EFFECT OF CARBON DIOXIDE ON GROWTH OF POINSETTIAS[1]

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Kreusler (5) in 1885 found that plants used carbon dioxide in proportion to the supply present, up to at least 1000 ppm. In 1902, Demoussy (1) reported increased growth of geraniums in the greenhouse following CO_2 enrichment of the atmosphere.

Ordinary air contains approximately 300 ppm carbon dioxide. Plants growing inside a closed greenhouse during the winter months will frequently encounter a deficiency of CO_2 (3). The early commercial use of supplemental CO_2 was hindered by toxic impurities in some sources of CO_2 and by the lack of accurate metering devices. Consequently, greenhouse operators made little use of supplemental CO_2 in the intervening years. Recent work by Goldsberry (2) among others has stimulated a renewal of interest in the injection of supplemental CO_2 into greenhouses. Currently many commercial growers throughout the country are using supplemental CO_2. The effect of CO_2 on poinsettias has not been extensively investigated. Mikkelsen (6) reported that supplemental CO_2 accelerated rooting of poinsettia cuttings by 3 to 5 days and improved plant quality.

Objectives of this study were to determine (a) whether the injection of supplemental CO_2 into the greenhouse atmosphere affected the growth of poinsettias and, (b) whether the effect of the supplemental CO_2 varied with the variety grown, date of propagation, size of cuttings used, level of CO_2, and time (date) of starting the injection of CO_2.

Materials and Methods

Cuttings of the varieties Barbara Ecke Supreme, Elisabeth Ecke and Paul Mikkelsen were rooted in soil in 2½-inch pots on four dates and grown in the conventional manner until planted in 6-inch pans. Then the plants were equally divided among three similar greenhouse sections with CO_2 levels of approximately 300 (check), 1000 and 2000 ppm. Coated, slow release, 14-14-14 fertilizer was mixed in the panning soil. A 60-62° F. night temperature and a normal photoperiod were maintained.

Results

August 16 Propagation. Data presented in Table 1 shows the diameter of the bract clusters of plants of two varieties grown with supplemental CO_2 was 0.7 to 1.8 inches larger than that of check plants. Plants in the three treatments were similar in other respects.

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Table 1. Comparison of poinsettias grown at three CO_2 levels. Plants were propagated August 16 and 24, 1966 and shifted to three plants per 6-inch pan on November 9 at which time the CO_2 treatments were initiated. Measurements were taken on December 19.

Variety	Barbara Ecke Supreme				Elisabeth Ecke				Paul Mikkelsen			
Treatment	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]
August 16 prop.												
Check	15	13.1	11.0	Dec. 12	27	10.4	10.4	Dec. 14	-			
1000 ppm CO_2	15	13.0	12.2	Dec. 24	27	10.9	12.2	Dec. 14	-			
2000 ppm CO_2	15	12.6	11.7	Dec. 14	27	11.1	12.0	Dec. 12	-			
August 24 prop.												
Check	15	10.3	10.6	Dec. 12	-				15	11.9	8.4	Dec. 14
1000 ppm CO_2	15	9.8	10.8	Dec. 9	-				15	12.1	9.6	Dec. 16
2000 ppm CO_2	15	11.0	11.4	Dec. 9	-				15	12.3	10.6	Dec. 12

[1] Measured from pot rim.

[2] Date at least half of plants showed pollen.

August 24 Propagation. As shown in Table 1, diameter of bract cluster was up to 2.2 inches larger when supplemental CO_2 was injected into the greenhouse atmosphere. Differences in other respects were insignificant.

September 8 Propagation. Supplemental light of limited intensity from a neighoring greenhouse delayed maturity of the varieties Barbara Ecke Supreme and Elisabeth Ecke. Plants of Paul Mikkelsen were not delayed although the bract clusters were smaller in diameter. The light "leak" was discovered and blocked out on October 27.

Plant height and diameter of bract cluster increased and time to maturity decreased in proportion to the CO_2 level for plants of Barbara Ecke Supreme and Elisabeth Ecke (Table 2). Plants of Paul Mikkelsen did not respond visibly to different CO_2 levels.

September 15 Propagation. This group consisted of plants propagated from large and small (7) cuttings of three varieties, but only two levels of CO_2 were used.

Plants of all varieties from cuttings of both sizes grew taller and matured earlier when supplied with supplemental CO_2 (Table 3). Plants from large cuttings showed a greater increase in plant size in most instances than did plants from small cuttings. Plants from small cuttings usually showed a greater acceleration in blooming (although they still bloomed later) from injection of supplemental CO_2 than did plants from large cuttings.

Discussion

All varieties used in the study benefited from higher CO_2 levels in the greenhouse when the photoperiod was normal. Plants of the Paul Mikkelsen variety showed the smallest increase in plant size, but these plants were not grown as recommended by the originator. He suggested a night temperature of 65° to 67° F. (6) rather than 60°, prior to Thanksgiving, to obtain optimum bract size. Because the bract size of Paul Mikkelsen is naturally smaller than that of Barbara Ecke Supreme or Elisabeth Ecke, the effect of supplemental CO_2 on this variety at the higher temperature should be determined. Holley and Goldsberry (4) pointed out that raising day temperatures 5° F. "allows the plants to use CO_2 more efficiently and increases the time CO_2 can be added."

