EFFECTS OF CERTAIN PLANT GROWTH REGULATORS UPON COLD HARDINESS OF LYCHEES

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Growth and development of plants can be artificially controlled or modified in many instances. Practical methods have been developed for chemical control of tuber sprouting, fruit ripening, seed germination and several other physiological processes. One mechanism which is little understood and as yet subject to little control is that through which plants adapt themselves to changes in environmental temperatures. In many species, plant tissue capable of withstanding extreme cold – as much as 50 to 100 degrees F. below freezing – at one stage of development cannot survive freezing temperatures at others. Subtropical, non-deciduous plants, although not subjected to such extremes of temperature in their natural environment, nevertheless develop increased cold resistance in cool weather. The discovery of methods by which such plants could be maintained at a maximum degree of cold resistance during periods when cold weather may be expected would provide another valuable technique for adapting plants to environmental conditions which cannot be controlled.

Methods used today for inducing cold hardiness are wholly empirical. It is common knowledge that "mature" tissue is more resistant than "new growth" to cold damage. For this reason, cultural practices intended to induce dormancy in plants during cold weather are regularly used. These, however, are not always effective. Many species put out new growth flushes frequently, even in mid-winter, despite all efforts to promote dormancy.

The lychee (*Litchi chinensis* Sonn.) is typical in this respect. This species, particularly in the juvenile stage, seldom becomes sufficiently dormant that it does not resume growth when warm weather occurs in winter. This tendency of young trees to continue growth throughout the year, and therefore to remain highly susceptible to cold injury, is often not particularly detrimental in standard nursery practice, since small trees are usually maintained in a well-protected location where heaters may be used when necessary for cold protection. With the initiation of a new program for evaluation of lychee introductions at the U. S. Dept. of Agriculture's Plant Introduction Station, Miami, Florida it became necessary, because of the number of trees involved, to grow small lychees under field conditions in exposed locations. The investigations reported herein were undertaken to determine whether chemically induced growth inhibition of small plants might provide increased tolerance to low temperatures.

Cold hardiness of plant tissue is known to be correlated with a number of changes which usually accompany maturation. Decreased water content, higher osmotic pressure, increased carbohydrates, higher soluble protein content, increased cell permeability and other physical and chemical changes often appear to be associated with the development of cold resistance. The literature in which these findings are reported has been reviewed by Levitt (6,7) and Chandler (1).

Recent reports have indicated that chemical treatments may be used to modify the susceptibility of some plants to cold injury. Corns found that 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) or sodium naphthaleneacetate increased the frost resistance of parsnips (3) and that sodium 2, 2-dichloropropionate (Dalapon) had a similar effect upon sugar beets (4). Swarbrick (8) and Crane (5) reported that growth substances retard abscission and promote development of young fruits which have been subjected to freezing temperatures. Cooper and Peynado (2) observed that grapefruit irrigated with 100 ppm solution of 2, 4, 5-T showed a slight increase in cold hardiness.

Corns observed no adverse effects of 4 or 8 ppm Dalapon upon sugar beets. Cooper and Peynado noted that grapefruit trees irrigated with 100 ppm solutions of 2, 4, 5-T eventually developed toxicity symptoms. Therefore, despite the favorable effect of the treatments upon cold resistance, their adverse effects offset the advantages resulting from their use.

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Procedure

Uniform lots of 8-month old seedlings of Bengal Lychee, P. I. 94066, were treated with spray applications of Dalapon and maleic hydrazide (MH), and subsequently subjected to several hours of below-freezing temperatures. Preliminary trials with tomato and lychee plants were carried out to determine tolerance to these materials. As a result of these tests, concentrations of 10 and 100 ppm Dalapon and of 500 and 1000 ppm MH were selected for spray treatments.

Sprays were applied to run-off with a compressed-air spraygun on January 26. At that time, the plants had leaves from a November growth flush which, although fully expanded, still retained the light color and translucent appearance of young leaves.

After 20 days, the treated plants were subjected to one night of artificially induced freezing temperatures. For the cold treatment the plants were divided into 6 replicates, each consisting of one untreated control plant, two plants receiving different levels of Dalapon, and two receiving different levels of MH. Five replicates were used in the cold tests. The plants which constituted the sixth replicate were not subjected to low temperatures, but were set aside for observing the effects of the spray treatments alone. Twenty days after the spray treatments were applied, when the plants were subjected to cold treatments, no symptoms of injury from the spray materials had developed. However, continued observation of plants used in preliminary trials had suggested that the 100 ppm Dalapon and 1000 ppm MH sprays caused more leaf injury than earlier observations had indicated.

