Cold Spring Orchard

Research & Education Center

2005 ANNUAL REPORT

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June 1, 2005

Dear Reader,

The University of Massachusetts Fruit Program is very pleased to bring to you the first Annual Report of the University of Massachusetts Cold Spring Orchard Research & Education Center. The UMass Cold Spring Orchard is a "living laboratory" and is central to our Program's research, educational, and outreach activities. Much has changed during the UMass Cold Spring Orchard's 43 years of existence, but it still, as at its beginning, has the central goal of improving the economic viability and environmental sustainability of Massachusetts fruit farms.

Since this is our first significant report, I will review a bit of the history surrounding the establishment of the UMass Cold Spring Orchard. The previous University research and teaching orchard was on the east side of the UMass Amherst campus. Threatened University expansion inspired Massachusetts Fruit Growers' Association's (MFGA) Board of Directors to charge a facilities committee with the job of finding a new orchard site. This group began the search for appropriate and nearby locations in early October, 1961. Stacy Gay, a member of the facilities committee heard about an old dairy farm in Belchertown that was available. The committee reviewed the property, and on October 23, the MFGA Directors voted to buy the former Hanifin Farm. On October 30, the facilities committee was authorized to make a down payment on the purchase. On November 10, the Hampden County Fruit Growers Association contributed $2,000 to the effort to combine with the $1,000 authorized by the MFGA Directors. The down payment was given on November 16, and MFGA obtained the deed on December 28 and assumed a $30,000 mortgage on December 30. They paid off the mortgage from donations from members by May, 1962, and The UMass Cold Spring Orchard (formerly the UMass Horticultural Research Center) was presented on June 26, 1962 to the University of Massachusetts as a gift from the Massachusetts Fruit Growers' Association. In the subsequent years, buildings were refurbished, fields were fenced, and tree planting began in earnest in 1964. MFGA initiated legislation in the late 1960's to fund a new building at the UMass Cold Spring Orchard. In 1972, Chandler Laboratory was dedicated and now serves as laboratory, classroom, office, and cold-storage space.

Dr. Franklin W. Southwick was actively involved with the Massachusetts Fruit Growers' Association, serving as its Secretary/Treasurer for 36 years. Also as head of the Department of Horticulture, he was very involved with the acquisition of UMass Cold Spring Orchard and was its first Director. It is with great pleasure that we dedicate our first annual report to his memory.

This Report compiles the results of nearly all 2004 research and demonstration projects conducted at the UMass Cold Spring Orchard. We hope that it gives you a glimpse of the activities and potential benefits provided by the facility.

Sincerely,

Wesley R. Autio
Fruit Program Leader & Editor

University of Massachusetts Cold Spring Orchard Research & Education Center

Annual Report for 2005

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UMass Cold Spring Orchard Research & Education Center: Director's Report

Duane W. Greene
Department of Plant, Soil, & Insect Sciences, University of Massachusetts

We are pleased to share with you the first Annual Report of the Cold Spring Orchard Research & Education Center. Over the years we have been involved in many and diverse activities in the areas of graduate and undergraduate education, fundamental and applied research in support of the fruit industry, and outreach programs to commercial fruit growers and the public. We hope that through this report we can show in more detail the nature of our contributions.

The research reports illustrate the diversity of activities and disciplines at the UMass Cold Spring Orchard. Major programs exist in tree-fruit rootstock evaluation and performance. Planting and research activity in small fruit has increase quite dramatically in recent years. Evaluation of peach, cherry, and apple varieties is ongoing and is providing valuable information to allow growers to make intelligent and location-specific selection of varieties to plant. We have several fruit plantings that are part of regional and international Regional Projects. Work on insect and disease management is ongoing and isr eported in this publication. Significant research is being done on the use of plant hormones to regulate plant behavior include vegetative growth control, flowering , fruit set, fruit abscission, and fruit ripening. Regular air and controlled atmosphere storage facilities allow for postharvest evaluation of many orchard experiments to determine how changes in culture and management can influence the postharvest life of fruit, especially apples.

