Fruit Notes

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Fruit Notes

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Wesley R. Autio and Jon M. Clements
Stockbridge School of Agriculture, University of Massachusetts

Terence Robinson
Cornell University

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 Currently, the future use of Tiberon is in doubt, since Bayer Corporation has withdrawn the product (Robinson et al., 2014).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.

Acknowledgement

The Authors appreciate the financial support by Adams County Nursery, The International Fruit Tree Association, the Northwest Nursery Improvement Institute, Rutgers University, the New Jersey Agricultural Experiment Station, and Mike Beese, Dave Johnson and numerous other Rutgers Master Gardeners who assisted with hundreds of hours of data collection.

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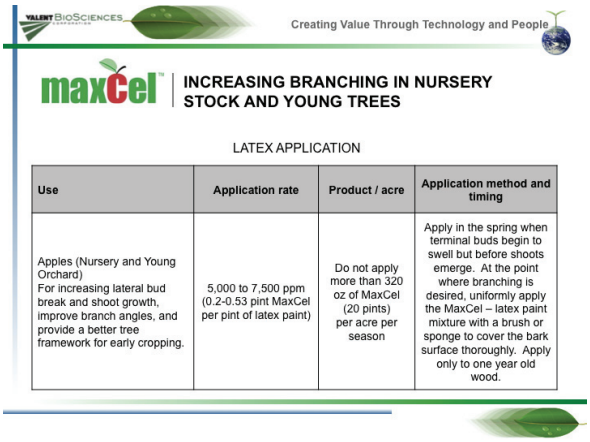
Duane W. Green, 1983. Use of Promalin to increase branching of young trees. *Fruit Notes* 48(2):20-22.

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

Increasing Branching of Newly Planted Apple Trees

Jon Clements
Extension Educator, University of Massachusetts

In 2013, Valent BioSciences expanded the Maxcel™ label to include branching of nursery stock and young trees (Figure 1). In 2014, the 5,000 ppm rate was used in white latex indoor paint on just-planted 1/4 inch diameter "whip" Honeycrisp/B.9 apple trees at the UMass Cold Spring Orchard Research & Education Center. The paint was applied using a foam brush to the area where branching was desired after the buds had started to swell but just before bud break. By mid-June, the results were favorable; it appears the latex application was very effective at breaking branches (Figure 2) compared to the untreated trees (Figure 3). This type of Maxcel application is recommended before bud-break on pencil-diameter, one-year-old wood to promote branching.


Creating Value Through Technology and People

maxCel™ INCREASING BRANCHING IN NURSERY STOCK AND YOUNG TREES

LATEX APPLICATION

Use	Application rate	Product / acre	Application method and timing
Apples (Nursery and Young Orchard) For increasing lateral bud break and shoot growth, improve branch angles, and provide a better tree framework for early cropping.	5,000 to 7,500 ppm (0.2-0.53 pint MaxCel per pint of latex paint)	Do not apply more than 320 oz of MaxCel (20 pints) per acre per season	Apply in the spring when terminal buds begin to swell but before shoots emerge. At the point where branching is desired, uniformly apply the MaxCel – latex paint mixture with a brush or sponge to cover the bark surface thoroughly. Apply only to one year old wood.

Figure 1. The Maxcel label noting its use to enhance branching.


Figure 2. Honeycrisp/B.9 tree treated at bud swell with 5,000 ppm Maxcel in white indoor latex paint.


Figure 3. Honeycrisp/B.9 tree not treated (control) but planted and photographed at the same time as the tree in Figure 2.

Influence of Spotted-wing Drosophila on Insecticide Use in NJ Blueberries

Dean Polk
New Jersey Agricultural Experiment Station

Insecticide use programs for NJ blueberries have been historically based on the control of blueberry maggot and other key pests. Early-season pests have consisted of cranberry fruitworm, prebloom, and then plum curculio immediately after the bees are removed. This was usually followed by a single treatment for cranberry fruitworm, and 1-2 treatments for aphids. Blueberry maggot (BBM) usually emerges in early June, which triggered BBM management for the remainder of the growing season. Since BBM was often not found in every field, insecticides could be targeted to only those areas that required BBM treatments. In recent years, up through 2010-11, this meant that most spray schedules were based on targeted applications of reduced risk insecticides, including neonicotinoid and spinosyn products.

