COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Effect of Ethylene on Carnation Growth: Part I

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Can ambient ethylene levels be damaging to carnations? Abeles and Heggestad (2) noted reduced vegetative growth on all their test plants at 25 ppb C_2H_4. The purpose of this research was to determine the extent of carnation growth reduction at acute and chronic C_2H_4 dosages.

Methods

Red Sim carnation plants, grown two plants per 8-in. pot in gravel, were used for all experiments conducted at Colorado State University. Carnations were exposed to 100 ppb, 300 ppb, and 500 ppb C_2H_4 for varying durations at different growth stages; the control plants received ambient ethylene levels (about 25 ppb in Fort Collins). After treatment in the CSU pollution chambers (Bull. 277), the plants were grown under normal greenhouse conditions to harvest (5). Watering was controlled automatically three times a day during low light periods and four times a day during high light periods. Nutrient solution was incorporated into the water supply following recommended rates. A summary of the experiments is shown in Table 1.

Periodically during the experimental period, ethylene concentrations were checked by gas chromatography. At harvest, the plants were cut off at the soil line and the following data collected: 1) height (cm), from top of pot to middle of terminal buds or flowers; 2) leaf length (average of three leaves per plant, fourth leaf pair from the terminal); 3) leaf width; 4) stem length (average of three stems, from origin to middle of bud or flower); 5) number of nodes (average of three stems); 6) internode length (stem length/number of nodes); 7) total number of lateral shoots (average of three stems); 8) fresh weight; 9) dry weight; and 10) date of harvest.

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Results and Discussion

Stem and Internode Length. The continuous C_2H_4 treatment showed the most dramatic reduction in stem length (Fig. 1, Bull. 277). The shorter C_2H_4 exposures produced varying degrees of stem shortening, depending on the stage of plant growth during treatment and the C_2H_4 dosage. A decrease in internode length coincided with stem growth reduction.

Number of Laterals. Only the continuous C_2H_4 treatment caused a significant increase in the total number of laterals per stem. A "shrubbiness" was noticed with the shorter C_2H_4 exposures. The shrubby appearance could have been due to a concentration of laterals within a certain area on the stem.

Leaf Growth. The continuous, periodic, and two-week C_2H_4 exposures produced notable leaf shortening. There was little effect on leaf width.

Plant Weights. Due to severe growth retardation, the continuous C_2H_4 treatment produced a marked reduction in fresh and dry weights. The shorter C_2H_4 exposures had little effect on plant weights.

Table 1. Experiments conducted on Red Sim carnation plants between April 4 and December 29, 1973.

Experiment number	Dates	Exposure period	Plant stages at start of treatment	No. of pots/ stage/chamber
1	4/4/73 to flowering	planting to flowering	just planted	7
2	8/30/73 to 9/13/73	2 weeks	a. rapid elongation[1] b. bud initiation[2] c. just pinched[3]	2 2 2
3	9/25/73 to 10/9/73	2 weeks	a. rapid elongation b. bud initiation c. just pinched	2 2 2
4	10/11/73 to 10/18/73	1 week	a. showing bud color b. just pinched c. just planted	2 2 2
5	11/9/73 to 11/12/73	3 days	a. rapid elongation b. bud initiation	3 3
6	a. 11/13-11/15 b. 11/26-11/28 c. 12/9-12/11 d. 12/19-12/21 e. 12/27-12/29	5 2-day treatments	2 to 4 fully expanded leaf pairs	3

[1]*7-10 fully expanded leaf pairs*
[2]*4-7 fully expanded leaf pairs*
[3]*Single pinch leaving 4-5 leaf pairs.*

Earlier Flowering. Earlier flowering of C_2H_4 treated plants was noted in varying degrees in all experiments.

Plants treated during rapid growth stages (e.g., "rapid elongation" and "bud initiation") were more susceptible to C_2H_4 than plants treated during stages of relatively less rapid growth (e.g., "showing bud color," "pinched," and "planted"). In all treatments, plants treated during the growth stages — 1) planted, 2) pinched, 3) rapid elongation, and 4) bud initiation — showed statistically significant plant damage, i.e., stem shortening; however, concentrations of 300 ppb and 500 ppb C_2H_4 were required for this effect. The periodic ethylene treatment produced observable stem shortening at 100 ppb, although the difference between the control and the 100 ppb treatment was not statistically significant (Fig. 1).

Following work by Barden(3), a dosage term (ppb-days) was used. By combining data, a relationship was found between carnation stem length and C_2H_4 dosage (Fig. 2). Figure 2 shows a more rapid stem reduction at lower C_2H_4 dosages than at higher ones. However, information beyond the data points is hypothetical. The need for a filtered control was established. It appeared that low C_2H_4 dosages had a greater effect on plant growth as compared to higher dosages at which a maximal level for plant damage is reached and is readily seen (Fig. 2). It is suspected that the control plants were damaged by receiving ambient C_2H_4 levels (1,2). If a filtered control had been used, the difference between the control plants and the C_2H_4 treated plants would have been greater.

Continuous exposure to low C_2H_4 levels could result in more serious plant growth reduction than was first considered. With this in mind, how much ethylene is there in Denver air? Work by Hanan(4) revealed C_2H_4 levels from three stations within a 2-sq.-mile area of Denver to range from 5 to 160 ppb. The average C_2H_4 level for his test period was about 45 ppb. A continuous C_2H_4 level of 45 ppb may cause short stems (Fig. 2).

