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FIRST YEAR EFFECTS OF A GA SYNTHESIS INHIBITOR ON GROWTH, PHOTOSYNTHESIS, ETHYLENE, FREEZING TOLERANCE, AND SOME FRUIT CHARACTERISTICS IN APPLE TREES

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ABSTRACT

The main effect of some plant growth retardants such as uniconazole and paclobutrazol, is to inhibit gibberellin (GA) biosynthesis. However other effects such as inhibition of sterol (Fletcher and Hofstra 1988) and abscisic acid (ABA) (Wang et al. 1987) biosynthesis have been attributed to these compounds. Since terpenoid pathway is affected it is likely that cytokinin biosynthesis may also be altered (Grossmann 1990). Izumi et al. (1988) found an increase in ethylene production in rice plants. Uniconazole is a triazole (azo group: $CH_3N=NCH_3$) structurally similar to paclobutrazol (Davis et al. 1989). It suppresses shoot length at much lower rates than paclobutrazol and other growth retardants (Steffens 1988).

Uniconazole is a promising chemical for fruit growers because it acts at low rates, with very low mobility within the plant (Sterrett 1988). It has some fungitoxic activity (Fletcher et al. 1986) apparently not altering fruit quality (Tukey 1989). It has also been suggested that uniconazole can protect plants against some environmental stresses (Fletcher 1989). With growth suppression, apple growers can possibly gain by lowering pruning costs. Furthermore reduced growth allows better light penetration and air movement within the trees, promotes red color development in fruit and enhanced net photosynthesis.

In this study we evaluated the influence of uniconazole on tree growth, physiology and some fruit characteristics in the same year when application was made. Freeze-thaw stress tolerance of dormant tissue was measured in the winter following application. Foliar application of uniconazole (XE-1019) was made to five-year-old 'Roger McIntosh' /M 111 apple rootstocks in a complete randomized design replicated four times. The concentrations used were 0, 65, and 130 mg l^{-1}. The first application was made at petal fall, with others at three week intervals. Additionally, some trees received 50 mg l^{-1} GA_{4+7} four weeks after the uniconazole treatments.

Shoot growth was evaluated in five shoots per tree. No significant differences were found among various treatments. Lehman et al. (1990) reported similar results with paclobutrazol applied to apple trees. Some studies with triazoles have shown effects on shoot growth occur in the second year after treatment. Disagreements in results are mainly caused by differences in the time of application, the rootstock used, and methods of application (foliar, drench, stem injection, or stem painting).

Net photosynthesis, stomatal conductance, and initial transpiration were measured in the field using a LI-COR LI-6000 Portable Photosynthesis System. The measurements were made in

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the middle of the day, seven weeks after a single application. For treatments receiving three applications of uniconazole, measurements were made one week after final application. Two attached leaves, present when uniconazole was applied, were selected for the measurements. Leaves received more than 1000 μ mol m^{-2} s^{-1} of sun radiation (400-700 nm) when measured. No significant differences occurred among treatments for these three physiological parameters. Fowler et al. (1989) showed that the uniconazole treatment to apple trees did not affect net photosynthesis of leaves present at the time of application. Wieland and Wample (1985) also reported no effect on photosynthesis and transpiration rate when paclobutrazol was applied to apple trees. These responses are difficult to compare among studies because other studies often measure these variables on detached leaves. Differences in the light intensity that leaves receive, and the age of the leaves also are variables.

Triazoles may protect plants against some environmental stresses. This protection has been reported to be via enhanced levels or enhanced activity of several antioxidants (Upadhyaya et al. 1989). We evaluated the freezing tolerance of the first internode of new growth by using slow freezing and thawing rates (Steffen et al. 1989). Electrolyte leakage was measured following freezing to various temperatures down to -75 °C. No differences were found among 0, 65,130 mg l^{-1} uniconazole, and GA_{4+7} treatment. Reports on the influence of triazoles on cold hardiness are conflicting. Studies of cold tolerance with woody species have shown that paclobutrazol can either increase cold hardiness (Webster et al. 1986); reduce cold hardiness (Proebsting and Mills 1985); or have no influence on cold hardiness (Ahmedullah et al. 1986). More studies are needed to clarify the influence of triazoles on long term cold tolerance.

Ethylene production inside the fruit was evaluated five times during fruit development. Air from the fruit cavity was extracted with a needle and the amount of ethylene determined using a Shimadzu (GC-9AM) gas chromatograph. No significant differences were found among the treatments. Same results were obtained by Elfving et al. (1989) with apple fruits. Izumi et al. (1988) found an increase in ethylene evolution in rice seedlings with uniconazole. In our study the fruits which received uniconazole during the first phase of their growth did not show any increase in ethylene production at harvest. Because of the great exchange of assimilates between fruit and leaves during fruit development, it is possible uniconazole could moved from the fruit to the closest leaf soon after application.

Fruit weight and fruit production per tree increased with GA treatment whereas uniconazole had no effect on fruit weight. A study with kiwifruit showed a reduction in fruit weight with GA treatment and no influence on fruit weight with paclobutrazol (Burge et al. 1990). The other fruit characteristics, pedicel length, flesh firmness (McCormick fruit tester FT327), and fruit shape (length/diameter) did not differ among treatments in our study. Burge et al. also did not find differences in pedicel length and fruit shape in kiwifruit after paclobutrazol treatment. However, Greene (1989) reported a reduced flesh firmness of apple with GA treatment. Sensitivity to external stimuli varies among different stages of fruit growth and development. Seed development is the key stage for fruit growth regulation. Consequently, large differences could be expected in fruit characteristics if an inhibitor of GA is applied during seed formation. Conflicting responses reported in the literature in regard to fruit quality are likely because the time of application of the growth regulator.

This work is continuing in an attempt to understand how the reduced mobility and persistency of the triazoles alter long term physiology of apple trees. By evaluating these trees for two or three years we hope to resolve some of the conflicting reports on the influence of these compounds on freezing stress resistance in apple trees.

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