Investigation of Increasing Cold Resistance of Bedding Plants with Retardants

Leszek Markiewicz*
Department of Floriculture
Cornell University

Studies of cold resistance in cultivated plants have an important place in agricultural research programs and some findings concerning the physiological causes of frost damage in plant material have been presented by Levitt and Vasil'yew (7, 8, 16).

Because of its complex nature, cold resistance can be achieved in many ways, among them the use of certain chemicals. Cold resistance has been induced by treatments of such chemicals as 2, 4, 5 trichlorophenoxy propionic acid and sodium napthalene acetate (2), Dalapon (3), 2, 4, 5 trichlorophenoxy acetic acid (4), thiouracil (5), maleic hydrazide (15), n-decenylsuccinic acid (6), gibberellins (14). Extensive investigations on different properties of growth retardants include those which were concerned with their effect on drought, heat and cold resistance in plants (1).

Some improvement in cold resistance has been obtained by treatment with retarding chemicals. Parker (13) reported that N-dimethylaminomaleamic acid (CO11) increased the hardiness of developing peanut plants by 2°C. Marth (9) found that frost damage to cabbage was markedly reduced by the application of growth retardants. When young plants were sprayed in the fall with B-Nine and Cycocel and then exposed to existing winter outdoor temperatures with a critical range of –1.1°C to –17.7°C, all of them survived. In contrast, 40-60% of the untreated plants were killed by the low temperature. Michniewicz and Kentzer (10) concluded, that Cycocel increased resistance against low temperature in tomato plants. Modlibowska (11) reported that a single spray of Cycocel on 1-year-old pear trees increased frost resistance of blossoms when they were exposed to a temperature of –3.5°C for 15 minutes eleven months after

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**Research Associate in the Department of Floriculture and Ornamental Horticulture 1965-67.*

The author wishes to express his appreciation to Dr. J. G. Seeley, Head of the Department, for giving him the opportunity to conduct this study, and to the staff of the greenhouses for help during the experiments.

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treatment. Flowers treated with Cycocel were damaged in about 50% of the trees while 81% of the untreated flowers were damaged.

Considering the ability of growth retardants to build up resistance against frost damage in some plants, it was decided to investigate their influence on frost resistance in some bedding plants.

The project was treated entirely from a practical point of view. In many parts of the temperate zone, climatic conditions in the Spring are not favorable for gardening. Late spring frosts, sometimes occurring for a few days (usually between May 10–May 30 depending upon the location), make the planting of annual decorative plants in late April or early May impossible even though the weather is favorable in general. These frosts delay gardening and force flower growers to keep plant materials about one month longer in protected places. Since in general, temperature drops only a few degrees below 32°F, it seemed that the use of growth retardants might induce resistance to this amount of cold if any resistance at all could be induced.

EXPERIMENTAL METHODS

Experiments were conducted from Fall 1965 to Spring 1966 in the greenhouses of the Department of Floriculture and Ornamental Horticulture at Cornell University, Ithaca, N. Y.

Experiment #1

Five species of annual bedding plants were used to test effectiveness of growth retardants on cold resistance:

Petunia hybrida, cv. 'Ballerina', *Salvia splendens*, cv.

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'America Bright Scarlet', *Tagetes erecta,* cv. 'Sovereign', *Vinca rosea,* cv. 'Rosea-rose', and *Zinnia elegans,* cv. 'Red Man'.

After some preliminary experiments the following treatments of growth retardants were chosen:

1. B-Nine[1], 1000 ppm, 500 ppm and 250 ppm, applied as a spray.
2. Cycocel[2], 5000 ppm drenched at doses of 1.0g, 0.5g, 0.2 g per 1000 cm^3 of soil.
3. Phosfon[3], 2000 ppm drenched at doses of 0.4g, 0.08g, 0.016g per 1000 cm^3 of soil.
4. Control, distilled water, spray.

The distilled water (control) and B-Nine were applied 3 times, 10 days apart. Cycocel and Phosfon were applied once. Treatments were started a few days after transplanting seedlings to containers.

