

The Use of Plant Growth Regulators for Branching of Nursery Trees in NY State

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The quality of nursery trees has a large impact on early production and profitability of high density systems. Today, nurserymen are not only asked to produce trees of good cali-

“A new plant growth regulator, cyclanilide (Tradename=Tiberon) very effectively induced lateral branching in nursery trees of 4 apple cultivars in the warm and humid year of 2010 in NY State. However, it also stopped shoot growth for several weeks and reduced final tree height to an unacceptable level compared to untreated trees or trees treated with Maxcel. Further work in NY State on lower rates and other timings with and without Streptomycin sprays are needed to fine tune the use of this potent branching chemical.”

per but also highly branched trees for the Tall Spindle system with short, well positioned lateral branches with wide crotch angles. This has required nurseries to improve their management to induce lateral branching.

Lateral branching or “feathering” of nursery trees is controlled by apical dominance within the stem of the tree wherein the terminal bud

of a nursery apple tree exerts control over the development of the lateral buds. The young leaves in the apical bud produces a hormone called auxin that diffuses downward and inhibits the development of lateral buds. Therefore, in order to produce a well-branched, highly marketable tree, apical dominance must be interrupted. Traditionally nurserymen have accomplished this through the removal of small undeveloped leaves, called “leaf pinching” or “plucking”, resulting in a transient reduction of auxin content in the stem content in then stem allowing lateral buds to develop into lateral shoots. With some cultivars, years, and climates a ‘markeatable’ feathered nursery apple tree can be produced with this technique. Unfortunately, it is inconsistent in the NY climate and most of the nursery apple cultivars require more than one “leaf pinching” to maintain low auxin content due to rapid stem elongation. This labor-intensive practice (a well-skilled nursery worker can “leaf pinch” a maximum of five to six thousand trees per day) substantially increases the costs in an apple nursery and must be conducted in a short period of time.

The use of plant growth regulator chemicals has been seen as a more consistent and less expensive method to induce lateral branching than manual “leaf pinching”. Currently, there are three PGRs that can potentially be used in nursery apple production. Promalin (mixture of a cytokinin and 2 gibberellins) and Maxcel (a cytokinin) have been sporadically used in nursery apple production in the US usually as a single spray. In the last 4 years we have done 2 new studies with multiple applications (3) of Maxcel to improve branching in NY nurseries. Our results show that 3 applications of 500 ppm have given very good branching with most cultivars. However this use has not yet been added to the Maxcel label. Interestingly,

the use of Maxcel has been adopted by Italian nurserymen and is a key step for the successful production of well feathered “knip-boom” apple trees. Depending on cultivar, Italian nurserymen apply from 1 to 4 Maxcel treatments with spray intervals of 5-7 days depending on temperatures after application (Dr. Walter Guerra, Italy, personal communication). Since 2009, a new branching agent, cyclanilide (Tiberon formulated by Bayer Environmental Science, N.C. USA), has been available in the US for use in outdoor nurseries of apple, sweet cherry, pear, and plum in Florida, Idaho, Oregon, Michigan, and Washington States. It is not currently registered for tree fruit nursery use in New York State, Europe, or elsewhere.

Studies of the effects of Tiberon for branch induction of nursery apple trees (and other fruit species) were conducted by Dr. Don Elfving, Washington State University (Elfving and Visser, 2005, 2006). Their studies were conducted with ‘Cameo’ and ‘Gala’ on M.26 and M.7 rootstocks; ‘TAC114 Fuji’ on M.26 rootstock; ‘ScarletSpur Delicious’ on B.118 rootstock; and ‘ScarletSpur Delicious’ on M.7 rootstock. Current label use recommends one to two applications of 50 to 100 ppm for apples and sweet cherries. For pears and plums lower rates of five to 20ppm are recommended. Since Tiberon was registered in the Spring of 2009, commercial nursery applications in the Northwest have been widespread and have mainly been single applications of 50 or 100 ppm.

Because most of the Tiberon research was conducted under Washington State environmental conditions, we decided to evaluate both Tiberon and Maxcel to compare their efficacy and safety for chemical branching of apple trees under New York State’s nursery conditions.