For cold treatments the plants were transferred at 7:00 P. M. to a refrigerated room at a temperature of 45°F. and held at this temperature for 2 hours, after which the room temperature was gradually lowered over the course of about 3 hours to 28°F. The plants remained at this temperature for approximately 6 hours, after which the room temperature was gradually raised over a period of about 1 hour to 45°F. When the temperature of the room reached this point, the plants were transferred back to partial shade in the lathhouse. Since only one replicate could be placed in the cold room at a time, 5 days were required for treatment of all replicates. While the plants were in the cold room, the pots were enclosed in an electrically heated box, in which the root temperature was maintained at approximately 50°F.

Thirty days after the cold treatments were applied, the plants were examined for evidence of cold injury, and the percent dead leaf area was determined. In counting individual leaves, a leaf was considered living only if more than 50 percent of its area was uninjured. The treated plants were also examined for evidence of damage to cambial and meristematic tissue, and the recovery and subsequent growth of all plants were recorded.

Results and Discussion

Effects of spray treatments upon cold resistance. The results of this experiment indicate that the susceptibility of lychee leaves to cold damage was decreased by the spray treatments. The leaf kill resulting from 6 hours of below-freezing temperatures ranged from about one-fifth of the total when 10 ppm Dalapon sprays were applied, to four-fifths when no spray or 100 ppm Dalapon sprays were applied, (Table 1).

Table 1. Influence of Dalapon and maleic hydrazide upon cold resistance of lychee leaves.

Spray material and concentration	Dead leaf area (percent of total)[1]
Dalapon 10 ppm	22
Maleic hydrazide 500 ppm	44
Maleic hydrazide 1000 ppm	62
Control	78
Dalapon 100 ppm	80

[1] Each valve is a mean for 5 plants.
Means bracketed together significantly different at the 5 percent level.

Significantly different means, as determined by the Duncan multiple range test, are also indicated in Table 1. It will be noted that both the 10 ppm Dalapon and the 500 ppm MH sprays caused a statistically significant reduction in the leaf area killed by the cold treatments. The differences between 100 ppm Dalapon or 1000 ppm MH sprays and control were not statistically significant. Thirty days after spray treatments were applied it was found that plants receiving 100 ppm Dalapon or 1000 ppm MH sprays showed severe injury, whether or not cold treatments were used. When plants were not subjected to freezing temperatures, no symptoms of leaf injury appeared on those receiving the lower level spray treatments. These results indicate that the injury to plants receiving the higher level spray treatments, as reported in Table 1, cannot be considered to be the effects of cold alone. Further trials will be required to determine the maximum levels of spray treatments which may be safely used and the levels which induce maximum cold resistance.

Effects of treatments upon subsequent growth. In all cases where spray treatments were applied, the resumption of normal growth was delayed. The plants receiving the high-level treatments did not resume growth for 3 months, and all new shoots originated from the axils of leaves other than those produced by the last growth flush. In most cases several shoots developed from two or more axils, and the resulting growth was poor for several weeks until one shoot gained dominance and developed into a new central stem. Plants receiving lower level spray treatments did not resume growth as quickly as control plants not subjected to cold treatments, but all resumed growth within 10 weeks. Two of the cold-treated plants sprayed with 10 ppm Dalapon showed no evidence of any damage, either to leaves or terminal meristems, and these resumed normal growth in late April. Unsprayed plants subjected to cold treatments developed new shoots in April from axils of the older leaves. Such shoots grew more rapidly on these plants than on those which had received the higher level spray treatments, suggesting that no treatment at all was superior to treatment with relatively high levels of these materials.

Summary and Conclusions

Ten ppm Dalapon and 500 ppm maleic hydrazide sprays increased the cold resistance of leaves of small lychee trees. These treatments retarded growth, but apparently caused no permanent damage. Sprays of 100 ppm Dalapon and 1000 ppm maleic hydrazide were toxic and appeared to cause more injury to the plants than the cold treatments used in this experiment. Further trials will be necessary before the value of these materials for increasing cold resistance can be adequately determined.

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INVESTIGATIONS ON GROWTH SUBSTANCES IN PEACH BUDS

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In plants, periods of growth by elongation alternate with periods in which little growth takes place. The phase of outward inactivity in the growth cycle has been termed "dormancy". A number of plants, particularly those adapted to growing in a temperate climate, will not resume active growth in the spring unless they have been exposed to a sufficient amount of cold during the winter. Many Floridians have observed this phenomena in trying to get temperate-climate plants to thrive under local climatic conditions. For example, certain varieties of apple, apricot, blackberry, blueberry, peach, plum, etc., will not grow and fruit well in this state. The major barrier to growing many of these plants in parts of Florida is that winters are frequently too mild to provide sufficient chilling to terminate bud dormancy.

For many years, empirical research has sought for chemicals and types of treatment to break or induce dormancy. A good many treatments have been found which can alter dormancy, but only in the last few years has there begun to evolve the semblance of a physiological understanding of dormancy and how it can intelligently be controlled.

Most present concepts of the physiological mechanisms controlling dormancy embrace the idea that the rest of buds is intimately associated with either a super or suboptimal