With the arrival of the spotted-wing drosophila (SWD) in 2011-12, these practices changed. SWD cannot be controlled with neonicotinoid materials. The insect has a very short life cycle, and numbers rapidly increase during the middle of the summer. The fact that there is no tolerance for larvae in the fruit has led to the repeated use of broad-spectrum insecticides. We collected grower insecticide use records for 8 farms between 2010 through 2013. A spray record analysis showed drastic changes in pest management practices resulting in increased number of applications, increased use of OP and carbamate materials, increased use of pyrethroids and spinosyns, and a decreased use of neonicotinoid materials. The number of applications increased by about 60%, and the amount of active ingredient more than doubled because of SWD presence. See Figures 1 and 2.

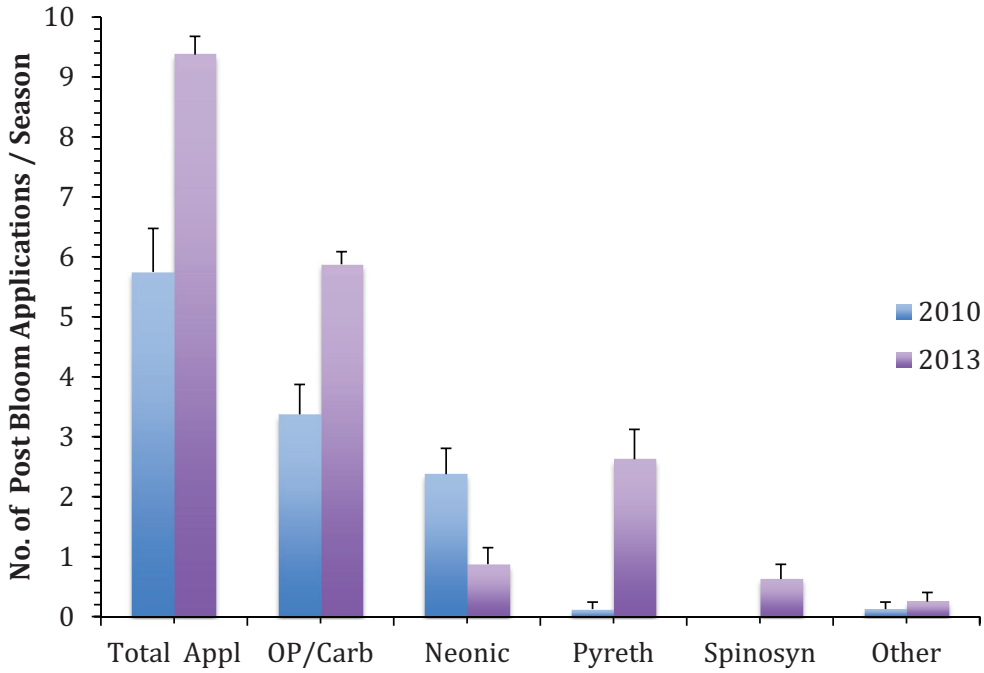


Figure 1. Change in the number of insecticide applications between 2010 and 2013.