Materials and Methods

An experiment was conducted in 2010 to determine the effect of Tiberon and Maxcel on branching of apple nursery trees of four apple cultivars in a nursery located in Wolcott, NY. All trials used a randomized complete-block designs with 3 replications distributed down a row of the appropriate scion/rootstock combination. Each experimental unit was a section of row consisting of 10 trees. Proprietary formulations of cyclanilide (Tiberon) and benzyl adenine (Maxcel) were used in the trials. All plant growth regulator treatments were supplemented with one pint of Regulaid/100 gallons and applied with a manually operated Solo backpack sprayer with one nozzle. The upper 8-10 inch terminal section of each nursery tree was sprayed in one pass. Nursery trees were not irrigated and were treated for fire blight control with streptomycin before and after our PGR treatments were applied. The nursery was tilled as needed for weed control and pre-emergent herbicides were not used.

Two Tiberon treatments (50ppm and 100ppm), two Maxcel treatments (250ppm and 500ppm), and the tank-mix treatment of Tiberon (50ppm) and Maxcel (250ppm) were applied twice or three times 2 weeks apart to standard fall budded nursery trees of ‘Royal Empire’/B.9, ‘Sun Fuji’/B.9, ‘Linda Mac’/B.9, and ‘Macoun’/B.9 in the second year of the nursery cycle when the budded scion was growing. On the first application date (June 18 or 21, 2010), the

central leader shoot tips for 'Royal Empire', 'Sun Fuji', 'Linda Mac', and 'Macoun' trees were at 29, 31, 31, and 29 inches above the soil surface, respectively. Control trees were unsprayed.

Tree height was measured 4 additional times throughout the season for 'Royal Empire' and 'Sun Fuji' trees, and four times for 'Linda Mac' and 'Macoun' trees. Caliper was measured 5 inches above the bud unions for all cultivars on August 30th.

In November 2010, all trees from each plot were measured in the nursery for: (1) trunk diameter measured five inches above bud union, (2) length of central leader above ground level to tip, (3) total number of feathery (any lateral shoot longer than four inches), (4) distance from the ground level to each of the induced feathery, (5) length of each feather, and (6) crotch angle of each feather.

Results

Tree Height. For all varieties shoot growth measurements showed that Tiberon treatments rapidly stopped central leader growth and reduced terminal shoot elongation rate and final length of the central leader shoot on October 13 (Figure 1). Terminal shoot tips treated twice with both rates of Tiberon continued to elongate slowly during the late summer and early fall, but did not achieve a similar height to the untreated control trees. There was no effect of rate of Tiberon with 'Empire', 'Fuji' or 'Macoun' but with 'McIntosh' the lower rate had less effect of shoot growth than the high rate. The difficult-to-feather cultivar 'Macoun' trees were the most affected by the Tiberon treatments, with a central leader length reduction ranging from 12 to approximately 16 inches when compared to the control trees. Both rates of Tiberon produced undesirable effects of tree structure and final tree height on 'Macoun' trees.

Maxcel had no effect on shoot growth rate of final tree height of 'Empire', 'McIntosh' or 'Macoun' but with 'Fuji' Maxcel caused an inhibition of shoot growth that was rate dependant. Tiberon treated trees were smaller at the end of the season than trees treated with Maxcel (Figure 2). 'Sun Fuji' final tree height was affected by Tiberon treatments slightly more than 'Royal Empire' when compared to the unsprayed trees. When the lower rate of Tiberon, and the lower rate of Maxcel were applied together twice, final tree height was reduced similar to Tiberon alone.

Number And Average Length Of Feathers. Both Maxcel and Tiberon treatments induced a substantial increase in numbers of feathery on all cultivars (Figure 3). Sprays of Tiberon at both rates induced an increase in shorter feathery which averaged 8-10 inches in

