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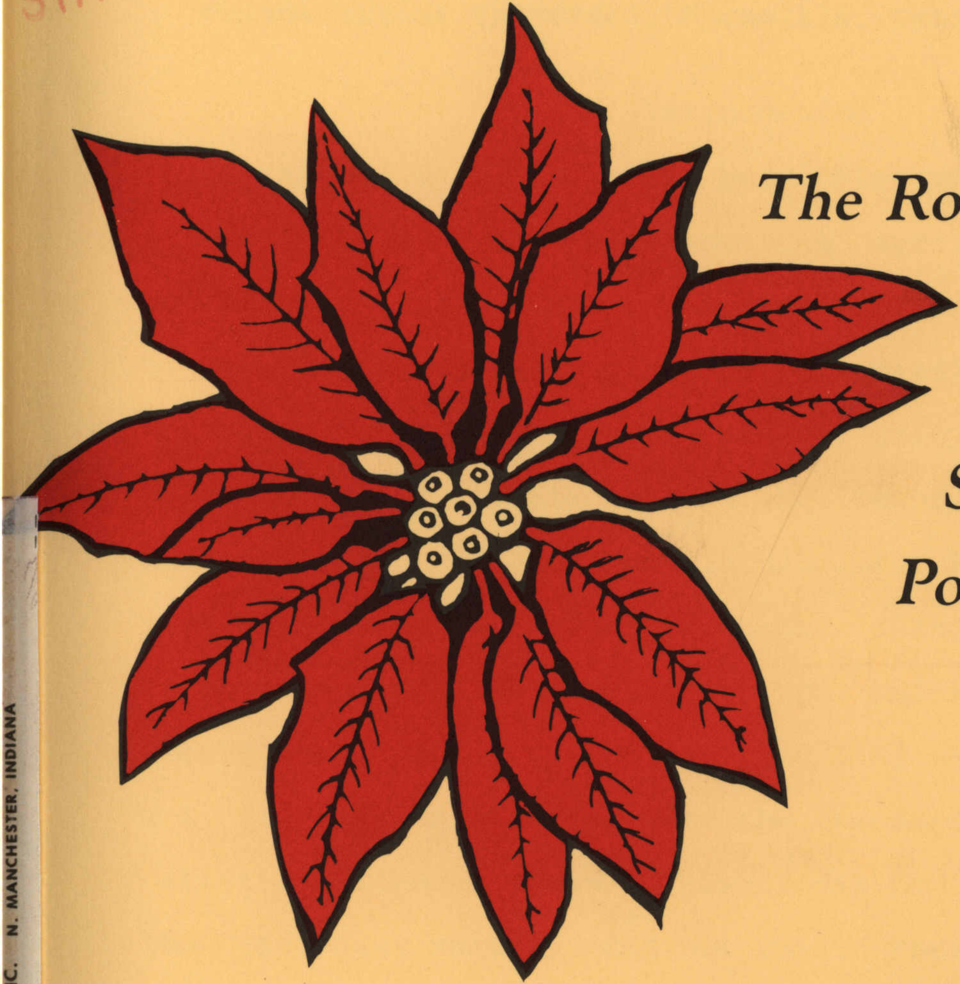

# *The Role of Nitrogen and Calcium on Stem Strength of Poinsettia (1986)*

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and Landscape Design

# THE ROLE OF NITROGEN AND CALCIUM ON STEM STRENGTH OF POINSETTIA (1986)

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## Introduction

Multibranched Cultivars.--The currently popular self-branching poinsettias produce multiflowering specimens from the planned pinching of single plants. These have largely replaced the use of several individual unbranched (standard) cuttings in a single container. The more popular cultivar groups (Hegg, Gutbier, and Mikkelsen) are characterized by being longer lasting and multibranched, and they exhibit excellent leaf retention. These characteristics have led to broad changes in the production techniques and the popularity of poinsettias for Christmas decoration. Prior to the early 1970's, the cultivar Eckespoint C-1 and its derivatives were the standard for the poinsettia market. Although these cultivars did not last much longer than the Christmas season, did not retain their foliage well, and produced few lateral branches following a terminal pinch, they did produce very strong stems and large horizontal bracts.

The introduction to the trade and extensive usage of multibranched poinsettia cultivars have created several production problems for growers. Larson et al. (16) stated that: "Perhaps the handicaps of some of the multibranched cultivars are that lateral shoots break off very easily, molybdenum deficiency is almost a certainty if the the potting medium is too acid (pH 5.0

or less), and drooping of bracts often occurs when the plants are shipped to market." Lateral stem breakage is particularly acute when these cultivars are grown as single- or double-pinched specimens. The branches on these cultivars are weaker at the juncture of the lateral stem with the main trunk, or axil, than are those formed on C-1 type poinsettias (17, 23). These branches often split from the main stem resulting in a misshapen plant with much less marketability (2, 9, 23). Losses occur when the poinsettias are removed from the greenhouse benches, placed in sleeves, transported to market, and handled by consumers.