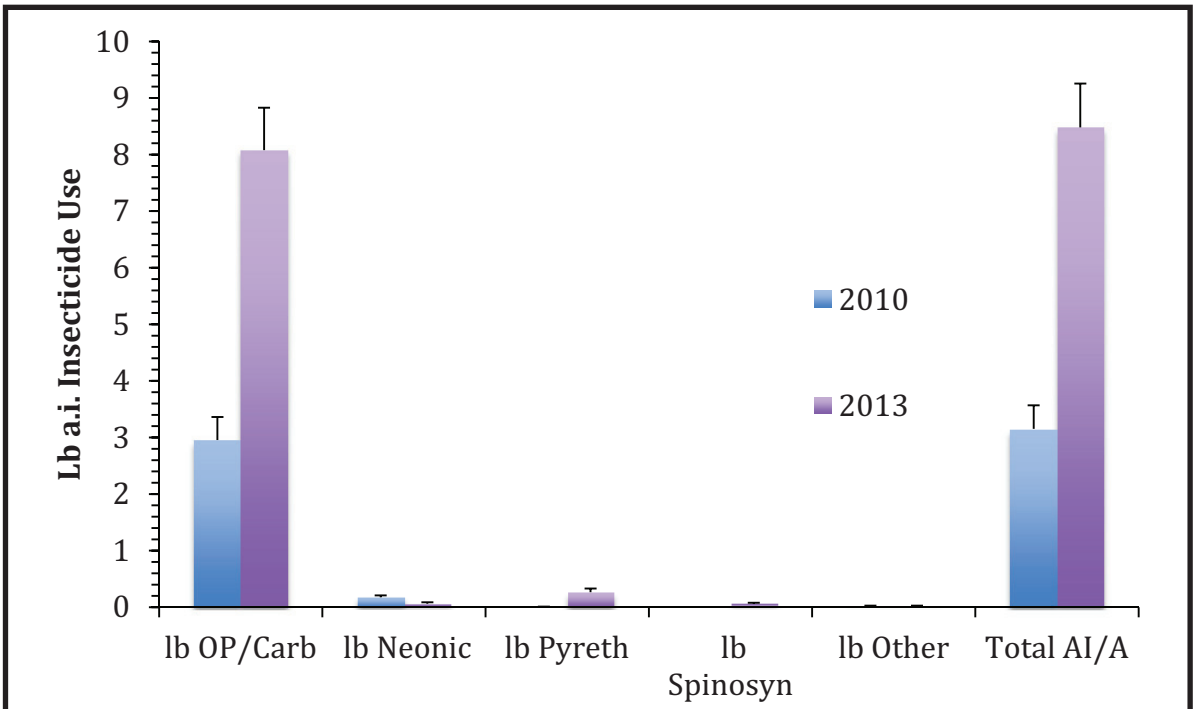


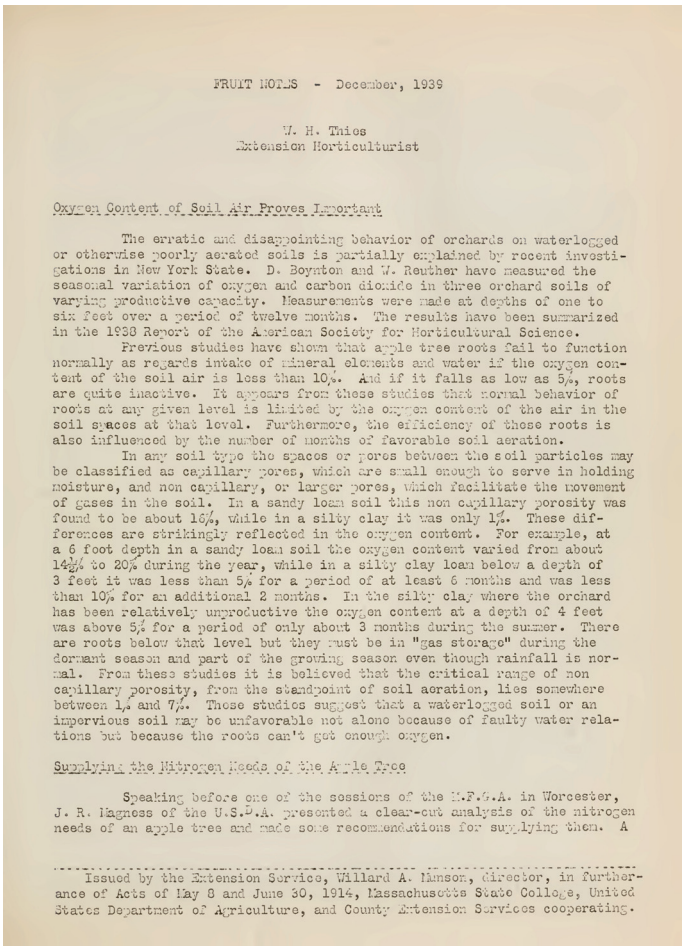
Figure 2. Change in the total lb a.i. use between 2010 and 2013

Hormones and the Dropping of Fruit

Laurence Southwick
Department of Pomology, Massachusetts State College

There is considerable popular interest in hormones at the present time with a tendency on the part of many to believe that Utopia for agriculture can be reached via the mysterious hormone route. This belief is based on the tremendous progress made in the past few years concerning the nature of hormones and their manifestly universal presence and importance wherever life exists.

