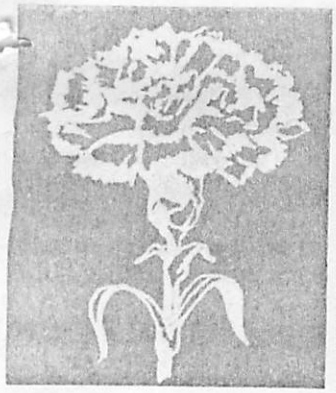

COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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EFFECT OF ETHYLENE ON CARNATION KEEPING LIFE

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Carnations are susceptible to flower damage when exposed to relatively low ethylene levels (2,3). Sources of ethylene that may cause injury include automobile exhaust, fruits, flowers, diseased or injured tissues, burning or decaying organic matter, growth regulators, and improperly vented or adjusted greenhouse heaters (1). Ethylene damage can result from long exposures to low ethylene concentrations or short exposures to high concentrations.

Ethylene injury to cut flowers can occur at any step from the growers' level to the retail sales outlet. Damage may be visible, as with sleepy flowers, or may be hidden, causing substantial loss of vase life. An economic loss for the carnation industry results in either case.

The purpose of this study was to provide information on four factors affecting the sensitivity of Colorado carnations to ethylene injury: 1) ethylene concentration, 2) length of exposures, 3) exposure temperature, and 4) stage of flower development (open flowers vs buds). Keeping studies were used to evaluate ethylene damage.

MATERIALS AND METHODS

White Sim carnations grown at Lake Street were used for all experiments. Uniform open flowers were cut from first-year plants; buds showing ½-inch color were cut from second-year plants. The carnations, graded fancy or standard, were cut to 16 inches before ethylene treatment.

In each of 14 experiments, 120 open flowers or buds were divided and exposed to four different ethylene levels for a given time period at a given temperature. Exposure temperatures were 35, 50, and 70°F. Exposure time varied from 12 hours to 10 days.

Flowers and buds were sealed in plastic chambers and exposed to ethylene-in-air flowing at 200 ml/min. Prior to the addition of ethylene, background C_2H_4 levels were reduced to less than 10 ppb. The effect of ethylene on open flowers and buds was determined in reference to the keeping life of control flowers exposed to background concentrations only.

Keeping trials were run on the carnations after ethylene treatment. After recutting the stems, the carnations were placed in keeping solutions of four percent sugar, 200 ppm HQC, and 50 ppm $AgNO_3$ in distilled water. The keeping room was maintained at a temperature of 70°F, at 35 to 45 percent relative humidity. Flowers were discarded at the first sign of petal burn or wilt. Vase life for open flowers was the number of days from placement in solution to one day before being discarded. For buds, vase life was the number of days from opening (circle of outer petals perpendicular to stem) to one day before being discarded. Keeping life of treated carnations was expressed as a percent of control flower keeping life.

[1] *This paper is a portion of the thesis submitted in partial fulfillment of the requirements for the M.S. degree. Miss Barden was a National Science Foundation Trainee.*

RESULTS AND DISCUSSION

Ethylene concentrations and exposure times were evaluated simultaneously by use of a dosage term, ppb-hours. To derive ppb-hours, parts per billion ethylene as analyzed periodically during an experiment were plotted against hours of exposure. The area under the curve provided a measure of dosage in ppb-hours. Dividing the dosage by hours of exposure yielded average ppb values for levels within experiments. Similar dosage values could result from different combinations of exposure time and ethylene concentration. For example, 2000 ppb-hours could result from 20 hours at 100 ppb, 10 hours at 200 ppb, or 40 hours at 50 ppb. Keeping life was found to correlate closely with dosage at each exposure temperature regardless of the manner in which dosages were derived.

Dosages and corresponding keeping lives from different experiments were combined to give an overall view of the response of carnations to ethylene. After data were pooled, six curves of keeping life vs ethylene dosage were plotted to represent open flowers or buds exposed at 35, 50, or 70°F (Fig. 1,2). Carnation response to ethylene was not linear, meaning that keeping life did not decrease the same amount for each increase in dosage.

