exocarp is insignificant and that weathering has not occurred.

Metabolic studies. Radiochromatographic scans of methanolic extracts of fruits revealed no evidence of any ^{14}C metabolite. All radioactivity in the samples occurred at the Rf of ^{14}C-ethephon. However, an autoradiogram of the ^{14}C active peaks (Fig. 1 and 2) revealed metabolites in fruits harvested 40 days after treatment which were still evident by 95 days after treatment.

The extracts which were streaked on the TLC plates were quite viscous, particularly those at 95 days. As a result, the solvent moved through the origin more slowly than was the case with the ^{14}C-ethephon standard. This affected the ultimate Rf of each sample compared to the standard.

Research has been initiated with the intention of identifying the unknown metabolites noted in this study.

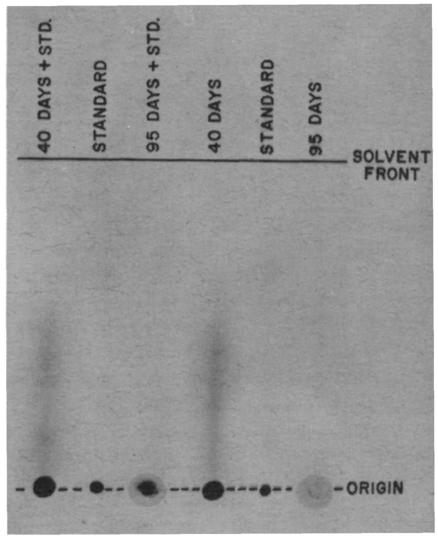

Fig. 1. Autoradiograph of extracts of peach fruits treated with ^{14}C-ethephon. Samples were taken 40 and 95 days after treatment. TLC plates were developed in benzene:acetic acid:water (8:3:5, v/v/v).

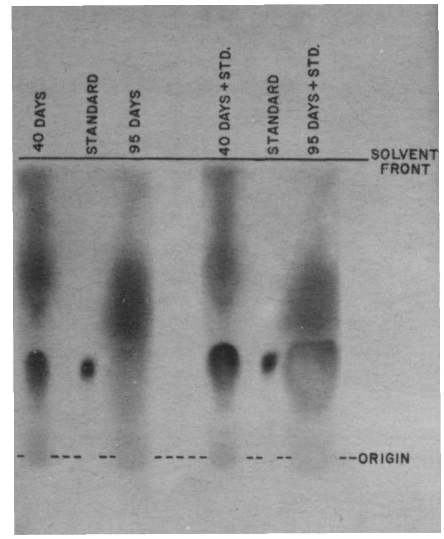

Fig. 2. Autoradiograph of extracts of peach fruits treated with ^{14}C-ethephon. Samples were taken 40 and 95 days after treatment. TLC plates were developed in methanol:isopropanol:ammonium hydroxide:water (9:6:2:3, v/v/v/v).

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Boron Levels in Stems, Leaves, and Flower Parts of Carnation[1]

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Abstract. **The B levels of green tissues of *Dianthus caryophyllus* L. cv. Improved White Sim grown in sand culture increased but those of the important reproductive parts did not vary as solution B concentration increased over a range of adequate levels.**

Symptoms of B deficiency in carnations have been reported by Mastalerz et al. (5), Nelson and Boodley (7) and Oertli (8) but there have been some differences as to which tissues were first affected and their severity. There is limited information on the B levels of tissues other than the leaves recommended for foliar analysis purposes. In this study B levels in the stems, leaves and separated flower parts of plants are noted and symptomatology of B deficiency in carnation is described.

We planted 240 rooted cuttings in July 1969 in 4 replicates, each of 10 plants. Hoagland's No. 1 solution (3), with minor elements was used, but the concn of B, as boric acid, was varied (Table 1). Plant tissues were collected as the flowers reached senescence. Two crops from the same plants were collected and analyzed separately. The stems and leaves were separated from the flower which was divided into petals, stigma-style, ovary contents (placenta and ovules), ovary wall, calyx, and receptacle.

The tissues were analyzed for B by either the quinalizarin (6) or curcumin (1) method depending upon sample size. Since there were no differences (5% level) between the B levels of the parts from the 2 sampling dates, the data were combined (Table 1).

The first indication of deficiency was a shortening of the internodes below the bud 7 months after the plants had been planted (Fig. 1). At this time the tips of the leaves, directly below the bud, turned reddish purple. The stems became stiff and it was difficult to disbud the blooms as the side buds did not snap as readily as in those plants receiving B. The buds ceased to grow, became purplish at the tip, and dried to a straw color. A decrease in the no. of petals (Fig. 2), a prominent stigma-style and epinastic curvature of the bud as previously reported (5) were noted.