Plant growth substances, variously called growth hormones, growth regulators, growth enzymes, phytohormones and auxins, are definitely known to occur in plants in very minute quantities. In fact, they are essential for normal cell enlargement and recently have been shown to influence fruiting processes. Further, it has been found that the substances which are essential for the growth of plant parts above the ground often inhibit root growth. The mechanism by which hormones "activate" growth is not well understood at the present time.



FRUIT NOTES - December, 1939

W. H. Tries
Extension Horticulturist

Oxygen Content of Soil Air Proves Important

The erratic and disappointing behavior of orchards on waterlogged or otherwise poorly aerated soils is partially explained by recent investigations in New York State. D. Boynton and W. Reuther have measured the seasonal variation of oxygen and carbon dioxide in three orchard soils of varying productive capacity. Measurements were made at depths of one to six feet over a period of twelve months. The results have been summarized in the 1938 Report of the American Society for Horticultural Science.

Previous studies have shown that apple tree roots fail to function normally as regards intake of mineral elements and water if the oxygen content of the soil air is less than 10%. And if it falls as low as 5%, roots are quite inactive. It appears from these studies that normal behavior of roots at any given level is limited by the oxygen content of the air in the soil spaces at that level. Furthermore, the efficiency of these roots is also influenced by the number of months of favorable soil aeration.

In any soil type the spaces or pores between the soil particles may be classified as capillary pores, which are small enough to serve in holding moisture, and non capillary, or larger pores, which facilitate the movement of gases in the soil. In a sandy loam soil this non capillary porosity was found to be about 16%, while in a silty clay it was only 1%. These differences are strikingly reflected in the oxygen content. For example, at a 6 foot depth in a sandy loam soil the oxygen content varied from about 14% to 20% during the year, while in a silty clay loam below a depth of 3 feet it was less than 5% for a period of at least 6 months and was less than 10% for an additional 2 months. In the silty clay where the orchard has been relatively unproductive the oxygen content at a depth of 4 feet was above 5% for a period of only about 3 months during the summer. There are roots below that level but they must be in "gas storage" during the dormant season and part of the growing season even though rainfall is normal. From these studies it is believed that the critical range of non capillary porosity, from the standpoint of soil aeration, lies somewhere between 1% and 7%. These studies suggest that a waterlogged soil or an impervious soil may be unfavorable not alone because of faulty water relations but because the roots can't get enough oxygen.

Supplying the Nitrogen Needs of the Apple Tree

Speaking before one of the sessions of the M.F.G.A. in Worcester, J. R. Magness of the U.S.D.A. presented a clear-cut analysis of the nitrogen needs of an apple tree and made some recommendations for supplying them. A

Issued by the Extension Service, Willard A. Munson, director, in furtherance of Acts of May 8 and June 30, 1914, Massachusetts State College, United States Department of Agriculture, and County Extension Services cooperating.

