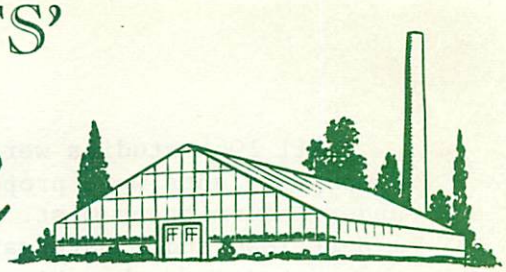
MINNESOTA
STATE FLORISTS'
Bulletin



Agricultural Extension Service
University of Minnesota
Institute of Agriculture
St. Paul, Minn. 55101

Editor, Richard E. Widmer
Department of
Horticultural Science
June 1, 1965

POINSETTIA GROWTH REGULATOR STUDIES[1]

R. E. Widmer, R. L. Hintze[2] and R. H. Mattson[2]

Attractive, well proportioned poinsettias have become a reality in recent years. In 1960, Lindstrom and Tolbert (2) reported that the application of CCC (2-chlorethyl trimethylammonium chloride) to the soil of poinsettia plants resulted in the development of short plants with thick stems. Larson and McIntyre (1) found that B-995 (N-dimethylaminosuccinamic acid) effectively regulated the growth of poinsettias under certain conditions. Widmer (3, 4, 5) reported that both soil applications of CCC, sold under the name Cycocel, and foliar applications of B-995, sold under the name B-Nine, regulated growth and provided compact bract formation of poinsettias under Minnesota growing conditions. He also noted that the degree of effectiveness was related to the method of application, wetting agent used, fertilization practices, and other factors.

Basic objectives of studies conducted in 1964 were as follows:

1. Compare relative effectiveness of foliar and soil applications of CCC.
2. Compare the relative effectiveness of CCC and B-Nine on Barbara Ecke Supreme, Elisabeth Ecke, and Paul Mikkelsen varieties.
3. Determine the influence of temperature on effectiveness of CCC and B-Nine.
4. Determine the effect on bract formation of growth regulators applied in November.

---

[1] Paper No. 5704 Scientific Journal Series Agricultural Experiment Station, University of Minnesota.

[2] R. L. Hintze and R. H. Mattson are graduate assistants in Floriculture.

Materials and Methods

All 1964 studies were conducted in the University greenhouses on the St. Paul Campus. Plants were propagated by placing cuttings in soil in 2½-inch clay pots under intermittent mist. The soil mixture consisted of 2 parts sphagnum peat moss, 1 part loam and 1 part sand, with 10½ pounds of a 14-14-14 coated fertilizer incorporated in each cubic yard of soil.* The panning soil was a mixture of 2 parts loam and 1 part sphagnum peat moss with coated 14-14-14 mixed in before planting. The quantity of 14-14-14 used varied from 7 to 14 pounds per cubic yard of soil, depending on date of panning. All mixtures and pots were sterilized. Plants were grown in full light intensity, in the natural photoperiod and at a minimum temperature of 60°F unless otherwise indicated.

Technical CCC, with Dreft added as a wetting agent, and the commercial preparation B-Nine which included the wetting agent were used. Quantities of growth regulator solution applied as a soil drench were 17, 100, and 250 ml. per 2½-, 4-, and 6-inch pots, respectively. Foliar applications were applied until runoff. Water was kept off the foliage for 24 hours after application to prevent washing off the growth regulator.

All plants were watered freely to encourage rapid growth. The plants were graded into uniform groups per treatment at the start of each study.

Varietal Response

Cuttings of Barbara Ecke Supreme, Elisabeth Ecke, and Paul Mikkelsen varieties were taken on August 12. Treatments to compare soil and foliar applications of CCC were applied on September 11 to established plants in 2½-inch pots, as indicated in Table 1. There were 10 plants per treatment. They were transferred to 6-inch pans on October 14 - three plants each in two pans, and four in the third pan.

Plants of all varieties sprayed with a solution of 6000 ppm CCC exhibited marginal yellowing on some of the leaves on October 1. Plants of Paul Mikkelsen sprayed with a solution of 3000 ppm CCC also exhibited some yellow leaf margins, although to a lesser degree. Data presented in Table 1 show that plant height and bract diameter were restricted by all applications of CCC. Soil and foliar applications provided similar results with the varieties Barbara Ecke Supreme and Paul Mikkelsen, whereas the foliar applications were slightly more effective with Elisabeth Ecke. At least half of the plants of Paul Mikkelsen showed pollen on November 24, of Barbara Ecke Supreme on November 28, and of Elisabeth Ecke on December 3. Chlorosis was no longer evident at this time.