<u>Nutrition.</u>--While many environmental factors influence plant growth and development, the primary cultural treatment that may be manipulated by the grower is that of nutrition. That the fiber development and ultimate stem strength of the the multi-branched poinsettia cultivars might be enhanced through proper selection of fertilizer regimes is supported by the literature on plant nutrition.

NITROGEN. The role of nitrogen in the utilization of carbohydrates to form amino acids and ultimately the synthesis of proteins is well documented. As nitrogen levels increase in a corresponding decrease in deposited carbohydrates occurs, resulting in a more succulent plant. A decrease in fiber content of cotton has been demonstrated under conditions of excess nitrogen fertilization (28).

The source of the nitrogen may be as important to the quality of the plant as the quantity of nitrogen provided.

Plants can generally absorb both the cationic ammonium ion, $NH_4^+$, and the anionic nitrate, $NO_3^-$. In most well aerated aerated soils, the principal form of available nitrogen is nitrate ions and plant growth is satisfactory with it as the sole source of nitrogen. However, while these plants may also utilize ammonium ions, they are placed under a greater stress if only ammonium ions furnish nitrogen (3, 25). This occurs because absorption of ammonium creates a high demand for carbon skeletons and, if photosynthesis fails to keep pace, a depletion of carbohydrates results. Nitrate nitrogen must be reduced before it is assimilated; therefore, the immediate demand for carbohydrates is less than in the case of ammonium absorption.

The effects of nitrogen formulation on the growth of poinsettias has been studied, but with disagreement among researchers. Boodley (5) found that ammonium nitrogen caused a reduction in water uptake under conditions of water stress, e.g., high light and high temperature. This is less severe under cool, cloudy weather. Shanks (22) recommended that growers fertilize with a 25-10-10 formulation developed at Maryland. This fertilizer formulation contains nitrogen in the following ratios: 2.6% nitrate, 1.8% ammonium, and 20.6% urea.

A report by Ecke (8) showed that poinsettia growth is adversely affected by excesses of either ammonium or urea. He suggested that no more than half of the nitrogen should be from ammonium and that urea should be omitted entirely, if possible. This concept was supported in a study of nitrate:ammonium nitrogen ratios, where it was recommended that ammonium not be used on poinsettias (7). It was found that ammonium injury most often occurs as a result of the interaction of a high ammonium concentration, and urea which is more likely to occur with lower rates of nitrification. In other supporting research, Gaffney et al. (10) recommended that over half the nitrogen should be in the nitrate form when using fertilizers containing both nitrate and ammonium ions. They found that plants provided only ammonium nitrogen produced stunted root systems and brittle stems.

A combination of potassium nitrate and calcium nitrate has been suggested as the best nitrogen source for poinsettias (5, 8). While it does not supply a reserve source of nitrogen, it eliminates the chances for ammonium toxicity. Plants grown solely on potassim nitrate and calcium nitrate in a peat-lite medium were the most uniform in height, produced the best-developed and deeply colored bracts, developed the best root system, and retained foliage better than plants tested with other fertlizers (5). Poinsettias grown with high proportions of calcium nitrate have also been shown to be naturally shorter than those provided ammonium nitrate (8).

The form of nitrogen absorbed by poinsettia roots also affects utilization of other plant nutrients. When plants are provided nitrogen in the form of ammonium, molybdenum requirements are considerably smaller than when nitrate is the source of nitrogen (1). The reason for this is that an important function of molybdenum is in the reduction of nitrate through activation of nitrate reductase (4). This does not occur when nitrogen is provided in the reduced form, e.g., as ammonium ions. Joiner and Harbaugh (13) emphasize the importance of supplying nitrogen and potash in a ratio of about 1:1. In addition, the ratio of nitrate to ammonium should be kept at 65%:35% (nitrate:ammonium) according to these researchers. They recommend that poinsettias be fertilized with a combination of ammonium nitrate and potassium nitrate to provide nitrogen:potash and nitrate:ammonium in the correct ratios.

