COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Richard Kingman, Executive Director
2785 N. Spear Blvd. , Suite 230, Denver, Colorado 80211

Bulletin 259

December 1971

CALCIUM - BORON NUTRITION OF CARNATION

JOHN PARKER

The application of boron to greenhouse carnations has been a standard practice for many years. Often cases of boron deficiency have been reported on carnations already receiving regular applications of boron. Reports such as these have prompted growers to apply even larger amounts of boron. While carnations are tolerant of moderately high levels of substrate boron, toxicity symptoms have been noted in many cases. The objectives of this calcium/boron study were: 1) to reevaluate B nutrition of carnation in relation to currently recommended Ca levels and 2) to evaluate B nutrition in relation to commonly found calcium and boron levels.

It was hoped that the "tree-like" petal markings and "chewed-calyx" symptoms sometimes attributed to high tissue levels of boron could be duplicated in this experiment. These symptoms often appear on white and light pink flowered cultivars of Sim during August and September. The cultivar Boston, and its sport Gigi, are especially prone to the latter symptom.

METHODS AND MATERIALS

A Ca/B study was started on March 20, 1970. The study involved boron levels of 0, 0.8, 4, and 8 ppm and Ca levels of 3.5 and 8.0 me/1 for a total of 8 treatments. Carnation plants (2 per pot) of the cultivar CSU White were grown in gravel and irrigated automatically at the desired frequency and duration with one of the 8 nutrient solutions. Each treatment contained 8 pots or 16 plants.

Plant material was harvested at normal cutting levels on July 18 and August 1, 1970, and fresh weight yields and stem lengths recorded. Tissue samples were taken on July 18, 1970 and sent to Pennsylvania State University for analysis. The experiment was terminated on October 20, 1970. Total fresh weight yields per pot were recorded.

LITERATURE REVIEW

While the function of B in plant metabolism remains somewhat in question, indications are that B is involved in sugar translocation and fat metabolism. The importance of the function of B to commercial growers is that the more optimum the growing conditions the higher the B requirement. Since one of the main factors involved in optimum growth of carnation is light, more B should be required under high light conditions. Differences in incident solar radiation probably account for the great variation in B tissue level recommendations found in various parts of the country.

Carnations have been shown to be quite tolerant to high levels of B. B toxicity usually shows up as uniform scorching and death of leaf tips. Red treeshaped markings on the petals of Pink Sim were noted by Holley (1959) on plants grown with high B levels. Oertli and Kohl (1961) relate B tolerance of carnation to the type of leaf venation present in carnation. The parallel venation of carnation allows toxic concentrations of B to be transported to leaf tips. These tips will become necrotic but will continue to act as "sinks" for B concentrations. Since very little leaf surface is lost in this manner, yield of carnations is not greatly affected by high B levels. This is in contrast to other plant species such as chrysanthemum, whose leaf venation causes a greater distribution of toxic amounts of B and results in greater loss of leaf surface due to necrosis. Quite often B levels used for carnations may damage other crops.

Messing (1955) describes B deficiency of carnations grown in sand culture as follows: death of terminal bud, excessive development of axillary shoots, shortening of internodes, and splitting of the leaf base with the axillary shoots growing through the split leaf base. Mastalerz, Drake, and Steckel (1956), in investigating B deficiency of carnations in soil, noted that foliar symptoms were not particularly prominent and proposed that discrepancies in symptom expression were probably due to the fact that B levels present in soil were higher than those with which Messing worked in sand culture.

Recommendations for normal tissue levels for B vary somewhat; generally 30 ppm is considered the minimum level necessary for adequate carnation growth.

A relationship exists between Ca and B in plant tissue which is referred to as the Ca/B ratio. The Ca/B phenomenon involves two important factors, i.e. the effect of Ca on B and the effect of B on Ca. Investigators such as Reeve and Shive (1944) noted that there is a decrease in the B content of plant tissue with increasing Ca in the plant substrate. Mastalerz et al. (1956) found that carnations require a Ca/B ratio of 300 to 600 for normal growth and that B may be deficient at a ratio above 1200. Drake et al. (1941) noted that B has an effect on the solubility of Ca in plant tissue. In plants suffering from B deficiency Ca was considerably more insoluble than when B deficiency was not a problem. This fact suggests that physiologically B deficiency may be similar to Ca deficiency. If plants are deficient in B, even though Ca levels seem normal, the Ca may be so insoluble that plants actually suffer from Ca deficiency.