Experiments were repeated 3 times. Seeds were sown on October 20, 1965, December 14, 1965 and February 10, 1966, in 6 inch pots sealed in polyethylene bags to avoid water loss during germination period. The seeds were germinated at a temperature of 21°C (70°F) under artificial continuous light and then in the 4-leaf stage were transplanted to the containers (Tuffy Tray TTy 5). Ten plants were put in each container with 4 packs in each treatment.

The containers were located randomly on the benches in the greenhouse at 15.5°C (60°F) night and 21°C (70°F) day temperatures. To eliminate the influence of different day lengths, 16 hour photoperiods were used.

The soil mixture consisted of 9 parts soil, 6 parts peat moss, 4 parts Perlite, and 2 parts sand with 2 ounces of superphosphate and 1 ounce of 10-10-10 fertilizer per bushel of soil mixture.

When flower buds were visible, plants were exposed to –5°C (about 23°F) for 2 hours in a chest freezer, after which the freezer was left open until the air temperature rose to 4°C (about 37°F). The freezers were then closed for 1 hour while the temperature dropped to 0°C (32°F). The plants were then placed at room temperature (about 70°F) for 12 hours and then examined and the number of frozen plants in each treatment was established.

Experiment 2

Treatments of B-Nine 1000 ppm, Cycocel 5000 ppm, Phosfon 4000 ppm were sprayed on plants of *Salvia, Petunia, Tagetes, Vinca* and *Zinnia,* which, in the stage of fully open first flower were exposed to frost. Other factors the same as in experiment #1.

Experiment 3

Seedlings of *Vinca rosea* and *Petunia hybrida* at the 4-leaf stage were sprayed with B-Nine 1000 ppm and in the control treatment with distilled water. The treatment was repeated 3 times for 3 days in a row with the last treatment applied one day before plants were exposed to –5°C (23°F) temperature. The experiment was repeated 3 times and for each variant 100 seedlings were used. Other details of procedure were the same as in experiments 1 and 2.

Results and conclusions

The plants treated with B-Nine, Cycocel and Phosfon showed more or less the typical feature of plants sensitive to growth retardants (short and thick stems, dark green leaves) depending upon the chemical and its concentration (Fig. 1, 2, 3, 4.).

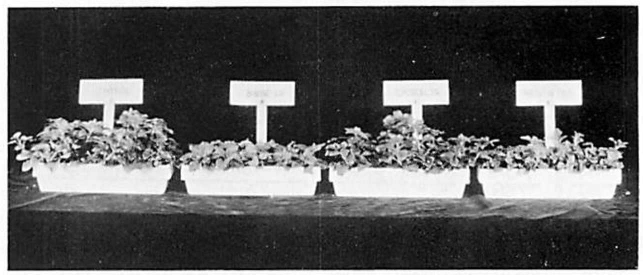

FIGURE 1. *Petunia hybrida,* cv. 'Ballerina'. Retardation effect as result of treatment with growth retardant.

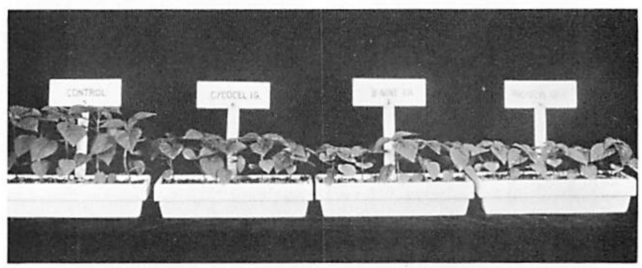

FIGURE 2. *Salvia splendens,* cv. 'America Bright Scarlet'. Retardation effect as a result of treatment with growth retardants.

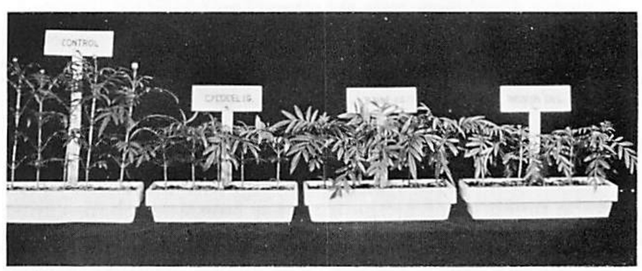

FIGURE 3. *Tagetes erecta,* cv. 'Sovereign'. Retardation effect as a result of treatment with growth retardants.