Farm activities have undergone a metamorphosis over the past several years. A retails stand opened recently, and since that time, sales have experienced double digit growth. Education and outreach has extended to include children in preschool and in grade schools. This has been done through conducting tours during the fall where students can see first hand how fruit grow and how they are harvested and stored.

Education remains a central component of our mission. The UMass Cold Spring Orchard serves as an outdoor laboratory for students in the Department of Plant, Soil, and Insect Sciences. Pruning, tree fruit, and small fruit classes depend on the UMass Cold Spring Orchard for hands-on and practical experience in honing skills in these practically-oriented classes. The UMass Cold Spring Orchard serves as a training ground for UMass students who eventually become employed by commercial fruit growers or start their own business. We have employed and helped train nearly 3 dozen student who have received valuable on-the-job training.

The UMass Cold Spring Orchard has a tree-fruit specialist house at the facility to help growers with cultural, pest, or management problems. Further, numerous outreach meeting are scheduled at the facility through the year. The UMass Cold Spring Orchard is the hub of activity for the fruit growing public throughout the season.

The facility is most fortunate to have a highly dedicated support staff and an internationally recognized group of researchers working there. We serve not only Massachusetts but also the greater New England Region. We have been successful in large part because of the dedication, hard work and expertise of all involved with the UMass Cold Spring Orchard.

Generating funds to support teaching, research, and outreach activities at the UMass Cold Spring Orchard remains a continuing challenge. Dedicated fruit growers, University Development Office, University personnel, the Fruit Program are working tirelessly to develop an endowment fund that may be used to support upkeep and maintenance of the farm. It will also help support research activities where external funding is difficult to find or is nonexistent.

The dedication of all involved with the UMass Cold Spring Orchard Research & Education Center is strong, and we believe that the future looks bright for continued support for the fruit industry, education of our students, and outreach activities for residents of the Commonwealth.

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UMass Cold Spring Orchard Research & Education Center: Farm Report

Joseph Sincuk
Department of Plant, Soil, & Insect Sciences, University of Massachusetts

Crop

The apple crop was excellent with production reaching approximately 5,000 bushels. The crop was well thinned, sized, and balanced. Fall weather conditions, characterized by bright sunny days and cool nights, resulted in very high quality and attractive fruit. Cold winter temperatures killed the majority of peach flowers, ultimately leaving us with a very small crop and large hole in our wholesale and retail sales program.

There has been a continued effort to downsize and adjust the crop to a size that is more manageable with the workforce that is available on the farm. Nearly four acres of old, large, and non-productive trees were removed this past year reducing the bushels produced by 500 to 1,000. Plantings of newer varieties such as Hudson's Golden Gem, Sansa, Honeycrisp, and Gingergold are just starting to come into production. These were very well received by the public.

Outreach and Education

We have moved forward with an educational and outreach relationship with the local school systems. Over 900 kindergarten through second grade school children visited the farm and received an educational tour while also having an opportunity to pick a half peck of apples. The content of the tour continues to develop and be refined to better meet the needs of both the students and teachers. There also are other groups that participate in tours aimed at older children and adults, such as youth groups and Master Gardeners.

The orchard made many donations to a variety of civic and church organizations. We also contributed a significant amount of apples throughout the fall and winter to the efforts of the Western Mass Food Bank.

The orchard has continued its tradition of employing students, giving three individuals an opportunity to apprentice and gain experience with a variety of farm and research skills. This is on-the-job training while they are taking classes on the main campus in Amherst.

Sales Program

The wholesale program increased with the public's demand for local and healthfully produced fruit. We continued to sell to the University of Massachusetts Dining Commons, Bread and Circus, and a number of other local fruit stands and stores. We also sold to a number of local school systems including; Belchertown, Granby, and Chicopee.