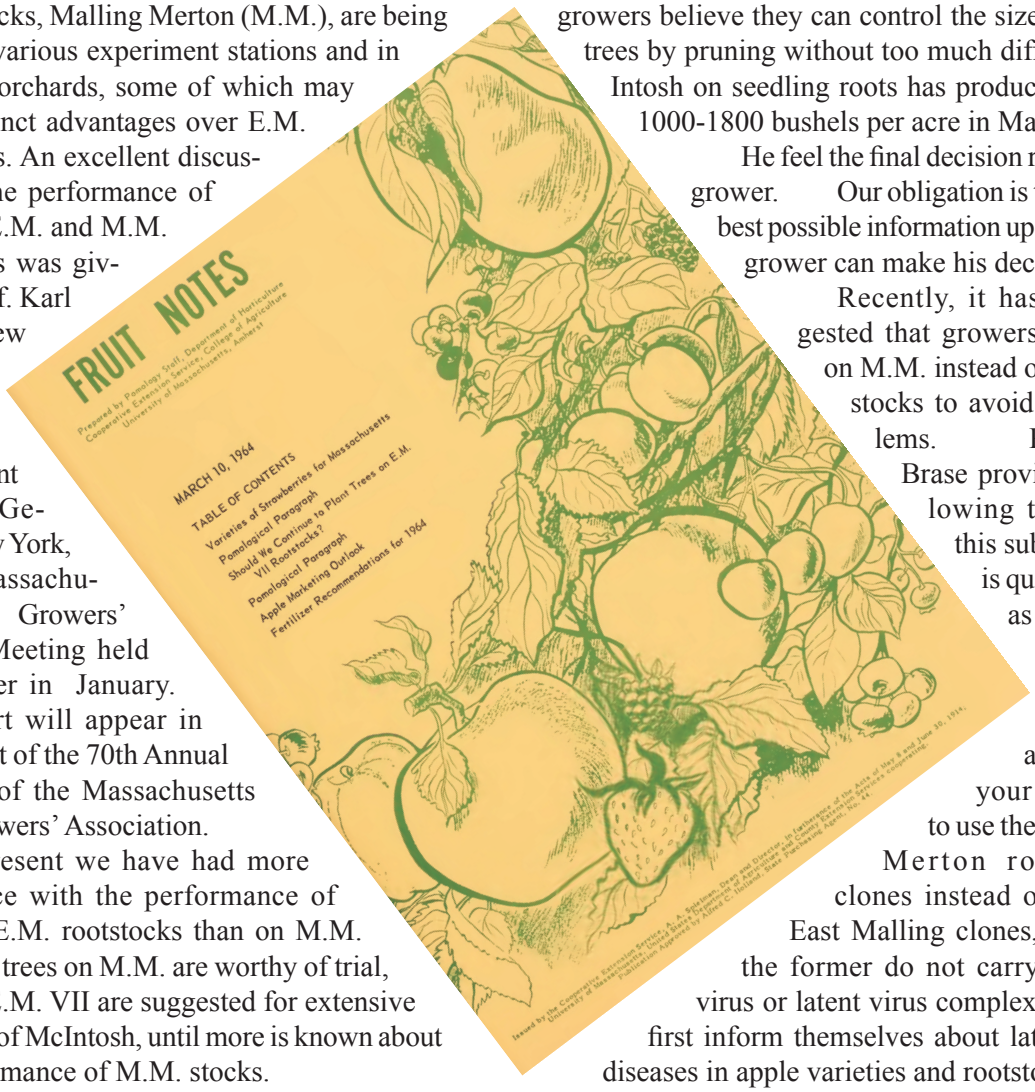
But what has this to do with the dropping of fruit? Many fruit growers have heard of investigations regarding the use of hormones to prevent pre-harvest dropping. Scientists at the U.S. Horticultural Station at Beltsville, Maryland, have found that many plant substances have the faculty of delaying normal abscission (dropping) of various plant organs including flowers, stems, petioles and even maturing apples. Recently, with several varieties, very low concentrations of growth substances applied as late sprays noticeably lessened the fruit drop. Other limited tests suggest the same result. We conducted similar tests this fall in two of our McIntosh blocks in Amherst. In one case, the results seemed favorable but, in the other, they were inconclusive. It is just possible that we used too weak a concentration (0.0005%) and perhaps the material used (naphthalene acetamide) was applied a little late. However, on the basis of the results to date, we believe this new method should be following with not more than a moderate enthusiasm by most growers until more is known concerning its possibilities.

Probably additional data on this subject will be forthcoming during the next few months. Further, next season, we plan to carry on more extended experiments here at Massachusetts State College. If growers wish to try out hormone spraying on a small scale, a good plan to follow is to select trees of the same age, with similar vigor and crop and leave alternate trees in the same row, for example, as check (untreated) trees. Otherwise, comparisons of any value will be difficult to make. (Additional information on these new materials will appear in the next issue of *Fruit Notes*.)

Should We Continue to Plant Trees on E.M. VII Rootstocks?

William J. Lord
Department of Horticulture, University of Massachusetts

The most popular size controlling rootstock in Massachusetts has been E.M. VII. Now another series of rootstocks, Malling Merton (M.M.), are being tested at various experiment stations and in growers' orchards, some of which may have distinct advantages over E.M. rootstocks. An excellent discussion of the performance of trees on E.M. and M.M. rootstocks was given by Prof. Karl Brase, New York Agricultural Experiment Station, Geneva, New York, at the Massachusetts Fruit Growers' Annual Meeting held at Gardner in January. His report will appear in the Report of the 70th Annual Meeting of the Massachusetts Fruit Growers' Association.