---

* Equivalent to 1/3 oz. 14-14-14 per 6-inch pot or 8 1/3 oz. per bushel of soil.

Table 1. Comparison of soil and foliar applications of CCC to 3 varieties of poinsettias propagated August 12 and treated September 11. There were 10 plants per treatment. Plants were measured on December 14.

	Variety					
	Barbara Ecke Supreme		Elisabeth Ecke		Paul Mikkelsen	
	Height (inches)	Bract Diameter (inches)	Height (inches)	Bract Diameter (inches)	Height (inches)	Bract Diameter (inches)
Untreated Check	16.4	15.6	12.3	12.8	16.3	11.7
CCC, 3000 ppm, soil	12.3	13.5	10.7	11.9	13.7	9.7
CCC, 6000 ppm, soil	12.2	13.0	8.3	10.7	12.3	9.4
CCC, 3000 ppm, foliar	12.1	13.5	9.3	11.5	14.2	9.8
CCC, 6000 ppm, foliar	12.2	12.7	8.1	9.1	12.8	9.7

CCC and B-Nine

Study 1. Cuttings of Barbara Ecke Supreme were taken on August 5. The growth regulators were applied on September 8 and, in some instances, repeated on September 22 as shown in Table 2. All plants were planted three per 6-inch pan on October 14. A night temperature of 70°F was maintained until November 2, and 60°F., thereafter. There were seven pans of three plants each per treatment.

Bract development was delayed and somewhat uneven because of the high night temperature until November 2. Results are presented in Table 2. Plants in all treatments were shorter than the untreated check. Bract diameter of treated plants was usually less than for that of check plants.

Table 2. Comparison of effect of CCC and B-Nine on Barbara Ecke Supreme poinsettias propagated August 5, treated September 8 and 22, panned October 14 and measured at anthesis-December 17 and 21. There were 21 plants per treatment.

Treatment	Height (inches)	Bract Diameter (inches)	Comments
Untreated check	21.0	13.9	
CCC 3000 ppm to soil	16.8	13.8	
CCC 6000 ppm to soil	15.1	13.3	
CCC 3000 ppm foliar once	18.1	13.4	
CCC 3000 ppm foliar twice	17.0	12.6	yellow marginal band on some leaves, Oct. 3
CCC 6000 ppm foliar once	17.8	13.5	
CCC 6000 ppm foliar twice	13.5	12.0	severe yellow and green banding along leaf margins, Oct. 3
B-Nine 5000 ppm foliar once	16.9	14.0	
B-Nine 5000 ppm foliar twice	14.7	12.8	
B-Nine 7500 ppm foliar once	15.0	13.4	
B-Nine 7500 ppm foliar twice	12.5	12.2*	some yellow leaf margins, Oct. 3
B-Nine 10,000 ppm foliar once	14.4	13.3*	
B-Nine 10,000 ppm foliar twice	11.3	11.7*	many yellow leaf margins, Oct. 3

* Some aborted flowers

Applications of CCC to the soil appeared to be slightly more effective in curtailing plant stretch than foliar applications. Plants treated with B-Nine were shorter and slightly smaller in bract diameter than were plants treated with CCC. Plants of similar height resulted from single applications of 3000 and 6000 ppm and a double application of 3000 ppm of CCC. A second application of 6000 resulted in plants that were appreciably shorter. Repeat applications of B-Nine to each concentration significantly reduced plant height and bract diameter. Many of the florets of plants treated with the higher concentrations of B-Nine failed to develop to normal size and frequently abscised prematurely.

Higher rates or repeat treatments of foliar applications of CCC frequently caused chlorotic areas near or at the margins of scattered leaves. In some instances a green line or band running parallel to the leaf margin was evident within the chlorotic area. Higher rates and repeat applications of B-Nine frequently caused chlorotic leaf margins which resembled potash deficiency symptoms. Potash levels in the soil were checked and found to be adequate. The chlorotic areas which developed shortly after treatment were no longer evident at anthesis. The application of either growth regulator resulted in a deeper green foliage color. The degree of deepening of the green foliage color was in proportion to the quantity of growth regulator applied.