The UMass Cold Spring Orchard saw an increase in income of nearly 25% over the past year, even with a very diminished peach crop. The public's demand for new and unique apple varieties has drawn an ever increasing number of customers to our store. This increased number of customers has allowed us to boost sales in other areas. In an attempt to increase cider sales we have put an extra effort into making a custom blend with the careful selection of hand picked and mature fruit. Fruit are chosen to make a cider product that is both unique and delicious. This proved fruitful by increasing cider sales by 30%, producing nearly 3,500 units. Customers also purchase many other products when buying apples and cider, such as pumpkins, gourds, squash, and jams. The public was also given a unique opportunity to aid in the research and evaluation of new apple varieties grown in the new apple variety block. Each week one of these new varieties was displayed at the stand, the customer was allowed to taste the apple and then asked to fill out an evaluation form. These forms were analyzed by Duane Greene and used to determine an apple's appeal to the customer base. A report on customer acceptance of these new varieties is presented later in the report.

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Predicting the Response to Chemical Thinners on Apples

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Chemical thinning is one of the most important management activities an orchardist is required to do because of the importance of the decisions involved and the uncertainties associated with the outcome. Poor thinning will have significant repercussions for two years. In the year of application, inadequate thinning will result in small fruit that will bring a very low price. The year following poor thinning, return bloom is likely to be inadequate or nonexistent.

Traditionally, the majority of thinning was done at the time fruit are most vulnerable to chemical thinners, at the 7 to 10 mm stage of fruit development (Williams and Edgerton, 1981; Forshey, 1986). In many years thinner activity is variable, due in large part, to variable weather following thinner application, (Byers et al., 1990; Williams and Fallahi, 1999) and varying sensitivity. The loss of crop due to over-thinning is obvious, but occurs less often than under-thinning. The negative economic consequence of insufficient thinning have forced most orchardists to reappraise the thinning strategy used in the past which was based upon a single thinner application. Increasingly, local thinning recommendations suggest using multiple thinner applications, starting as early as bloom (Greene, 2002; Schwallier, 1996). Increased thinner activity is often achieved, because thinner applications have greater probability to coincide with weather that is favorable for thinning. Using this thinning strategy, growers are urged to observe responses to earlier thinner application and make a decision about the need for additional sprays. A problem with this approach is that no guidelines have been provided to help growers estimate the effects of the first thinning treatment in a timely manner. An easy-to-use system is needed to help growers decide if a supplemental thinner application is necessary to achieve adequate thinning.

A number of researchers have noted that fruit destined to drop during the June drop period, stop growth well in advance of the time that they actually abscise (Byers et al., 1991; Greene and Krupa, Lakso et al., 2001; 1999; Marini, 1998; Ward and Marini, 1999). Ward and Marini (1999) evaluated a number of ways to assess thinner response and concluded that fruit growth measurements were the only accurate and practical way to assess thinner response. Greene and Krupa (1999) suggested that measurements of fruit growth rate has the potential as a predictor of chemical thinner response. In a series of thinning trials the usefulness and accuracy of this method were confirmed (Greene et al., 2004).

Over a several-year period we have developed, and continue to refine, a grower-friendly system to predict thinner response and final fruit set based upon following the growth rate of individual fruit in a spur. The purpose of this article is to provide a general description of this procedure and to provide evidence that this is an accurate way to predict final fruit within 7 days of thinner application in good thinning weather, and within 9 days when unfavorable weather follows application.