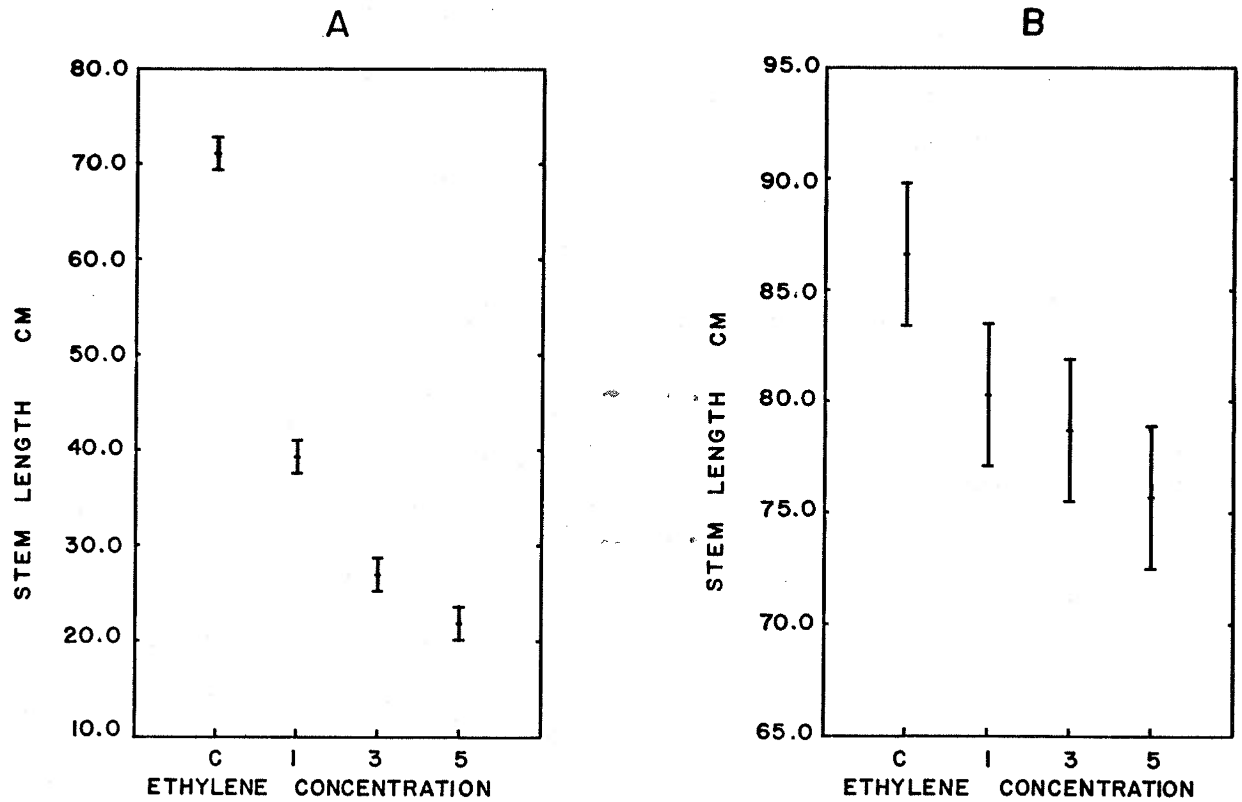

Figure 1. Effect of continuous (plot A) and periodic (plot B) ethylene treatments on carnation stem length.* Continuous treatment from time of planting to flowering; periodic treatment (five 2-day treatments over a 7-week period) with carnations showing two to four fully expanded leaf pairs at the start of treatment.

C = control
1 = 100 ppb ethylene
3 = 200 ppb ethylene
5 = 500 ppb ethylene

*Bars that overlap are not significantly different from one another at the 5% level of confidence.

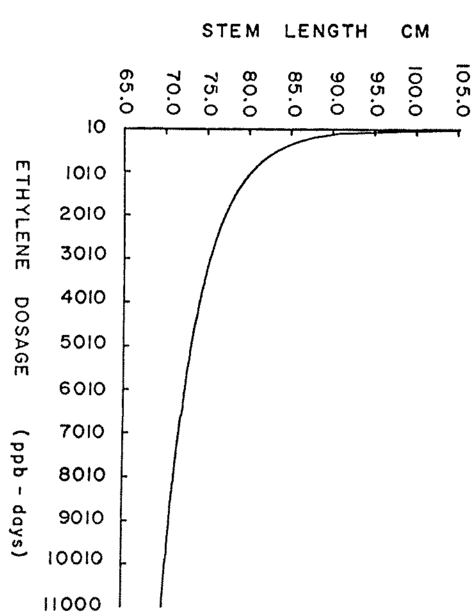

Figure 2. Relationship between carnation stem length and ethylene dosage (ppb-days). An average slope and intercept was computed from the following logarithmic plots: 1) periodic treatment, 2) rapid elongation for 3 days and 2 weeks, 3) bud initiation for 3 days and 2 weeks, and 4) pinched for 1 week and 2 weeks. The average correlation was 0.74 (perfect = 1.0). The individual curves were not significantly different from each other. A dosage of 1010 ppb-days is equivalent to 100 ppb for 10.1 days, or 25 ppb for 40.4 days. The latter appears to be common in Denver. An ethylene dosage was computed for the control on the basis of an average 25 ppb ambient C_2H_4 level in Fort Collins. The lowest dosage was 75 ppb-days; the highest was 7,000 ppb-days. The curve is a linear plot of the equation Log y=a+b (logx).

In conclusion, low ethylene dosages producing chronic plant damage may be a serious threat to greenhouse operations. Chronic damage is difficult to detect visually unless the treated plants can be compared to plants grown in an ethylene-free environment. It appears that most urban areas have ambient C_2H_4 levels high enough to cause plant damage in greenhouses. Presently, there are no practical methods for filtering C_2H_4 on a large scale. The owner of an established range in an urban area can do little to reduce ambient C_2H_4 concentrations. However, C_2H_4 levels in suburban areas should be considered before a grower chooses a site for a new range.

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Your Editor,

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