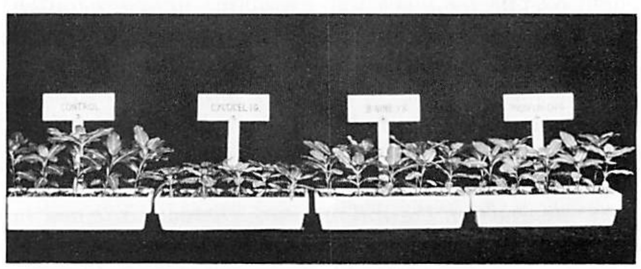

FIGURE 4. *Vinca rosea,* cv. 'Rosea-rose'. Retardation effect as result of treatment with growth retardants.

There was, however, a range of variation (40-70%) in frost damage of exposed plants, both treated with growth

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[1] B-Nine, N-dimethylaminosuccinamic acid 5%. United States Rubber Co., Naugatuck Chemical Division, Naugatuck, Conn.

[2] Cycocel, (2-chloroethyl) trimethylammonium chloride 11.8%. American Cyanamid Co., Agricultural Division, Princeton, N. J.

[3] Phosfon, tributyl-2, 4, dichlorobenzylphosphonium chloride 10%. Chemicals Division, Virginia-Carolina Chemical Corp, Richmond, Virginia.

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retardants and untreated. One must conclude that under conditions described in this study growth retardants *did not increase markedly* their resistance to low temperature. In some cases a higher percentage of survival was obtained with growth retardants (as for instance is demonstrated in Fig. 5) but at the same time another replication showed the opposite situation. Unfortunately, no uniform pattern was noticed in the above three experiments.

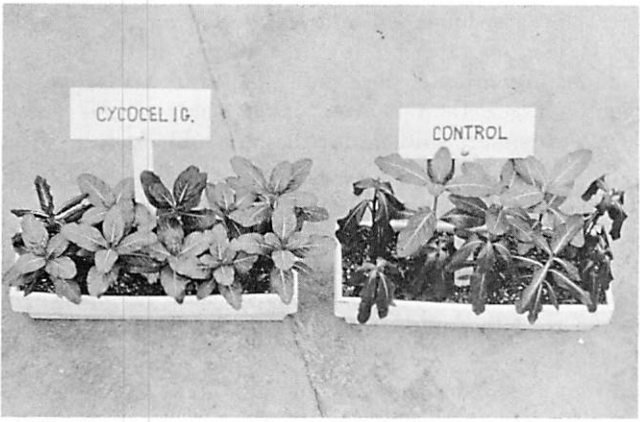

FIGURE 5. *Vinca rosea*, cv. 'Rosea-rose'. After cold treatment. Six plants killed in the control while only 2 injured in Cycocel treatment.

The results suggest that another factor may have masked the influence of the growth retardants on cold resistance. Olien (12), after investigating the freezing process in crown of barley, concluded that several phases of hardiness were based on differences in freezing pattern and that killing temperature was associated with moisture content. This statement leads us to look at the differences in moisture content in containers and in individual plants as a possible explanation of the high range of variation in percentage of killed plants.

Possibly the moisture level was not exactly the same in each container or the distribution of water to individual plants was not equal. If that factor really plays such an important role in the freezing process, one can find an explanation for the failure to improve cold resistance during the experiments in this study.

Since, as stated earlier, the purpose of this study was principally practical, conditions similar to those existing in practical gardening were used so far as the handling of plant material was concerned. One may expect a lack of uniform water distribution under regular garden conditions, or in any type of container. One can also expect different moisture content in plant material, and therefore different response to low temperature.

Obviously, the increase in cold resistance resulting from the use of growth retardants, if any, was small. Perhaps other factors masked any possible improvement of cold hardiness of the plants used in this experiment. Therefore, based on these results under regular garden conditions, the use of growth retardants on *Salvia, Petunia, Tagetes, Vinca* and *Zinnia* is not likely to improve cold hardiness.

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