Generalized Procedure

When fruit size reaches the 7- to 8-mm stage, 70 to 100 spurs are selected randomly on 4 to 8 trees. These spurs are tagged and identified with numbered, iridescent-orange tags so that they can be located easily on the trees. Fruit are individually identified in the spur by either writing a number of individual dots on each with a permanent marker or by some other method. Just prior to spraying, all fruit in the cluster on all spurs are measured with a digital or recording caliper at the

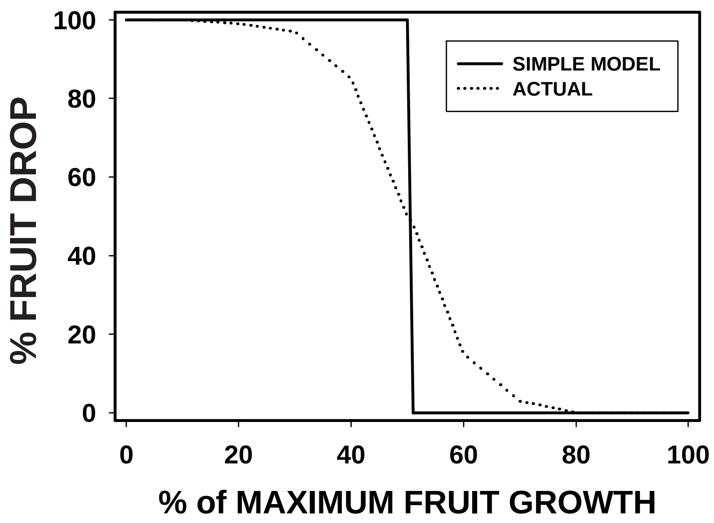

Figure 1. The general relationship between apple fruit drop often found in experiments (Actual) and the simplified 50% cutoff method used in estimation of fruit drop or retention.

location on the fruit where it was identified with a permanent marker. Thinners are applied, and at 2- to 3-day intervals, all fruit in cluster are measured at the point where fruit were numbered and then recorded. This measuring process is continued for 12 to 14 days. There are two key things that must not be deviated from during the measuring and data collection process. First, fruit must be measured at the same location on the fruit each time, since fruit are frequently asymmetrical and measuring the fruit at a different location can cause variability that is greater than the fruit growth over an individual measurement period. Secondly, the growth of individual fruit must be identified so that their growth rate can be calculated individually.

Identifying fruit that will persist to harvest

Initially it may appear that identification of fruit that will persist to harvest may be an impossible task. In actuality, identification of these has proven to be relatively easy and very reliable. It is generally accepted, and confirmed in the literature, that the largest and fastest growing fruit are most able to compete with smaller and slower growing fruit and persist to harvest. We like to have the average of about 20 fruit in the fastest growing group. For example, we have selected the three fastest growing fruit from the 7 trees from which data are taken for a total of 21 fruit in these experiments. Their growth rate is calculated over the most recent measurement period and then an average growth rate of the fruit is calculated. Experience has shown that usually 99% of the fastest growing fruit persist.

Predicting which fruit will persist or drop

Although the relationship between fruit drop and fruit growth rate is a curve, based upon previous expe-