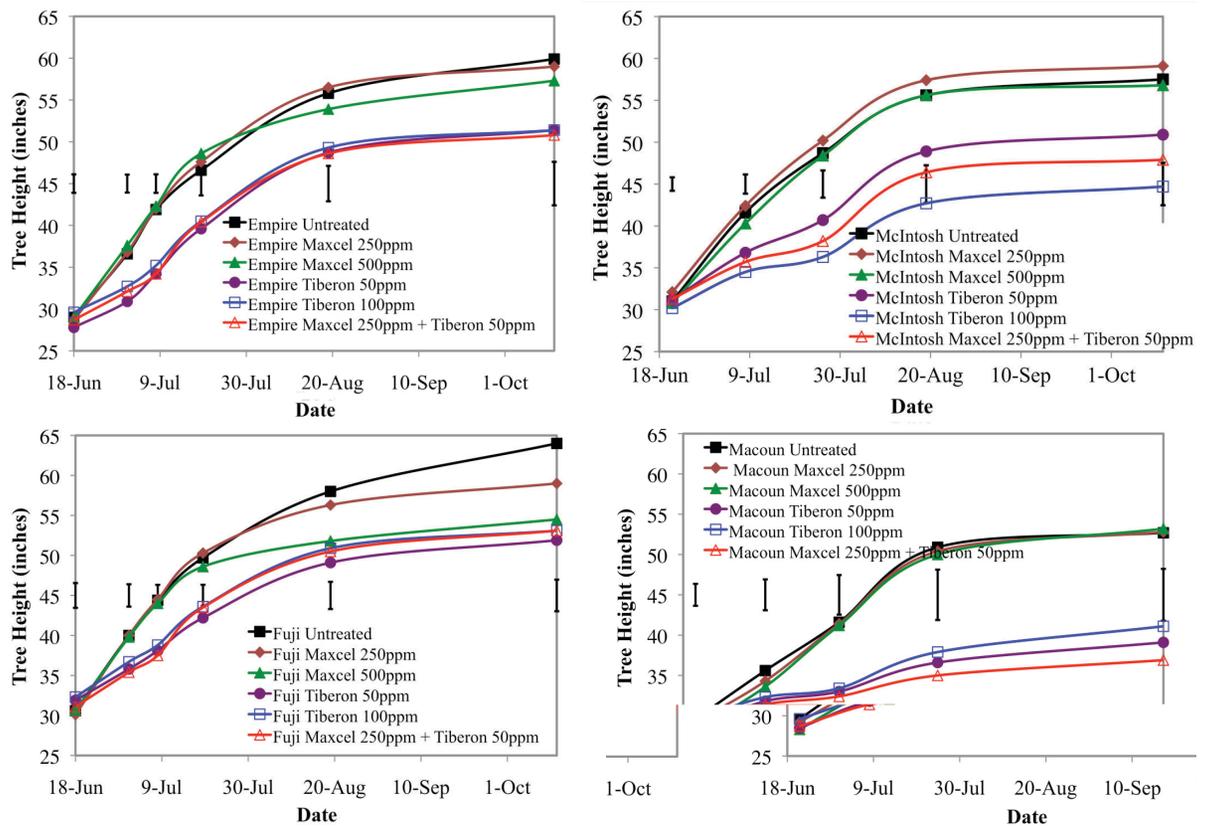


Figure 1. Effects of cyanilide (Tiberon) and/or benzyl adenine (Maxcel) on central leader growth (inches) of 'Royal Empire'/B.9, 'Sun Fuji'/B.9, 'Linda Mac' /B.9 and 'Macoun'/B.9 apple trees in the nursery during 2010 growing season (Wolcott, NY).

length (6-7 short feathery per tree) compared with Maxcel treatments (Figure 4). Apparently, Tiberon was more effective than Maxcel for inducing lateral branching on 'Empire', 'Fuji', and 'McIntosh' but less on 'Macoun' trees.

Branch Angles. Tiberon treatments increased lateral branch angle, especially for 'Fuji' with branch angles of 60° or more (Figure 5). The branch angle of feathery on Maxcel treated 'Empire' and 'Fuji' trees was 45° or less with the higher rate of Maxcel.

Height Of First Feather On Trunk. The height above the ground level of the lowest induced feather was lower for Tiberon

