can also retard reproductive development.

In addition to nutritional status, other factors such as daylength and temperature may have also influenced bract development. It is necessary that daylength must continue to shorten and the temperature must be in the optimum range. The optimum range for normal flower development to occur is from 16 to 27°C (Larson, 1988).

Paclobutrazol application, on the other hand, enhanced earlier bract development in poinsettia plants compared to the control and the pinched plants. The combined effects of nutrient level and plant growth regulation on bract development was not significant indicating independent effects of these two variables on bract development.

Plants under L_4 and L_2 feeding regimes produced bigger bracts, although those under L_2 had comparable bract size with those under L_1 (Table 4). Plants under L_3 treatment had smaller bracts which was comparable to the control. This was probably because plants under this treatment were able to produce more vegetative parts due to increased nutritional status particularly N level. Smaller plants are also expected to produce bracts proportional to their size.

Similarly, paclobutrazol application reduced bract size and this was also related to the overall reduction of size of the treated plants. However, in case

Fig. 2. Poinsettia plants treated with paclobutrazol (G_1) under different levels of N, P and K (L_0 = control; L_1 = 200-200-200 ppm N, P and K; L_2 = 300-300-300 ppm N, P and K; L_3 = 200-200-300 ppm N, P, and K; and L_4 = 300-200-200 ppm N, P, and K).

of pinched plants, reduced bract diameter may be due to the timing of pinching or some other factors that were not considered in this study.

The interaction effect of nutrient level and plant growth regulation on bract diameter was not significant.

Overall Plant Quality

The overall quality rating of the potted poinsettia plants (5-highest; 1-lowest) which was based on leaf and bract appearance, compactness of the plant and intensity of bract coloration generally improved with the application of fertilizer (Table 4). Among the nutrient levels, L_3 produced plants of the best quality followed by L_4, L_2 and L_1.Moreover, the application of paclobutrazol produced better quality plants compared to the pinched and control plants (Figure 2).

The interaction between nutrient level and plant growth regulation method on crop quality rating was significant (Table 5). It was observed that nutrient level with more K, and paclobutrazol application produced plants that were shorter, sturdier, robust and more compact. These are the desirable characteristics of poinsettia plants. However, plants under L_4, L_2 and L_1 with paclobutrazol also produced plants of good quality except that they were a little bit taller.

CONCLUSION

Results of this study show that the influence of nutrient level on the quality of poinsettia relate to its varying influence on stem growth depending upon the relative concentration of N and K. Where K is higher relative to N, a more compact plant is produced. However, nitrogen could not be omitted in the nutrient solution because it will exert influence on the size of the floral bracts which is another aspect of quality of the poinsettia plant.

On the other hand, application of paclobutrazol proved to be a better plant growth regulation method compared to pinching because it caused shortening of internodes of the plant resulting in a more compact and sturdier appearance.

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