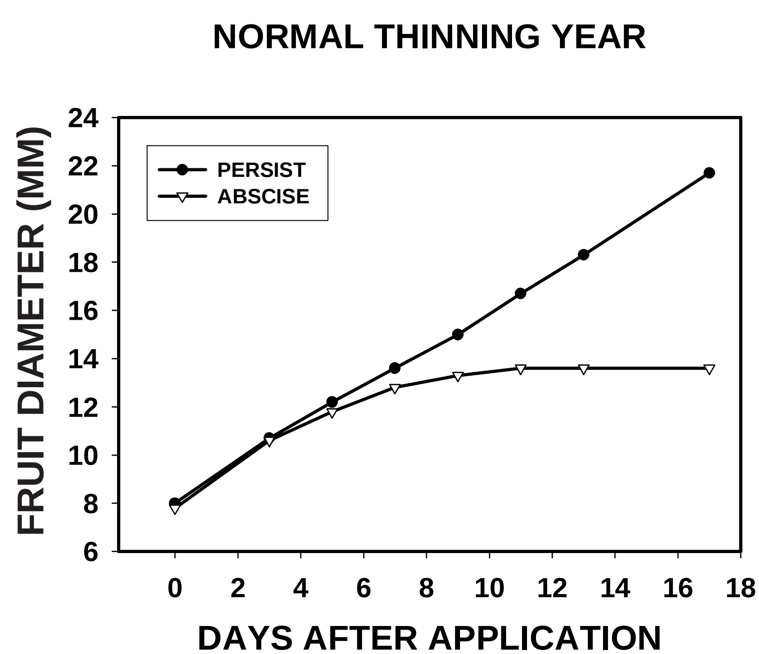

Figure 2. Growth of fruit that will persist to harvest and those that will abscise following thinner application when the weather in the post application period was favorable for thinning.

rience, we have selected 50% as our simplified cut-off level (Figure 1). We predict that a fruit will persist if the growth rate of that fruit is 50% or greater of the growth rate of the 20 fastest growing fruit. Conversely, we predict that a fruit will drop if the growth rate of that fruit slows to less than 50% of the growth rate of the fastest growing fruit during a measurement period of 3 or more days.

When can you make a reliable and accurate prediction?

Once applied, a thinner must be absorbed by the plant and must be translocated to the site of action to elicit a response. The first measurable response that signals that a fruit will abscise is a reduction in growth rate. This reduction in growth rate may occur over a several-day period, but eventually it will stop growing and ultimately abscise. The growth rate of a fruit that will persist to harvest and one that will abscise as the result of thinner application are illustrated in Figure 2. In a normal thinning year when temperatures are favorable, it is possible to measure a reduction in fruit growth within about 4 days of thinner application. This reduction is measurable even if it is less than 1 mm. As growth slows further, the reduction can be used to predict if the fruit will persist or abscise. In a normal thinning year, usually by 7 days after application, the growth rate reduction is sufficiently large so that an accurate prediction of whether it will persist or abscise can be made. There are years when cold and unfavorable weather follows thinner application. Under these conditions it takes longer for the thinner to act, thus the rate of fruit growth does not slow sufficiently such that an accurate prediction of abscission can not be made until 8 or 9 days after application (Figure 3.). We feel that the length of time required before an accurate prediction can be made is primarily temperature

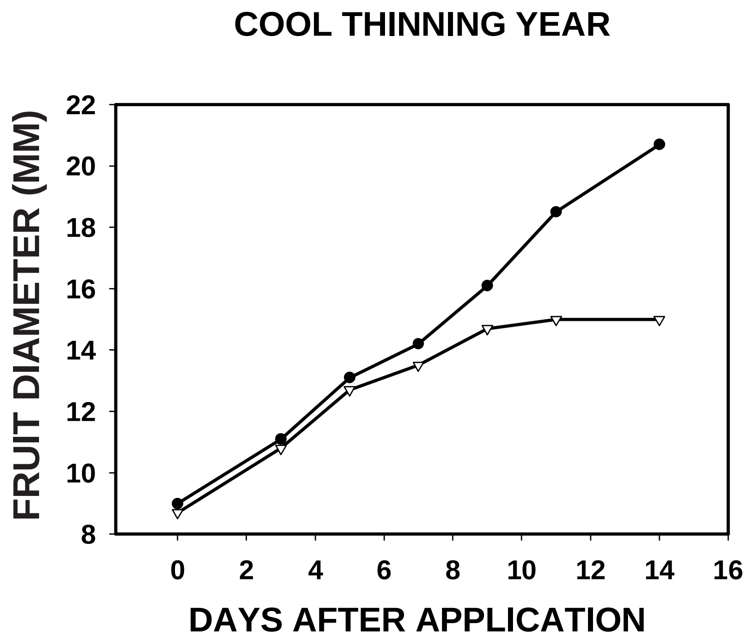

Figure 3. Growth of fruit that will persist to harvest and those that will abscise following thinner application when weather in the post application period was unfavorable for thinning.