Keeping life decreased as ethylene dosage increased. Exposure temperature caused substantial differences in the response of open flowers and buds to ethylene. To reduce open flower keeping life to 0 percent of the control (Fig. 1) required 4,400 ppb-hours at 70°F, 12,000 ppb-hours at 50°F, and 47,000 ppb-hours at 35°F. This represented more than a ten-fold increase in zero-life

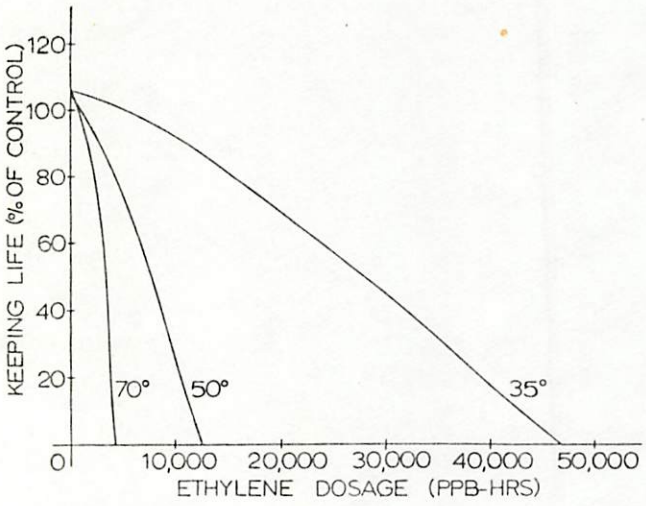

Figure 1. Relationship between open flower keeping life and ethylene dosages applied at 35, 50, and 70°F. The lines are statistically computed regressions with correlations ranging from 0.7 to 0.8.

dosage between 70 and 35°F. A similar temperature-regulated relationship occurred between bud keeping life and ethylene dosage (Fig. 2). Zero vase life dosages for buds were 8,400 ppb-hours at 70°F and 25,000 ppb-hours at 50°F. At 35°F, no keeping life decrease was recorded for buds, even at the highest dosage administered (55,080 ppb-hours).

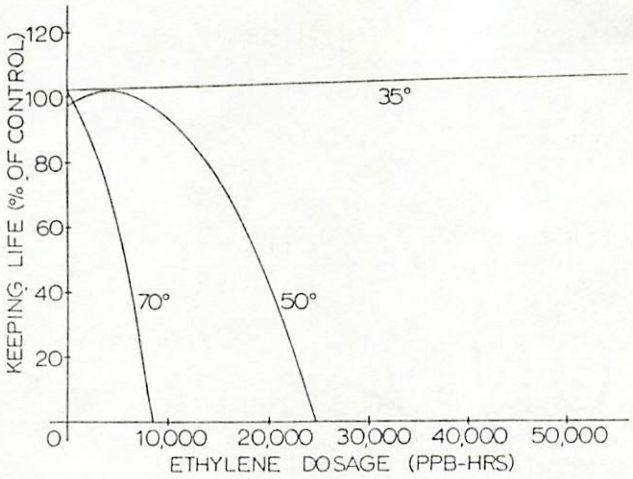

Figure 2. Relationship between bud keeping life and ethylene dosages applied at 35, 50, and 70°F. The lines are statistically computed regressions which, with exception of 35°F treatment, have correlation coefficients ranging from 0.8 to 0.9.

A 20 percent decrease in keeping life was arbitrarily chosen as a significant change from control keeping life, and dosages corresponding to this loss became threshold values. When these threshold dosages were plotted against the temperature of exposure (Figure 3), three observations were made: 1) temperatures needed to damage buds were higher than temperatures needed to damage open flowers at the same dosage; 2) as the dosage increased, exposure temperature required for a 20 percent loss of keeping life decreased; and 3) buds required exposure to higher threshold dosages at all temperatures to cause the same loss of keeping life.