RESULTS AND DISCUSSION

Yield values, tissue values, and Ca/B ratios for the 8 treatments of the Ca/B study are shown in Table 1.

Tissue levels for Ca and B correlated closely with the substrate amounts supplied. The high Ca levels reduced B accumulation only in the extreme treatments receiving 0 and 8 ppm B. Little effect of the higher Ca level was noted at the intermediate B levels of 0.8 and 4 ppm.

Table 1. The effect of Ca/B treatments on the yield and tissue concentration of carnations grown in gravel culture.

Fresh weight yield g/pot	Applied Ca me/l	Ca tissue %	Applied B ppm	B tissue ppm	Ca/B ratio
1020bc*	3.5	1.14	8	340	34/1
954c	8.0	1.48	8	290	51/1
1187a	3.5	1.12	4	202	55/1
1197a	8.0	1.32	4	214	62/1
1167ab	3.5	1.14	0.8	83	137/1
1129ab	8.0	1.40	0.8	81	173/1
948c	3.5	1.14	0	36	317/1
1017bc	8.0	1.69	0	14	1064/1

*Values with the same letter are not significantly different at the 5% level.

Yields were significantly reduced at both the high (8 ppm) and low (0 ppm) levels of B regardless of the Ca level applied. Highest yields were obtained at the 0.8 and 4 ppm B levels at both Ca levels. No difference in yield was evident among these 4 treatments. Tissue values for these 4 treatments ranged from 81 to 214 ppm B. The Ca/B ratios giving the best yield in this study ranged from 55/1 to 173/1. The treatment receiving no B and low Ca contained what would normally be considered adequate B and also had a Ca/B ratio in the range recommended by Mastalerz (1956). Despite this the yield was greatly reduced in this treatment indicating that 30 ppm is not an adequate B tissue level for carnations under summer conditions in Colorado, and also that Ca/B ratios are not sacred and must be adjusted in proportion to the actual B requirement.

While the reduction in yield from both high and low levels of B was of the same magnitude, the treatments receiving no B were retarded in their development. Plants from the two treatments receiving no B came into flower 2-3 weeks later than all other treatments. Timing was not affected by the high B levels.

Typical B toxicity symptoms (leaf scorching) were noted in the treatment receiving 8 ppm B and 3.5 me/l Ca. No symptoms were evident with the same B level and 8.0 me/l Ca. No "tree-like" or "chewed-calyx" symptoms were noted in treatments receiving high B levels. No deficiency symptoms other than plant stunting were evident in the 0 ppm B treatments, although the 14 ppm B tissue levels reported for one of these treatments would clearly be in the deficient range.

CONCLUSIONS

1. Ca levels used did not significantly alter B tissue levels at normal B applications.
2. A rate of 0.8 ppm B (1 oz borax/1000 gallons of water) is adequate for carnations under high light conditions although a rate of 4 ppm B did not cause problems (care should be taken with other crops).
3. A 30 ppm tissue level of B is not adequate for carnations under high light conditions.
4. Visual symptoms should not be used to determine B status since significant reductions in yield may occur without the evidence of obvious symptoms.
5. Tissue levels of over 300 ppm B will cause toxicity symptoms on carnation (tip burn).

REFERENCES

Drake, M., D. H. Sieling, and G. D. Scarseth. 1941. Calcium-boron ratio as an important factor in controlling the boron starvation of plants. Agron. J. 33:454-462.

Holley. W. D. 1959. Trace element nutrition of carnations. Colo. Flw. Gro. Assoc. Bull. No. 105.

Mastalerz, J. W., M. Drake, and J. E. Steckel. 1956. Boron deficient carnations. Florist's Review CXVLLL: 3059.

Messing, J. H. 1955. The visual symptoms of some mineral deficiencies on perpetual flowering carnations. Carnation Craft no. 32.

Oertli, J. J. and H. C. Kohl. 1961. Some considerations about the tolerance of various plant species to excessive supplies of boron. Soil Sci. 92:243-247.

Reeve, E., and J. H. Shive. 1944. Potassium-boron and calcium-boron relationships in plant nutrition. Soil Sci. 57:1-14.