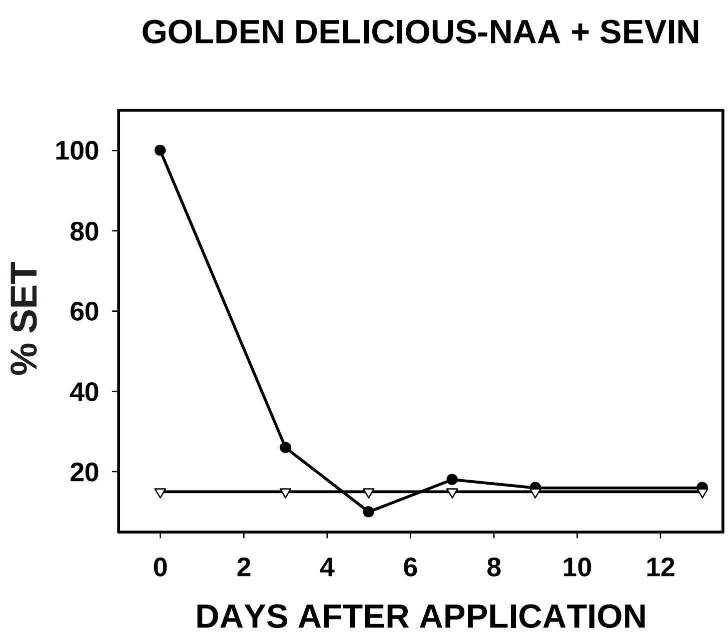

Figure 4. Predicted final set of Golden Delicious apples treated with 10 ppm NAA + 0.5 lb/100 gal carbaryl. Actual set line represents final set measured on spurs at the end of June drop.

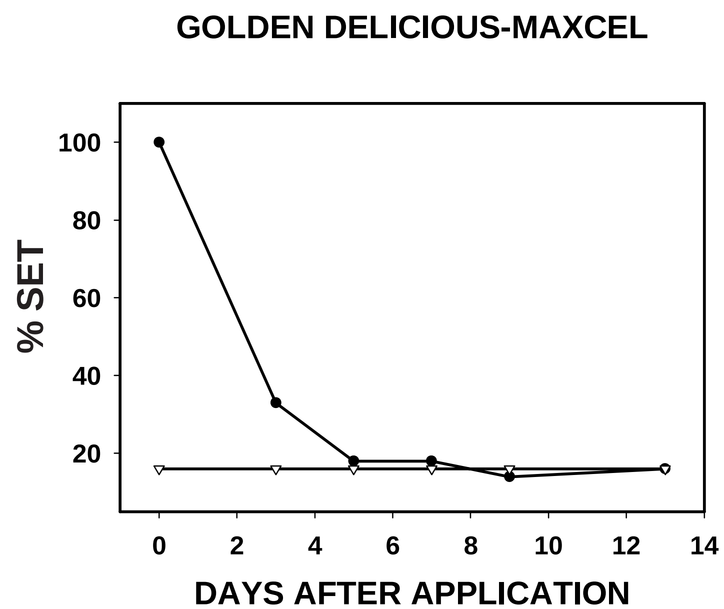

Figure 5. Predicted final set of Golden Delicious apples treated with 125 ppm MaxCel + 0.5lb/100 gal carbaryl. Actual set represents final set measured at the end of June drop.

related. If it is cold, the prediction will be delayed but the window of opportunity for follow-up thinning will also be longer. In subsequent work we hope to be able to provide growing-degree-day guidelines that will aid in determining when the prediction can safely be made.

Testing the Prediction Model

During the 2004 thinning season the prediction model was tested in three different experiments in Massachusetts and New York.

