Studies and Recommendations for Branching Young Apple Trees

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With the rapid adoption of the Tall Spindle system for apple production, growers need to utilize very high quality feathered trees to ensure production in the second leaf and help cover the significant increased costs of establishment. Over the last number of years as the benefits of highly feathered trees were observed, it became necessary to develop nursery management techniques to stimulate lateral branch development (Robinson et al., 2014) so that apple nurseries can produce the well feathered tree that growers demand for these systems. Promalin was shown to branch apple trees as early as 1983 (Green, 1983).

In the spring of 2009, a new branching chemical, Tiberon, was registered and used commercially in the Pacific Northwest. Its use significantly improved the quality of apple nursery trees. Currently, the future use of Tiberon is in doubt, since Bayer Corporation has withdrawn the product (Robinson et al., 2014). In 2010-2013, Robinson et al. (2014) conducted branching experiments with Maxcel and Promalin in Delaware, NY, Washington, and Chile.

Promalin, cytokinin and gibberlic acid plant growth regulators, has been labeled since the early 1980's, and Maxcel, a cytokinin plant growth regulator, was registered for chemical branching of nursery apple trees in 2013.

This article will focus on the experiments conducted at Adams County Nursery, Milton, Delaware.

Studies in Delaware

Adams County Nursery in Delaware is located near Milton, on costal plain soils, either loamy sand or sandy loam, 8 to 10 miles from the Atlantic Ocean. Temperature extremes are common at this site with many days of application at 90°F or higher.

Experiments were conducted in 2012 and 2013 to evaluate Maxcel and Promalin sprays. We treated and evaluated the growth rates of Golden Delicious, Macoun, and Day Break Fuji apple nursery trees in multiple experiments over these two seasons. The trials used a randomized complete-block design with 10 replications. All plant growth regulator treatments (PGR) were applied (Figure 1) with a manually operated hand-pump backpack sprayer in 2012. In 2013, a CO_2-pressurized Spraying Systems boom was used. It was constructed with a pressure regulator and a single cone jet nozzle. The unit was calibrated to spray 4 ml of solution to the shoot tip of each tree.

Our goal was to determine the efficacy of Maxcel and Promalin for nursery branching. We began began treatments when the budded nursery trees were 30-40 inches high. In 2012, the treatments were applied on a weekly basis up to 5 times. In evaluating the results we felt that this was too frequent, and in 2013, treatments were applied every 2 weeks.

In the 2012, we explored 1000 ppm on both Golden Delicious and Macoun (Table 1). In 2012 all treatments, except the control, contained Regulaid non-ionic surfactant at 1pint/100 gallons (0.125%) of finished spray solution.

Maxcel contains a substantial package of proprie-

Figure 1. Growth regulators were applied the to the growing point of nursery trees repeatedly through the growing season.

tary surfactants in its formulation (Clark, Personal Communication). Promalin does not have the same package of surfactants and the surfactant load is much lower in Promalin as compared to Maxcel. We attributed the observed phytoxicity with Maxcel in 2012 (Figure 2) to the additional surfactant (Regulaid) combined with the 90°F and higher temperatures.

All treatments caused a significant increase in the number of shoots (feathers) on Golden Delicious trees in 2012 (Table 1). Promalin at 400 ppm plus Regulaid resulted in the tallest trees, one of the important characteristics of well feathered tree suitable for the Tall Spindle system. With Macoun in 2012, all treatments caused a significant increase in branching (Table 2). Promalin at 500 ppm plus Regulaid again resulted in the tallest trees.

In 2013, all treatments again caused a significant increase in branching of Macoun trees, and Promalin at 400 ppm plus Regulaid produced the tallest trees (Table 3).

In summary, the best treatment for Golden Delicious even though it caused some damage was Maxcel at 500 ppm plus Regulaid. Promalin at 500 ppm plus Regulaid had a statistically similar number of feathers and approximately the same tree height. For Daybreak Fuji (numerical data not shown), Maxcel at 400 ppm plus Regulaid was the best treatment in 2013 (Figure 3). Maxcel at 500 ppm applied to Fuji caused damage on the growing tips, with or without Regulaid in the spray, and noticeable twisting of the leader was observed. For Macoun, Promalin at 500 ppm plus Regulaid was the best treatment in 2012 (Figure 4), and Promalin at 400 ppm plus Regulaid was the best in 2013.

Discussion

Both Maxcel and Promalin are very effective at inducing branching on the varieties that we tested. The number of feathers was a linear function of the number of sprays. With Fuji, we obtained up to 20 lateral branches with 5 sequential sprays (data not shown).

Our results with multiple applications of Maxcel have been very promising. For the coming years, it appears that the use of Maxcel if applied multiple times (4-5 sprays of 400ppm) will help US nurserymen and growers continue producing highly feathered apple trees. Promalin will have its place on the variety Macoun at 400-500ppm with 0.125% Regulaid.