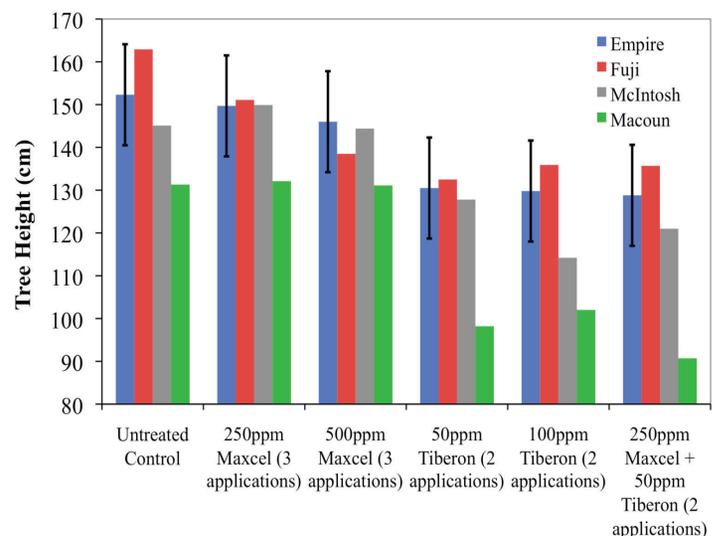


Figure 2. Effects of cyanilide (Tiberon) and/or benzyl adenine (Maxcel) on final tree height (cm) of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

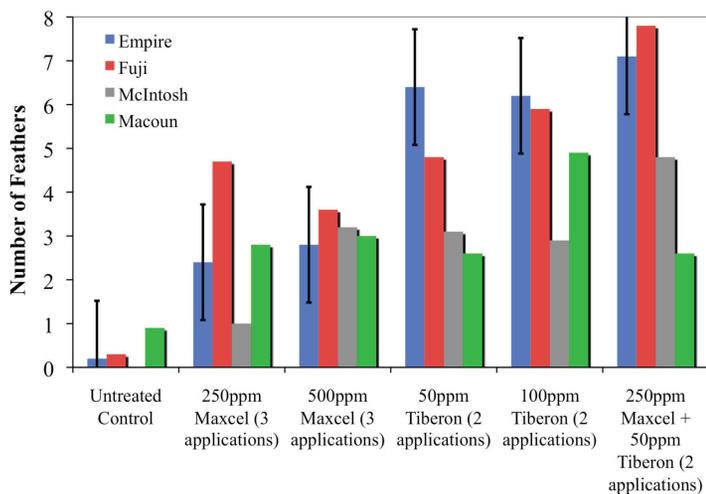


Figure 3. Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on final number of feathers of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

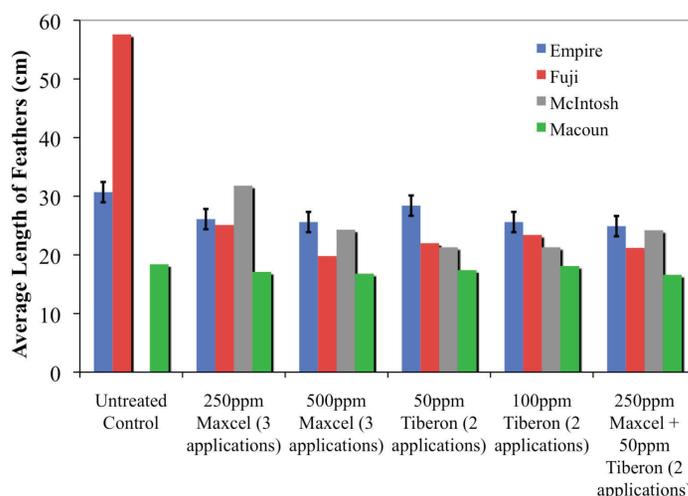


Figure 4. Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on average length of feathers (cm) of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

treatments than for Maxcel treatments (Figure 6). For all cultivars, the final height of the lowest induced feather of Tiberon treated trees ranged from 2 to 4 inches below the height of the shoot tip at the time of the first treatment while with Maxcel the height of the first feather was about the height of the shoot tip when it was first sprayed. The effect of Tiberon on the height of the first feather on the trunk was greater for ‘Fuji’, ‘McIntosh’, and ‘Macoun’ and was in direct proportion to the amount of Tiberon applied.

Trunk Cross Sectional Area. The trunk-cross sectional area of each cultivar was negatively influenced by Tiberon treatments and its mean area decreased in direct proportion to the amount of Tiberon applied (Figure 7). Tiberon produced a small reduction in trunk caliper for ‘Empire’, ‘Fuji’, and ‘McIntosh’, but it was more severe for the ‘Macoun’ cultivar by the end of the season. Maxcel treatments depending on cultivar had a smaller negative effect than Tiberon or no negative effect on trunk cross-sectional area.