Study 2. Cuttings of Barbara Ecke Supreme and Paul Mikkelsen were taken on September 2 and treated as indicated in Table 3. There were three 6-inch pans per treatment, two with three plants each and one with four plants. Panning of Barbara Ecke Supreme was two weeks late because of the pressure of field work.

Results are presented in Table 3. Because of the late application date, differences in plant height were relatively small. Bract diameter was reduced in almost every treatment. The response pattern was more irregular and with Barbara Ecke Supreme plants were shorter than were Paul Mikkelsen, probably because of delayed panning.

Foliar and soil applications of CCC influenced plant height similarly with the two varieties. Bract diameter was reduced to a greater extent by foliar applications. Increases in CCC concentration increased the effect on the plant. There was a trend toward greater plant response to two half-rate applications than to one full-rate application of the growth regulator.

Increases in the concentration of B-Nine applied increased the effect on plants of Barbara Ecke Supreme but not on Paul Mikkelsen. Plant response to two half-rate applications was either similar or greater than to one full-rate application of B-Nine.

Chlorotic margins were evident on scattered leaves of plants sprayed with one application of 3000 ppm CCC, and to a greater extent on plants sprayed twice with 3000 ppm CCC. Very little chlorosis was evident with two applications of 1500 ppm CCC. Two foliar applications of 10,000 ppm B-Nine caused the development of some light colored leaf margins on the variety Paul Mikkelsen. In general Paul Mikkelsen proved more susceptible to leaf yellowing. In all instances the chlorosis was no longer evident at anthesis.

The application of B-Nine delayed the maturity of Paul Mikkelsen by one week and Barbara Ecke Supreme by two weeks.

Table 3. Comparison of effect of CCC and B-Nine on Barbara Ecke Supreme and Paul Mikkelsen poinsettias propagated September 2, treated October 9 and 23, and measured at anthesis - December 9 and 14. Paul Mikkelsen plants were panned on October 19 and Barbara Ecke Supreme plants, November 3. There were 10 plants of each variety per treatment.

Treatment	Barbara Ecke Supreme		Paul Mikkelsen	
	Height (inches)	Bract Diameter (inches)	Height (inches)	Bract Diameter (inches)
Untreated check	7.8	12.0	10.5	10.4
CCC 1500 ppm to soil	8.9	11.1	12.6	11.6
CCC 3000 ppm to soil	9.2	11.3	9.6	10.1
CCC 6000 ppm to soil	8.7	10.5	8.9	8.8
CCC 1500 ppm foliar once	9.5	10.7	10.4	9.5
CCC 1500 ppm foliar twice	9.0	10.1	9.6	8.7
CCC 3000 ppm foliar once	9.1	11.0	10.0	9.2
CCC 3000 ppm foliar twice	7.9	10.2	9.2	8.9
B-Nine 5000 ppm foliar once	8.1	11.4	9.6	10.2
B-Nine 5000 ppm foliar twice	7.9	11.0	9.2	9.4
B-Nine 7500 ppm foliar once	7.6	10.8	9.6	10.2
B-Nine 7500 ppm foliar twice	7.6	10.5	8.5	9.3
B-Nine 7500 ppm foliar once and 5000 ppm repeat application	7.1	9.9	8.9	9.6
B-Nine 10,000 ppm foliar once	6.8	10.5	9.0	9.9
B-Nine 10,000 ppm foliar twice	6.8	10.2	8.6	9.3

Study 3. Cuttings of Barbara Ecke Supreme were taken on September 8 and treated on October 16 and 30, as indicated in Table 4.

Results are presented in Table 4. Foliar applications of CCC were more effective than soil applications at 1500 ppm and similar in effect at 3000 ppm. All treatments of CCC and B-Nine restricted plant height and almost all treatments restricted bract development. Yellow leaf margins were evident on some leaves where 3000 ppm CCC was applied to the foliage. The yellow areas had turned green at the time of anthesis. Lower concentrations of the two growth regulators were quite satisfactory for late October application. Second applications provided no additional benefits. Plants treated with B-Nine flowered approximately one week after plants treated with CCC.

Late Application

Numerous inquiries were received concerning the advisability of applying growth regulators in November to provide a more compact bract cluster. This study was initiated in an attempt to provide an answer to the question.