At present we have had more experience with the performance of trees on E.M. rootstocks than on M.M. Although trees on M.M. are worthy of trial, trees on E.M. VII are suggested for extensive plantings of McIntosh, until more is known about the performance of M.M. stocks.

Under some circumstances, trees on seedling rootstocks may be more desirable than those on size-controlling rootstocks, for example on exposed, windy sites. The need of size-controlling rootstocks for Red Delicious is doubtful. In many of our orchards, Red Delicious aren't excessively large trees, since they lack the inherent vigor of McIntosh in this region. Some growers believe they can control the size of seedling trees by pruning without too much difficulty. McIntosh on seedling roots has produced yields of 1000-1800 bushels per acre in Massachusetts.

He feel the final decision rests with the grower. Our obligation is to supply the best possible information upon which the grower can make his decision.

Recently, it has been suggested that growers plant trees on M.M. instead of E.M. rootstocks to avoid virus problems. Prof. Karl Brase provides the following thoughts on this subject, and he is quoted directly as follows.

"Those who advise your growers to use the Malling-Merton rootstock clones instead of certain East Malling clones, because the former do not carry a latent virus or latent virus complexes, better first inform themselves about latent virus diseases in apple varieties and rootstocks. Even among the M.M. group are clones that do not have a single mother plant that indexes virus free on certain indicators. The same is true of many of the so-called super strains of our well advertised varieties. There are latent virus

diseases present in apple varieties as well as in certain apple rootstock clones. But before one condemns the use of certain rootstock clones, one has to prove that the latent virus actually affects growth, bearing, and the end product, namely the fruit.

Virus diseases that do harm, of course, should be eliminated - I am referring here to those with visible symptoms either on the tree or the fruit. As long as we do not know what effect the latent virus present in the rootstock has upon the variety, we should not condemn the use of the rootstock.

We have used E.M. VII and others in the E.M. group for more than 30 years successfully and shall continue to do so. As far as we know now, the latent virus present in E.M. VII has not affected in any way the varieties we have grown on this rootstock.

I see no advantage in the use of rootstocks free of latent virus if we have to grow on them varieties that carry also a virus in a latent stage.

It will take a number of years to prove or disprove that the latent virus present in E.M. VII is harmful and affects the performance of the trees. As long as this is unknown, growers should not be alarmed about it."

Life Without Alar

Wesley R. Autio
Department of Plant & Soil Sciences, University of Massachusetts

In August, 1985, the controversy began regarding the safety of Alar™ residues on apples. Since that time, many discussions and arguments have occurred. A recent "60 Minutes" program fueled the controversy by presenting claims made by the Natural Resources Defense Council that Alar is a potent carcinogen. The scientific data available certainly do not support that view; however, the widespread publicity likely will eliminate Alar-use as a horticultural practice. Apple growers must look toward a future without Alar. In this article I shall present some of the ways that may help reduce the need for Alar.

Before discussing specific activities, we must be clear on what benefits are received from Alar. The first and foremost function of Alar is to act as a "stop-drop." This function allows a grower to harvest most of his crop before it drops to the ground. By allowing fruit to remain on the tree longer they are able to color more fully, giving higher grade fruit. One reason why fruit stay on the tree longer is that Alar delays the beginning of fruit ripening, which results in less-ripe fruit for storage, which then allows the fruit to retain high quality for a longer time. In particular, the apples stay firm for a longer period of time.

Alternative approaches to the use of Alar must address these benefits that Alar provides. Approaches will be divided into two types: short-term practices and long-term changes. Short-term practices include several activities, but in general these are practices which may be undertaken this season to reduce the losses associated with the non-use of Alar. Long-term changes require more time and capital to implement. It must be understood that Alar provided a great deal of benefit, and no practices are real alternatives; they only assist in reducing the losses associated with non-use of Alar.

Short-Term Practices

Pruning

Several *Fruit Notes* articles [52(3):7-8; 53(1):12-13; 53(2):1; and 53(3):1-2] have discussed the effects of pruning, particularly summer pruning, on the production of high quality fruit. Removal of upright, hanging, and shade-causing wood in the summer can result in a dramatic increase in light penetration, fruit coloration, and packout. Additionally, it causes earlier coloration and thus allows earlier harvest, hopefully reducing some of the need for Alar while

not reducing average fruit quality. Dormant pruning also is important, specifically in improving light penetration to the fruit. For more specific information about summer pruning practices, see *Fruit Notes* 53(2):1, and for more information about dormant pruning to improve packout, see *Fruit Notes* 53(1):12-13.