Dosages required to reduce keeping life to 0 percent of the control were higher for buds than for open flowers. At 70 and 50°F, open flower keeping life was reduced to zero at dosages half those needed to cause zero vase life in buds at the same temperatures. Buds exposed to 55,080 ppb-hours at 35°F had an average keeping life equivalent to control buds, while open flowers showed zero vase life after exposure to 47,000 ppb-hours at 35°F.

Damage symptoms were different for open flowers and buds exposed to high ethylene dosages. Flowers having low keeping life became visibly

sleepy during ethylene treatment. Within 24 hours after treatment, entire inflorescences collapsed and turned brown. Only the outer petals were injured on buds severely damaged by ethylene. These petals became sleepy during exposure to ethylene and desiccated after 24 to 48 hours in the keeping room, usually before the bud opened. Since inner petals were unaffected, the flowers appeared uninjured if outer petals were removed. Damaged buds opened normally and at the same rate as the control buds.

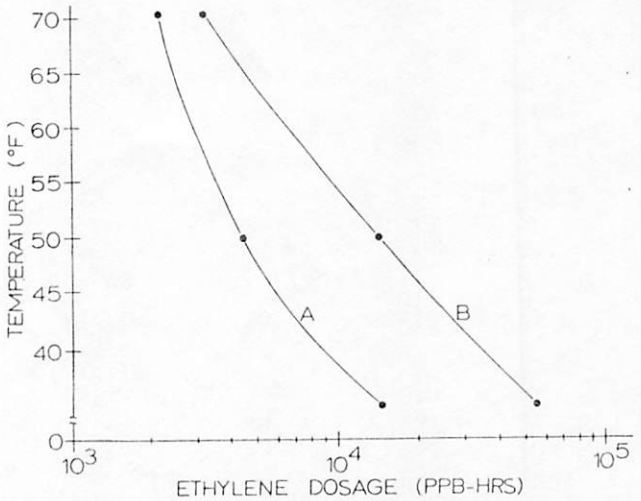

Figure 3. Relationship between temperature and ethylene dosage at which 20 percent loss of carnation keeping life occurred. Line A represents open flowers; line B represents buds.

Bud vase life in general averaged over two days longer than open flower vase life (8.6 vs 6.2 days). This was probably because: 1) bud-cut flowers were still tight on day one of the keeping trial and 2) bud-cut carnations did not lose vase life as a result of being open during the treatment period. Control keeping life varied from 4.6 to 7.9 days for open flowers and from 4.4 to 10.5 days for buds, largely as a result of temperature and length of exposure during ethylene treatment. Open flowers and buds partially damaged by ethylene showed petal burn and wilt earlier than control flowers. Leaves and stems were undamaged in all experiments. When ethylene dosages were corrected for altitude, results in this study corresponded with results in other studies conducted at or near sea level.

CONCLUSIONS

Expressing ethylene concentration and exposure time simultaneously in a dosage term (ppb-hours) facilitated comparison and evaluation of ethylene treatments in the study. Carnation keeping life correlated closely with dosage at each exposure temperature.

Keeping life decreased as dosage increased. Lowering the temperature at which carnations were exposed to ethylene increased damage threshold dosages as well as dosages needed to cause zero vase life. In general, carnation buds withstood higher ethylene concentrations, longer exposures, and higher temperatures better than open flowers under similar conditions.

To minimize ethylene injury to carnations, flowers should be: 1) cut as buds or shortly after opening to avoid prolonged exposure to ambient ethylene in greenhouse air, and 2) refrigerated as soon as possible after being cut and kept cool (preferably below 40°F) until time of retail sale.

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FLORICULTURE GRADUATES FOR JUNE

It has been a rewarding experience to work with and prepare young persons for careers in the floriculture industry. There are now students completing requirements for graduation four times a year.

Bruce C. Metzger, a native of Spokane, Washington, attended high school and the Community College in Spokane before going to Washington State University for most of his undergraduate work. He came to CSU in 1970 and has studied here for two years in satisfying requirements for his Master's degree. Bruce has measured the effects of cyclic lighting on carnation and tested several

Bruce Metzger

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