Table 1. Effects of various plant growth regulator treatments on Golden Delicious apple trees in the nursery, 2012. All treatments included 0.125% Regulaid. Means within columns not followed by a common letter are significantly different at odds of 19 to 1 (Tukey's HSD).

Treatment	Number of sprays	Tree height (cm)	Total number of shoots	Average shoot length (cm)
Untreated control	0	181 ab	8.6 b	21.7 a
Promalin 500ppm	4	191 a	16.7 a	14.2 b
Maxcel 500ppm	4	187 ab	16.9 a	13.9 b
Maxcel 500ppm	5	188 ab	21.2 a	13.1 b
Maxcel 1000ppm	4	175 b	18.3 a	13.2 b
Maxcel 1000ppm	5	173 b	17.3 a	14.5 b

Figure 2. Phytotoxicity symptoms on Golden Delicious in 2012 at Adam County Nursery, Delaware.

Table 2. Effects of various plant growth regulator treatments on Macoun apple trees in the nursery, 2012. All treatments included 0.125% Regulaid. Means within columns not followed by a common letter are significantly different at odds of 19 to 1 (Tukey's HSD).

Treatment	Number of sprays	Tree height (cm)	Total number of shoots	Average shoot length (cm)
Untreated control	0	160 b	3.7 b	13.9 a
Promalin 500ppm	4	178 a	17.9 a	8.1 b
Maxcel 500ppm	3	169 ab	16.9 a	7.9 b
Maxcel 1000ppm	3	161 ab	18.7 a	8.0 b

Table 3. Effects of various plant growth regulator treatments on Macoun apple trees in the nursery, 2013. Regulaid, where included, was at 0.125%. Means within columns not followed by a common letter are significantly different at odds of 19 to 1 (Tukey's HSD).

Treatment[y]	Number of sprays	Tree height (cm)	Total number of shoots	Average shoot length (cm)
Untreated control	0	150 b	0.3 d	26 a
Promalin 400ppm	4	155 b	6.2 bc	22 a
Promalin 400ppm + Regulaid	4	171 a	10.9 a	19 a
Promalin 500ppm	4	161 ab	5.7 bc	25 a
Maxcel 300ppm	4	158 b	4.6 c	19 a
Maxcel 300ppm + Regulaid	4	161 ab	9.6 ab	19 a
Maxcel 400ppm	4	156 b	11.6 a	20 a
Maxcel 400ppm + Regulaid	4	156 b	9.7 ab	20 a
Maxcel 500ppm	4	153 b	13.6 a	18 a

Figure 3. A comparison of treatments on Daybreak Fuji in 2013 at Adams County Nursery, Delaware.

Figure 4. Macoun tree untreated or treated four times with 500 ppm Promalin plus 0.125% Regulaid in 2012.

Having highly branched trees with good height and caliper is of such critical importance to the success of newly planted high-density orchards that continued research with Maxcel and Promalin rates and timings under different growing conditions in the Mid-Atlantic and Northeast is very important. Trees grown in western North America likely will respond differently.

Recommendations for the Mid-Atlantic Region and New Jersey

For most varieties, our recommendation is Maxcel at 400 ppm with no added surfactant and given in 4 to 5 applications beginning at 35 inches of tree height and repeated at 10-14-day intervals (5-6 inches of new growth).

For Macoun, we recommend Promalin at 400-500 ppm plus 0.125% Regulaid. Make 4-5 applications beginning at 35 inches of tree height and repeat at 10-14-day intervals (5-6 inches of new growth).

For cooler climates with shorter growing seasons, like New York and New England, the growth rate is slower. Three to four applications may be enough if made at growth intervals of 5 to 6 inches. Maxcel at 500 ppm will be more appropriate under cooler conditions.

Future Work

In 2014, we are conducting two large experiments at Adams County Nursery in Delaware. One is a replicated rate study on Daybreak Fuji with Maxcel and Promalin. The second experiment is evaluating 13 other varieties with Maxcel and Promalin as well, utilizing a total of 750 trees.

Figure 5. At the end of the season, many measurements were taken to evaluate the effectiveness of treatments. This extensive work required a team of dedicated individuals, all master gardener volunteers. Dave Johnson (upper photo) is the Master Gardener Fruit Team leader for Rutgers Snyder Farm. Bottom photo from left to right, Master Gardener Volunteers: John Christopher, Dave Johnson, Mike Beese, Barbara Harris, Dave Lilien, and Carl Lewis.

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Figure 6. Left to right: John Baugher Sr., Shaun Callahan, John Baugher Jr., and Win Cowgill at Adams County Nursery, Delaware.