CALCIUM. Calcium is commonly the major cation of the middle lamella of cell walls, of which calcium pectate is a principal constituent (6, 12). As such, calcium has an important bearing on the mechanical strength of tissues and fiber development of stems (21, 27). Calcium deficiency was shown to be related to disintegration of vascular tissue in celery heart rot (24). This study showed that nitrogen-induced excessive growth of leafy vegetables requires much more calcium than can be absorbed and translocated to growing points. Calcium chloride sprays alleviated this deficiency on younger growth. Calcium is described as having a well-recognized but unidentifiable structural role in maintining membrane integrity (11). Calcium coordinates strongly in production of complex molecular cross-linking, thus giving cellular stability. Struckmeyer (26) has shown in anatomical studies of calcium deficient poinsettias that leaf cells surrounding the vascular bundles had been altered, with obliteration of some phloem cells. This was accompanied by considerable crushing of phloem cells and disorganization of surrounding tissue.

Calcium uptake by plant roots is affected by both the quantity and type of nitrogen provided. The nitrogen stimulation of vegetative growth can induce a calcium requirement that cannot be accommodated by the rate of calcium absorbed by the roots (15,24). In addition, it has been shown that calcium deficiency occurs more often when plants are fertilized predominantly with ammoniacal nitrogen than when provided nitrate nitrogen (14, 19, 20, 29). The rapid ammonium cation absorption causes a competition for uptake of calcium ions (15). Nitrate nitrogen has been shown to give the opposite effect by stimulating cation uptake 19, 20). Since ammoniacal nitrogen has been shown to have a depressing effect on water uptake (5, 28), calcium uptake may be similarly reduced.

## Experimental Design

The purposes of this research were: 1.) to test the effects of a commonly used, high ammoniacal form fertilizer (15N-6.9P-14.1K) against a fertilizer source comprised primarily of nitrate nitrogen (15N-0P-12.4K) on the ultimate branch strength of poinsettia; and 2.) to confirm that branch strength can be enhanced by supplemental calcium as calcium chloride whole plant sprays.

Single rooted cuttings of Annette Hegg Dark Red, Gutbier V-14 (Glory), and Eckespoint C-1 Red were placed into 15-cm pots containing the commercial mix Pro-Mix BX {Premier Peat Co., Inc.} (1 peat:1 perlite:1 vermiculite by volume) and starter nutrients. No other amendments were added to this mix. Initial and final pH readings were taken to determine the effects of the fertility programs on pH. Single-stem plants were placed in a glass greenhouse on 30-cm centers. The plants were grown at 16 degree C nights prior to flower initiation and during bract formation and at 15 degree C for bract coloration.

Plants were irrigated with 200-mg N/liter (20N-8.6P-16.6K) when potted. When next irrigated the plants were leached with clear water. Fertilization treatments with the higher ammoniacal nitrogen or calcium nitrate formulation at 200-mg N/liter were begun as constant liquid feed at the third irrigation, 10 days following potting. Earlier experiments (18) indicated the necessity of beginning the nitrogen fertilization treatments early in the production cycle. Superphosphate (0N-8.6P-0K) was added at the rate of 2.7 kg/cu. meter to plants in the calcium nitrate (15-0-15) treatment group.

Additional calcium was supplied by spraying the foliage of the entire plant with a sprayer until a fine mist covered the foliage. Applications were made using calcium chloride at the rate of 100-mg Ca/liter. Treatments began five days following planting date and continued weekly until the experiment was terminated. This treatment was applied over a longer period than was done in preliminary studies, when calcium sprays were begun following the pinch and terminated at the start of bract coloration (18).

The experiment was a randomized complete block design with four treatments and ten replications. The treatments consisted of the following: 1) 15-16-17 (53% nitrate-N, as potassium nitrate; 47% ammonium and urea); 2) 15-0-15 (87% nitrate-N, primarily as calcium nitrate and potassium nitrate; 13% urea); 3) 15-16-17 plus calcium chloride sprays; and 4) 15-0-15 plus calcium chloride sprays. Mean separations were determined using Duncan's new multiple range tests.

The parameters measured when plants reached anthesis were flower diameter, plant height, total number of branches produced, and number of branches that had sheared from the main stem. Flower diameter was measured at the widest point of the inflorescence and expressed as bract area. Plant height was measured from the bottom of the pot to the top of the plant. Estimates of stem strength were based upon the number of branches that had broken from the main stem. Branches that had broken during production, as evidenced by node scars, and those that broke while data were being collected were included in this count. Plants were not subjected to additional force to stimulate breakage.