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Table 1. B levels of stems, leaves, and separated flower parts of carnations grown in nutrient solutions of varying B concn.

B concn (ppm)	No. of flowers[y]	Boron (ppm)[z] Stem	Leaves	Receptacle	Calyx	Stigma-style	Ovary contents	Ovary wall
0	–	9	9	(11)[x]	–	–	–	–
0.1	58a	16a[w]	48a	28a	20a	37a	48a	26a
0.25	57a	23a	85b	34ab	31ab	40a	52a	25a
0.5	58a	24a	128b	38bc	38bc	34a	49a	25a
1.0	52a	22a	16sc	42cd	41b	42a	51a	27a
2.5	51a	27a	347d	49d	64c	39a	50a	26a

[z]Dry wt basis; 8 replicates per treatment.

[y]Total; commercial quality.

[x]Entire bud. The individual values for zero B were not included in the statistical analysis because of limited samples.

[w]Mean separation in columns by Duncan's multiple range test, 5% level.

Fig. 1. B deficiency symptoms of carnation. Left: zero B. Right: 1.0 ppm B. Note the poorly developed bud, shortened internodes and the "witches broom" condition.

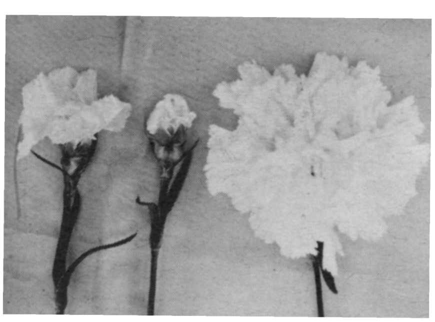

Fig. 2. Left: B deficient flowers. Right: normal flower.

Production of buds in the zero B treatment was sporadic and not enough flowers were produced for separation of the parts.

Foliar symptoms, similar to those reported by Nelson and Boodley (7) and Oertli (8), became apparent 10 months after planting. A pale yellowish color appeared along the midvein and the affected area later became purple and finally necrotic (Fig. 3). In advanced cases of deficiency, a "witches broom" condition developed at the lower nodes and bud development ceased (Fig. 1). When this condition developed during the summer months, the plant frequently succumbed; and the root system was found to be poorly developed. There were no differences in appearance of the plants receiving 0.1 ppm B or more in nutrient solutions.

Generally, the B levels of the chlorophyll bearing tissues, especially the leaves, increased as the B concn in the nutrient solution increased (Table 1), but the stems not at all. When the B concn was limiting (no added B) there was no difference in the levels in the separated parts. Over a range of "adequate" levels, B concn of the floral parts varied but there no significant difference in each part. This is in sharp contrast to the several-fold variation found in some 'Bartlett' flower parts during the prebloom and blooming period (9) associated with variations in the B concn of the growing medium. Eck and Campbell (2) studying the response of carnation to various Ca:B ratios found that the leaves reflected most accurately the amount of B in the soil, then the calyx, and the stem least. The accumulation of B in much larger amounts by the leaves than by other tissues, especially when this element in the growth medium is not limiting plant growth, suggests that leaf concn may be used as a sensitive indicator of the needs of carnation.

Lunt et al. (4) grew carnations in nutrient solutions with 2.0, 4.5, and 10.0 ppm B and found that the treatments had very little effect upon

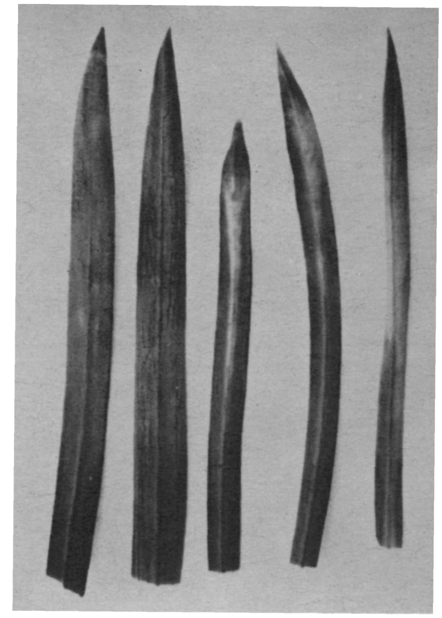

Fig. 3. Foliar symptoms of boron deficiency of carnation.

the quality and production of the blooms. Eck and Campbell (2) found yields uninfluenced by B concn but the quality of the bloom was affected when leaf tips showed toxicity symptoms. In our adequate B treatments these results were confirmed. The flowers were exceptionally large, averaging about 7 cm in diam with no differences among no. of blooms per treatment, bloom size, and stem substance. Nelson and Boodley (7) reported a splitting of the leaf at the nodal attachment as being possibly due to a B deficiency. We observed such a splitting in plants growing at all levels of B.

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