Chemical Treatments

There are no chemical alternatives to Alar. However, there are two chemicals that can be used to expand the harvest season: Ethrel and NAA. The problem with both chemicals is that they may render the fruit unusable for long-term storage by advancing ripening. Ethrel is used to advance the harvest season by breaking down to ethylene and triggering ripening. Treatment with Ethrel results in marketable fruit early in the season, but also fruit that probably must be consumed immediately, because they are too ripe to store. NAA is a "stop drop." It will significantly delay premature fruit drop, but it also advances fruit ripening. NAA can expand the season, but treated fruit must be sold relatively quickly. Details on the use of both of these chemicals are given in the *New England Apple Spray Guide*.

Harvest and Storage Management

Without Alar the fruit in storage probably will be riper than what growers are used to. To maintain fruit quality throughout the storage period, the fruit must be handled with greater attention to details than if they had been treated with Alar. This additional care includes more accurate attention to cooling and to the rapid establishment and maintenance of optimal temperature and atmosphere conditions, as well as to application of the appropriate postharvest chemical treatments. No longer will sloppy storage management be acceptable, since the fruit will show the quality of storage management more readily than before. In addition to storage management, the intensity of harvest management must be increased. Growers must accurately manage their harvest so that the most appropriate fruit are placed in long-term storage. This practice may include the more frequent use of the starch-iodine test for maturity assessment.

Increased Labor

Increasing harvest labor so that more fruit can be picked in a shorter period of time is one way to reduce the impact of the non-use of Alar; however, growers must be able to handle the increased quantity of fruit. Specifically, the orchard operation must be able to move the fruit quickly from the orchard to the storage, stack them in the storage, cool them quickly, and seal the storage (if CA is used) if the increased labor is going to pay off. Beside the availability of additional labor, one problem which may prevent this practice from being feasible is the size of the refrigeration plant. If there is not adequate refrigeration to cool the high quantity of fruit being placed in the storage per day then the additional labor is not truly reducing the impact of the non-use of Alar.

Long-term Changes

Changes in Cultivars

One of the characteristics of the New England apple industry which has increased the problems related to the loss of Alar is the large proportion (60 %) of the production devoted to McIntosh. A relatively simple way of reducing the need for Alar is to replace McIntosh with other cultivars which allow an expansion of the harvest season or do not require a chemical "stop-drop." Several cultivars have potential in New England, such as Gala, Mutsu, Libe1ty, Jonagold, and Red Fuji. Older cultivars like Cortland and Macoun also may deserve a greater role in the industry. Obviously, several years are required to change cultivars, and several years are required to develop markets for new cultivars.

Changes in Strains

Several McIntosh strains are now available. Marshall McIntosh has been the most planted strain over the last few years, primarily because of its higher coloring potential. Additional benefits which come from Marshall McIntosh are given by its earlier coloring and earlier ripening. It colors approximately 10 days prior to Rogers McIntosh and ripens approximately a week earlier. These two differences allow an advance-

ment of the McIntosh harvest season without the kind of quality loss found with the use of a chemical such as Ethrel. However, planting entirely to Marshall McIntosh will not reduce the losses associated with the non-use of Alar, because the entire harvest season will be earlier and just as concentrated as with a standard strain of McIntosh. Future orchards should have a mix of Marshall McIntosh with other strains to allow the maximum expansion of the harvest season.

Pioneer Mac (recently named by Adams County Nursery) technically is not a strain of McIntosh but actually is a seedling of McIntosh and thus a new cultivar; however, its fruit are virtually indistinguishable from McIntosh and undoubtedly will be accepted as McIntosh. Its reported advantage over standard McIntosh is that it ripens 2 weeks later. In 1988 at the University of Massachusetts Horticultural Research Center we established a replicated trial to compare Pioneer Mac to Marshall McIntosh and Rogers McIntosh. When information is available it will be reported through *Fruit Notes*. The benefits of Pioneer Mac may be great, but as with Marshall McIntosh it will be necessary to include earlier-ripening strains of McIntosh to provide a true expansion of the harvest season.