Discussion

The significant negative effect of Tiberon sprays in 2010 on shoot growth of the 4 cultivars we tested was a serious negative result. However, Tiberon treated trees had improved branching and

improved branch angles for all cultivars compared to Maxcel treated trees. In addition many of the feathers were short which is ideal for the Tall Spindle system. Fuji’s crotch angles were significantly increased and averaged 60° or more. Flatter angles produced by Tiberon with other cultivars would be a significant advantage for the Tall Spindle system since less labor would be required to tie feathers or branches down after planting. Many of the new Geneva® rootstocks produce nursery trees with flatter and more branches than similar commercial rootstocks (Fazio and Robinson, 2008). Nurserymen might produce flatter branches when growing upright growth-scion cultivars grafted on the new Geneva® rootstocks by including the use of Tiberon. Tree quality may potentially be improved by using Tiberon not just by producing good caliper trees with several short feathers, but also by inducing well feathered trees with wider crotch angles.

Although Tiberon had many positive results on branch induction, the severe negative effect on tree height is a serious concern. Results from our trial provide initial evidence (from only one year of nursery work) that Tiberon sprays to Macoun trees under New York climatic conditions can significantly reduce tree height and final caliper, and result in poor tree architecture. A similar negative result

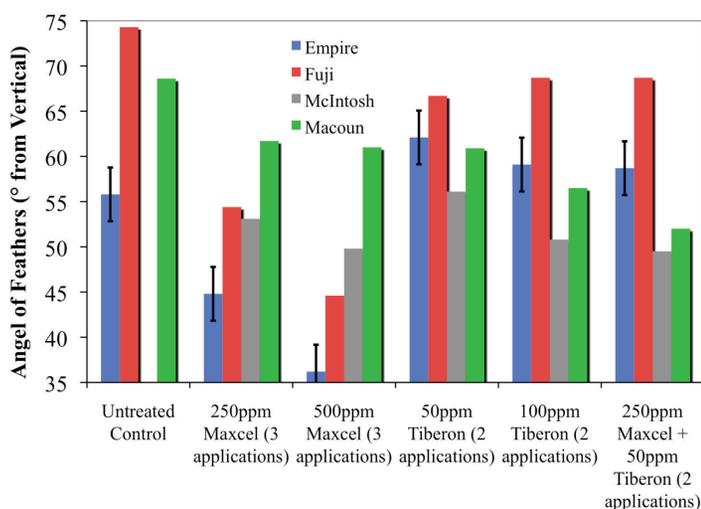


Figure 5. Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on branch angle of feathers (° from Vertical) of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

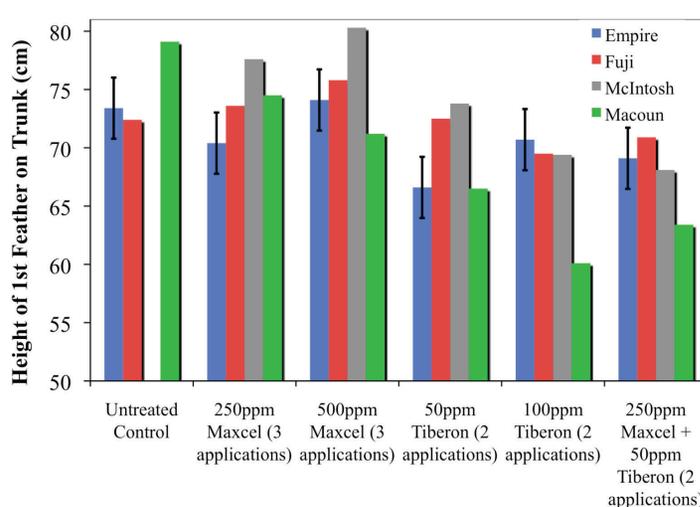


Figure 6. Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on height of first feather on trunk (cm) of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