Cuttings of Barbara Ecke Supreme, Elisabeth Ecke, and Paul Mikkelsen were taken on September 25. They were grown at a minimum night temperature of 70°F until November 2, planted three to a 5-inch pan on November 4 and treated on November 24 and December 1. Treatments are shown in Table 5. Insufficient plants were available to include all treatments for Elisabeth Ecke and Paul Mikkelsen.

The high temperature maintained until November 2 delayed the plants approximately a month. All treated plants were slightly shorter than the check. Bract diameter of treated plants was usually less than that of the check plants. Plants which received one or two applications of 500 ppm or one application of 1000 ppm CCC had attractive bracts in a more compact cluster. Some crinkling of the bracts occurred from one application of 1000 ppm CCC while one application of 1500 ppm and two applications of 1000 or 1500 ppm caused excessive crinkling, unevenness of development, and unattractive bract clusters.

Plants which received one or two applications of 500 ppm or one application of 1000 ppm of B-Nine were attractive. Bract clusters of plants of Elisabeth Ecke and Paul Mikkelsen treated with B-Nine were more compact, whereas bracts of Barbara Ecke Supreme were unaffected. Applications of higher rates of B-Nine delayed maturity and to some extent lowered plant quality.

Table 4. Comparison of effect of CCC and B-Nine on Barbara Ecke Supreme poinsettias propagated September 8, treated October 16 and 30, panned November 4, and measured at anthesis on December 17 and 21. There were 10 plants per treatment.

Treatment	Height (inches)	Bract Diameter (inches)	Comments
Untreated check	9.7	12.4	
CCC 1500 ppm to soil	8.2	12.4	
CCC 3000 ppm to soil	7.4	11.3	
CCC 6000 ppm to soil	7.3	10.6	
CCC 1500 ppm foliar once	6.9	10.2	
CCC 1500 ppm foliar twice	7.6	10.8	
CCC 3000 ppm foliar once	7.5	10.2	yellow leaf margins
CCC 3000 ppm foliar twice	6.9	9.7	yellow leaf margins
B-Nine 5000 ppm foliar once	7.5	10.3	
B-Nine 5000 ppm foliar twice	7.9	10.6	
B-Nine 7500 ppm foliar once	7.2	10.5	
B-Nine 7500 ppm foliar twice	6.5	9.2	
B-Nine 7500 ppm foliar once and 5000 repeat application	7.4	10.4	
B-Nine 10,000 ppm foliar once	7.1	10.2	
B-Nine 10,000 ppm foliar twice	7.0	10.5	

Table 5. Effect of late season foliar applications of growth regulators to poinsettias propagated September 25, panned November 4, and treated on November 24 and December 1. There were 9 plants per treatment for Elisabeth Ecke and Paul Mikkelsen, and 12 for Barbara Ecke Supreme. Measurements were taken on January 18.

Treatment	Barbara Ecke Supreme		Elisabeth Ecke		Paul Mikkelsen	
	Height (inches)	Bract Diameter (inches)	Height (inches)	Bract Diameter (inches)	Height (inches)	Bract Diameter (inches)
Untreated check	7.4	10.9	6.7	12.8	7.2	10.5
CCC 500 ppm once	6.8	10.4	---	---	---	---
CCC 500 ppm twice	6.6	9.9	---	---	---	---
CCC 1000 ppm once	6.6	8.9	---	---	---	---
CCC 1000 ppm twice	6.4	8.3	---	---	---	---
CCC 1500 ppm once	6.4	9.3	---	---	---	---
CCC 1500 ppm twice	6.4	9.8	---	---	---	---
B-Nine 500 ppm once	6.8	11.0	6.2	11.8	6.8	9.5
B-Nine 500 ppm twice	6.5	10.8	6.1	12.0	6.6	10.4
B-Nine 1000 ppm once	6.5	12.7	5.8	12.1	6.4	9.9
B-Nine 1000 ppm twice	6.1	10.1	---	---	---	---
B-Nine 1500 ppm once	6.1	8.0	5.7	12.1	5.9	9.7
B-Nine 1500 ppm twice	6.9	10.7	---	---	---	---

Discussion and Conclusions

Foliar and soil applications of CCC were similar in effect on height and bract development of the three varieties. Foliar applications of CCC frequently resulted in the development of chlorotic areas on the foliage, whereas the same concentration applied to the soil caused no chlorosis. Although the three varieties responded similarly to CCC, Paul Mikkelsen was more susceptible to the development of chlorotic areas following foliar applications. With these factors in mind, suggested rates of foliar applications of CCC are: 3000 ppm through September, 1500 ppm in October, and 500 ppm in November. Repeat applications may be needed, primarily in August and September. Although foliar applications of CCC may cause some temporary chlorosis, there are several advantages to this method of application. They include the following:

1. less chemical is required
2. less labor is required for application
3. effectiveness is not influenced by time of panning, as may be true with soil applications.