CO_2 treatments were initiated November 7, 9, and 10 which is approximately 35 days after the natural start of short days in the Twin City area. Effect of CO_2 on plant height was slight except for plants accidently exposed to a long photoperiod until October 27 (September 8 propagation). Diameter of the bract cluster usually was 1.1 to 2.9 inches greater with supplemental CO_2 and as much as 4.6 inches greater for the plants which were accidentally lighted. Date of maturity was accelerated by supplemental CO_2. Increased height is not usually desired except for late cuttings, and date of bloom may be controlled by photoperiod. Thus, the plants showed the greatest response to supplemental CO_2 in the most advantageous manner, with increased bract size. Older plants (August propagated) which usually bloom earlier were less responsive than younger plants (September propagated).

Plants propagated on September 8 showed the greatest response to supplemental CO_2. Those plants were lighted until October 27, thus they were vegetative until 10 days, rather than 35 days, prior to the start of CO_2 enrichment. Such results indicate it would be preferable to use supplemental CO_2 from the time of,

Table 2. Comparison of poinsettias grown at three CO_2 levels. Plants were propagated September 8, 1966 and shifted to three plants per 6-inch pan on October 29. The CO_2 treatments were initiated on November 7. Plants were lighted accidently in October (prior to October 27). Measurements were taken on December 23.

Variety	Barbara Ecke Supreme				Elisabeth Ecke				Paul Mikkelsen			
Treatment	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]
Check	15	13.4	10.6	Jan. 4	15	9.2	9.6	Jan. 9	15	7.9	8.1	Dec. 14
1000 ppm CO_2	15	16.3	12.6	Jan. 4	15	10.8	10.5	Jan. 4	15	7.5	7.6	Dec. 14
2000 ppm CO_2	15	18.6	15.2	Dec. 30	15	12.8	13.4	Jan. 2	15	7.1	8.3	Dec. 14

[1] Measured from pot rim.

[2] Date at least half of plants showed pollen.

Table 3. Comparison of poinsettias from two sizes of cuttings grown at two CO_2 levels. Plants propagated September 15, 1966 and shifted to three per 6-inch pan on November 10 at which time the CO_2 treatments were initiated. Measurements were taken on December 28.

Variety	Barbara Ecke Supreme				Elisabeth Ecke				Paul Mikkelsen			
Treatment	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]	Number of plants	Average plant height (inch)[1]	Average diameter bract cluster (inch)	Date of anthesis[2]
2½-inch cuttings												
Check	25	4.7	9.3	Dec. 28	12	6.8	10.1	Jan. 4	30	5.9	8.8	Jan. 6
2000 ppm CO_2	25	5.0	11.0	Dec. 26	12	7.0	11.9	Dec. 23	30	6.3	10.2	Dec. 23
5-inch cuttings												
Check	25	7.6	10.4	Dec. 26	16	7.2	9.5	Dec. 26	30	7.9	9.7	Dec. 30
2000 ppm CO_2	25	9.6	13.3	Dec. 21	16	7.6	12.1	Dec. 21	30	8.4	10.8	Dec. 21

[1] Measured from pot rim.

[2] Date at least one half of plants showed pollen.

or soon after, the initiation of short days. Since short days for poinsettias usually begin naturally in early October when the greenhouses are vented freely, early CO_2 injection is not always practical. However, many commercial growers use supplemental light in early October to delay bloom of Ecke varieties. This practice delays the critical time for initiating CO_2 injection thereby decreasing the likelihood the CO_2 will be lost through open vents. Lighting plants of Paul Mikkelsen results in poorer quality bract clusters and is not recommended. Therefore, for Paul Mikkelsen, the effect of lighting to delay the start of short days combined with CO_2 injection needs further investigation.

Based on the results of this study, the utilization of supplemental CO_2 in the greenhouse atmosphere should be especially beneficial for late-propagated plants where small bract clusters and late maturity are frequently a limiting factor.

Greater plant response at the higher CO_2 level appeared to justify the higher cost of CO_2 involved.

Summary

1. Plants of the varieties Barbara Ecke Supreme, Elisabeth Ecke and Paul Mikkelsen were grown at several CO_2 levels.

2. Plant response, which was in direct relation to the CO_2 level, included increases in plant height and diameter of the bract cluster plus earlier maturity.

3. Plants from large cuttings propagated on September 15 showed greater increases in plant height and diameter of the bract cluster when supplied with supplemental CO_2 than did plants from small cuttings.

4. Plants from small cuttings propagated on September 15 usually showed a greater acceleration in blooming from supplemental CO_2 than did plants from large cuttings.

5. When the injection of CO_2 was initiated approximately 35 days after the start of the short photoperiod, increased diameter of the bract cluster was the primary plant response.

6. When the injection of CO_2 was initiated 10 days after the start of the short photoperiod, increased plant height and an appreciable increase in diameter of the bract cluster usually resulted.

7. Injection of CO_2 into the greenhouse atmosphere should be especially beneficial for late propagated poinsettias.

8. Greater plant response at the higher CO_2 level appeared to justify the higher cost of CO_2 involved.

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