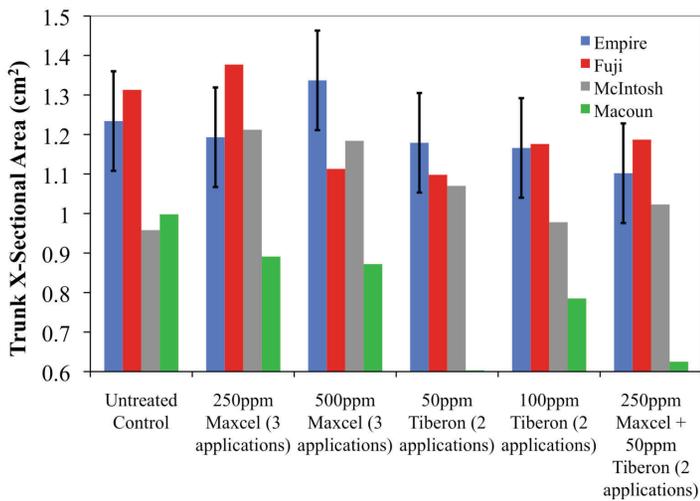


Figure 7. Effects of cyanilide (Tiberon) and/or benzyl adenine (Maxcel) on trunk cross sectional area (cm²) of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks.

was observed in 2010 on young bench grafted Topaz apple trees (Dr. Duane Greene, personal communication). In his study, bench grafts of Pinova, Fuji, Topaz, and Creston on M.9 were planted in the orchard in July 2009 and sprayed with Tiberon at 100 ppm in the spring of 2010 when terminal shoot growth was about 10 inches. Terminal growth at the end of the season was not affected on Fuji, Creston, and Pinova, but the highest single rate of Tiberon reduced terminal shoot growth on Topaz by about 25%. In another study in Massachusetts, one-year Macoun trees in the orchard treated with Tiberon at 100ppm had less leader growth (Jon Clements, personal communication). In our trial, the lower rate of Tiberon (50ppm) applied twice similarly affected Macoun trees. Perhaps the amount of active ingredient required to produce a suitable branching in Macoun trees is much less than currently recommended for apple nursery trees. For more acceptable chemical branching of Macoun (or other potentially more sensitive apple cultivars), lower rates will be evaluated in 2011.

Weather data (not shown) indicates that this experiment was conducted during a very hot and humid period with minimum and

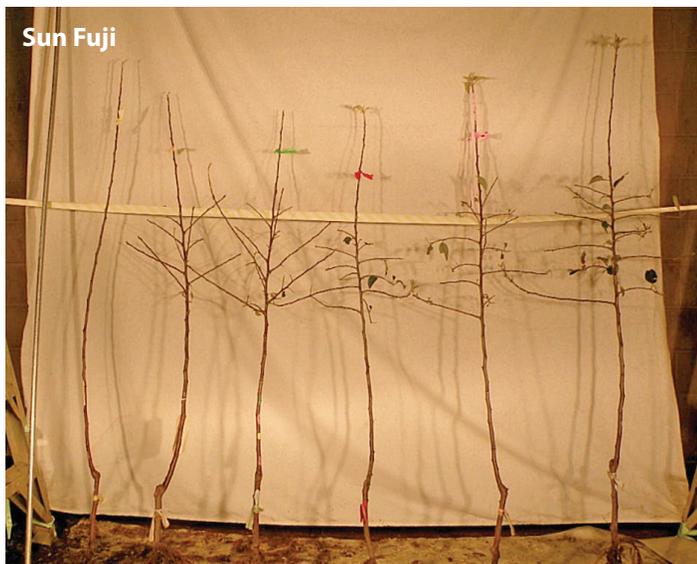
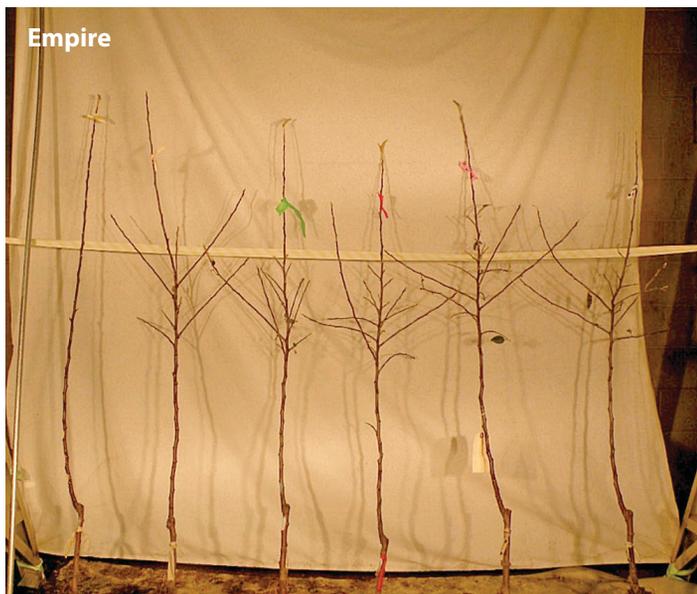