Applications of B-Nine to the foliage consistently controlled plant height and influenced the nature of the bract cluster. In several of the studies B-Nine was more effective than CCC in controlling plant height. Second applications of 7500 ppm and higher concentrations of B-Nine resulted in yellowing of leaf margins, sometimes accompanied by slight necrosis. Little of the chlorosis was evident at anthesis. Flowering of plants treated with B-Nine was delayed up to 2 weeks, even at lower rates of application. This delay is not necessarily a drawback since poinsettias normally bloom too early for Christmas. Repeat applications of 7500 ppm and applications of 10,000 ppm B-Nine caused some premature dropping of florets. Based on the aforementioned studies, suggested rates of application of B-Nine are: 7500 ppm through September, 5000 ppm in October, and 500 ppm in November. Repeat applications (preferably 5000 ppm in place of 7500 ppm) may be desired in some instances. These suggestions follow in general the manufacturer's recommendations for poinsettias.

Results with plants propagated August 5 and grown at a minimum night temperature of 70°F until November 2, showed that CCC was less effective than B-Nine in limiting plant stretch. This discrepancy was not evident when a 60°F night temperature was maintained. Apparently the effectiveness of CCC is decreased by increases in temperature. This conclusion is in agreement with observations previously noted by Widmer (5). The effectiveness of B-Nine did not appear to be altered by temperatures within the range of the studies reported in this paper.

Previous reports (1, 4, 5) indicated that B-995 provided inconsistent results when wetting agents such as Dreft and Tween 20 were used. In 1964 the new commercial preparation of B-Nine, which contained a different wetting agent, was used in all trials. Therefore, the improved results might conceivably be attributed to the use of the proper wetting agent.

Summary

1. Poinsettia plants of the varieties Barbara Ecke Supreme, Elisabeth Ecke and Paul Mikkelsen were treated with the growth regulators CCC and B-Nine.

2. The three varieties responded similarly to the growth regulators, although Paul Mikkelsen was slightly more prone to temporary chlorosis from foliar applications.

3. Foliar and soil applications of CCC provided similar results.

4. Increases in temperature decreased the effectiveness of CCC, but did not alter the effectiveness of B-Nine.

5. Applications of B-Nine delayed anthesis by 1 to 2 weeks.

6. Suggested rates for foliar applications of CCC are: 3000* ppm through September, 1500 ppm through October, and 500 ppm in November. November applications should be restricted to a limited number of plants the first year the grower uses the late application.

7. Suggested rates for foliar applications of B-Nine are: 7500** ppm through September, 5000 ppm through October, and 500 ppm in November. Once again, November application should be restricted to a small number of plants the first year.

*Cycocel

3000 ppm = 1 qt. in 10 gal. water
= 1 pt. in 5 gal. water
= 1 cupful (8 fl. oz. in 2.5 gal. water)

**B-Nine

5000 ppm = 0.5 percent solution
= 12 fl. oz. in 1 gal. water

Literature Cited

1. Larson, R. A. and M. McIntyre, August, 1963. Report on 1962 poinsettia height control studies, North Carolina Florists' Bulletin. pp. 1-10.

2. Lindstrom, R. S. and N. E. Tolbert. 1960. (2-chloroethyl)-Trimethyl ammonium chloride and related compounds as plant growth substances IV Effect on chrysanthemums and poinsettias. Quarterly Bulletin Agricultural Experiment Station 42, 4:917-928.

3. Widmer, R. E. April, 1962. Short poinsettias with CCC. Minnesota State Florists' Bul., pp. 1-6.

4. Widmer, R. E. June 1, 1963. Poinsettia height control with chemicals. Minn. State Florists' Bul., pp. 1-9.

5. Widmer, R. E. June 1, 1964. Growth regulators on poinsettias. Minn. State Florists' Bul., pp. 2-12.

****