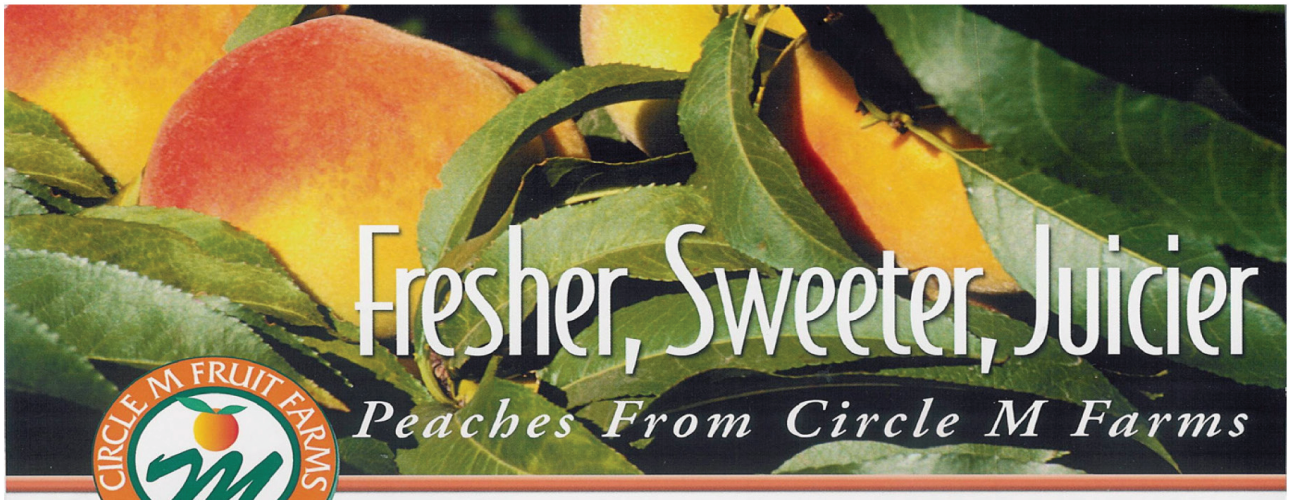
Rootstocks

Changes in rootstocks must occur to give benefits in two areas. First, more dwarfing rootstocks must be used. Large plantings of McIntosh as semi-dwarf trees will not be feasible to maintain without Alar. Growers must consider moving into the dwarf category, using M.9, M.9 EMLA, M.26, Mark, and possibly Ott.3 as rootstocks. Trees on these rootstocks are much easier to prune, require less spray material, and most importantly, in the context of this article, are much easier to harvest than are semi-dwarf or standard trees. Nearly all the fruit are harvestable from the ground, and the harvesting process can be done more rapidly. Because of high light penetration into the canopy, more of the fruit are highly colored, making selective harvesting less of a priority while improving packout. For more general information on these dwarfing rootstocks see *Fruit Notes* [51(4):22-24; 52(1):1-4; 53(1):4-7; 53(3):3-6; and 54(1):11-15].

The second potential benefit of a change in rootstocks is their effect on ripening. For three years we have been conducting research at the University of Massachusetts Horticultural Research Center on the effects of rootstocks on apple fruit quality and ripening [see *Fruit Notes* 52(2):5-10], and have found that Mark can delay ripening of Delicious and McIntosh fruit by as much as 5 days when compared to fruit from trees on M.26 EMLA and Ott.3. The use of rootstock to expand the harvest season should complement the use of different strains to expand further the McIntosh harvest season.

Conclusions

We do not have any easy answers to the question of what an apple grower can do to reduce the losses associated with the non-use of Alar. Short-term approaches, obviously, are stop-gap measures which may somewhat reduce the losses. The long-term changes will take time and capital to implement but should go far to eliminate the need for Alar. The New England apple industry has rough seas ahead, but if growers look to the future and begin to make some changes, it should be able to weather this storm.



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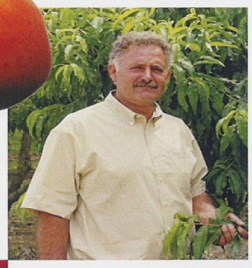

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