## Results

Nitrogen Source.--The effects of calcium nitrate as the primary nitrogen source varied somewhat with the poinsettia cultivar tested. Branch retention was enhanced on calcium nitrate fertilized plants compared to ammoniacal nitrogen fertilization with Eckespoint C-1 Red (Table 1) and Annette Hegg Dark Red (Table 2). Branch retention was not enhanced by calcium nitrate with Gutbier V-14 (Glory) (Table 3), but very few branches were lost by these plants. Bract area was reduced with Annette Hegg Dark Red (Table 2). This was attributed to the increased number of branches retained at anthesis. Reduced flower area was more than offset by enhanced symmetry of the plant and higher quality poinsettia. Height of all three cultivars was suppressed by calcium nitrate fertilization.

Calcium Sprays.--Calcium chloride foliar sprays did not enhance branch retention when supplemented with calcium nitrate liquid fertilization for the cultivars tested (Tables 1, 2, 3). Branch retention was enhanced when calcium chloride applications were made to all cultivars fertilized with 15-16-17. Height was suppressed in poinsettias when calcium sprays were applied to plants receiving the high ammoniacal nitrogen fertilization, but not when applied to plants receiving calcium nitrate fertilizer. Increased branching of Gutbier V-14 (Glory) resulted from the use of calcium chloride sprays with 15-16-17 fertilization. These sprays had no effect on flower area of any cultivar tested. None of the fertilizer treatments caused any differences in medium pH.

## Summary

Nitrogen supplied as calcium nitrate enhances stem strength and bract retention of Annette Hegg Dark Red poinsettias. The results of this research confirm those found by Lawton (18). Height of all cultivars tested was reduced significantly by calcium nitrate fertilization and plants could be maintained without the requirement for growth retarding chemical treatment. When 100 mg calcium/liter sprays were applied to ammonium-fertilized plants, a slight increase in branch retention resulted. However, this treatment does not prove to be justified when compared to calcium nitrate fertilizer treatments and the increased labor costs involved.

Supplying nitrogen as calcium nitrate may alleviate the problems associated with high ammoniacal nitrogen fertilization. The efficiency of calcium uptake is improved by the higher levels of nitrate ions in the soil and lower levels of ammonium ions present to compete with calcium ions for uptake. In addition, water stress is not associated with nitrate-N fertilizer as is ammoniacal nitrogen, so efficient calcium uptake is maintained. Root growth is enhanced in poinsettias fertilized with calcium nitrate, which results in an increased ability of the plant to take up calcium through the roots. Thus, the plants are able to meet calcium requirements as needed during growth, resulting in a stronger, more vigorous plant with enhanced stem strength.

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TABLE 1. Effects of nitrogen and calcium fertilization on mean bract area, height, and number of broken branches of Eckespoint C-1 Red poinsettias.

| Treatment | Bract area ($cm^2$) | Height (cm) | Broken branches (no./plant) |
|---|---|---|---|
| $NH_4$-N (15-16-17) | 138.8a[z] | 61.1 a | 1.4 a |
| $NH_4$-N +$CaCl_2$ | 128.4 ab | 57.9 ab | 0.6 b |
| $CaNO_3$-N (15-0-15) | 130.6 ab | 51.1 b | 0.2 b |
| $CaNO_3$-N + $CaCl_2$ | 120.9 b | 45.7 b | 0.1 b |

[z] Mean separation within columns by Duncan's new multiple range test, 5% level.

TABLE 2. Effects of nitrogen and calcium fertilization on mean bract area, height, and number of broken branches of Annette Hegg Dark Red poinsettias.

| Treatment | Bract area ($cm^2$) | Height (cm) | Broken branches (no./plant) |
|---|---|---|---|
| $NH_4$-N (15-16-17) | 149.5 a[z] | 70.8 a | 5.3 a |
| $NH_4$-N + $CaCl_2$ | 151.7 a | 66.8 b | 3.6 ab |
| $CaNO_3$-N (15-0-15) | 138.8 b | 51.8 c | 1.1 b |
| $CaNO_3$-N + $CaCl_2$ | 129.7 b | 49.7 c | 0.5 b |

[z] Mean separation within columns by Duncan's new multiple range test, 5% level.

TABLE 3. Effects of nitrogen and calcium fertilization on mean bract area, height, and broken branches of Gutbier V-14 poinsettias.

| Treatment | Bract area ($cm^2$) | Height (cm) | Broken branches (no./plant) |
|---|---|---|---|
| $NH_4$-N (15-16-17) | 152.8 a[z] | 57.1 a | 1.1 a |
| $NH_4$-N + $CaCl_2$ | 149.3 a | 52.6 ab | 0.9 ab |
| $CaNO_3$-N (15-0-15) | 148.6 a | 49.5 b | 0.2 b |
| $CaNO_3$ + $CaCl_2$ | 147.1 a | 44.3 c | 0.1 b |

[z] Mean separation within columns by Duncan's new multiple range test, 5% level.