Figure 8. Feathery response of 4 apple cultivar to 6 treatments (left to right in each photo): (1) untreated tree, (2) Maxcel 250ppm, (3) Maxcel 500ppm, (4) Tiberon 50ppm, (5) Tiberon 100ppm, and (6) Maxcel 250ppm + Tiberon 50ppm.

maximum temperatures of 71°F and 81°F, respectively (from June 18 until the end of July 2010). The first application of either Maxcel or Tiberon appeared to initially stop shoot growth, but Maxcel treated trees recovered more quickly and by two weeks after treatment Maxcel's average terminal shoot length for all cultivars was 47% higher than Tiberon. Daily growth rates (inches/day) of 'Empire' and 'Fuji' trees treated with Tiberon were higher than Maxcel between July 19 and August 19, indicating that these cultivars recovered and were actively growing 62 days after the first application. In general, Maxcel was a safer product than Tiberon under NY conditions.

We are not sure if the combined effect of Tiberon, hot weather conditions, and the antibiotic streptomycin may have exacerbated the injury observed in Macoun trees (and may have affected the other three cultivars to a lesser extent). All nursery trees (before we applied Tiberon and/or Maxcel on June 18 or 21) received one streptomycin applications for fire blight control. By the end of the experiment 5 streptomycin sprays had been applied. Previous research has shown that cyclanilide (the active ingredient of Tiberon) is very mobile even at low temperatures (below 60°F). Cyclanilide is also currently registered for use in cotton, but it is not registered alone. When it is combined with ethephon, cyclanilide improves and accelerates defoliation and boll opening of cotton (cyclanilide + ethephon = Finish™). Cyclanilide is also registered in combination with the chemical mepiquat chloride to improve vegetative growth

control in cotton (cyclanilide + mepiquat chloride = Stance™). In a non-replicated trial, the cooperating nurseryman decided to spray a single lower rate of Tiberon on Gala bench graft trees not treated with streptomycin and obtained normal height, well-feathered trees without the problems we observed on the 'Macoun' trees.

Our results are from only one hot and humid year with several streptomycin applications with only two Tiberon rates of 50ppm and 100ppm (as currently recommended), and only testing four apple cultivars with a less vigorous rootstock (B.9), so it would be premature to conclude that Tiberon should not be used on 'Macoun' trees. Nevertheless, the data from our 2010 nursery trial suggests that Tiberon is a very effective product for inducing several short feathers on 'Empire', 'Fuji', and 'McIntosh' nursery apple trees (Figure 8). Nurserymen may wish to minimize 'Macoun' exposure to Tiberon or at least try lower rates with this and other potential sensitive cultivars if the nursery has to be sprayed with streptomycin for fire blight control. A less vigorous rootstock may also influence the optimal Tiberon rate for chemical branching of nursery apple trees in the Northeast.

As a practical application guide, we found that the height of the lowest induced feathers on all apple cultivars tested appeared below the shoot tip height at the moment we targeted the first Tiberon sprays (June 18 for Empire, Fuji or June 21 for McIntosh, Macoun). This response in apple trees was previously reported

(Elfving and Visser, 2006). This should allow nurserymen using Tiberon to induce lateral branches to apply the first applications at 28-30 inches height above ground level so that first feathers can be induced at about 24-26 inches height. In Italy this height has also shown to be ideal for the knip-boom trees which are cut back in the nursery to a similar height (Weiss, 2004).

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Acknowledgements

The authors appreciate the contributions of Paul Wafeler and Bill Pitts for providing the nursery apple trees and for field assistance with data collection and field management of this experiment in Wolcott, NY. We also thank Liz Tee, Hugo Chávez and Ryan Robinson for their help in data collection and field assistance.

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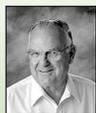
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