Golden Delicious - Massachusetts. Three limbs 15 to 20 cm in diameter on 7 mature Golden Delicious apple trees were selected. Fifteen spurs on each limb were selected and tagged. The fruit on these spurs were individually identified and then when fruit size reached 8 to 10 mm all fruit in the cluster were measured. NAA at 10 ppm + 0.5 lb/100 gal carbaryl (80 WP) was applied to one limb as a dilute spray and 125 ppm Maxcel + 0.5 lb/100 gal carbaryl to a second limb as dilute sprays on 25 May. A third limb served as an untreated control. Fruit were subsequently measured at 2- to 3-day intervals. Three and 5 days after application, a large number of the fruit had slowed growth to less than 50% of the growth rate of the fastest growing fruit (Figure 4). Since temperature was favorable for thinning, we feel that an accurate prediction of final set could have been made by 7 days after application. The prediction made at this time was 18% set while actual set measured in July after June drop was 15%, a prediction that was within 3% of the actual final set. Spurs on the limb treated with MaxCel and carbaryl showed similar accuracy in prediction of final set (Figure 5). At 7 days after application, we predicted a final set of 18% when final set was actually 16%.

Delicious - Massachusetts. Twenty one trees were selected and divided into 7 groups of 3 trees each in a block of mature Ace Delicious/M26. Fifteen spurs per tree were selected and

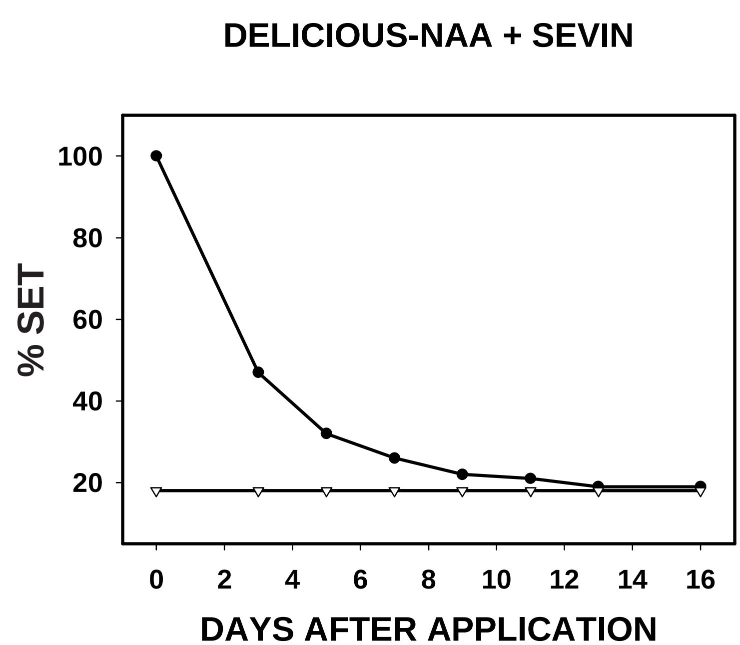

Figure 6. Predicted final set of Delicious apples treated with 7 ppm NAA + 0.5 lb/100 gal carbaryl. Actual set line represents final set measured on spurs at the end of June drop.

tagged and fruit numbered and measured similar to that described for the Golden Delicious. One tree in each block was sprayed with 7 ppm NAA + 0.5 lb/100 gal carbaryl and another with 125 ppm MaxCel + 0.5 lb/100 gal using a commercial airblast sprayer and applied at tree row volume dilute. A third tree in each block served as an untreated control. All fruit were measured just prior to application and again at 2 to 3 day intervals.

Prediction of final set on trees treated with NAA + carbaryl and MaxCel + carbaryl are illustrated in Figure 6 and Figure 7, respectively. Final set was determined in July at the end of June drop. In general, the greater the time period after application the more accurate was the prediction of final set. The goal with this system is to make a prediction within 7 days of application so that it will be possible to apply a supplemental thinner while fruit are still susceptible to chemical thinners. At 7 days after application, the model predicted 26% set on trees treated with NAA + carbaryl and the actual set was 18%. Similarly, on trees treated with MaxCel + carbaryl set was predicted to be 13% and actual set was 10%.

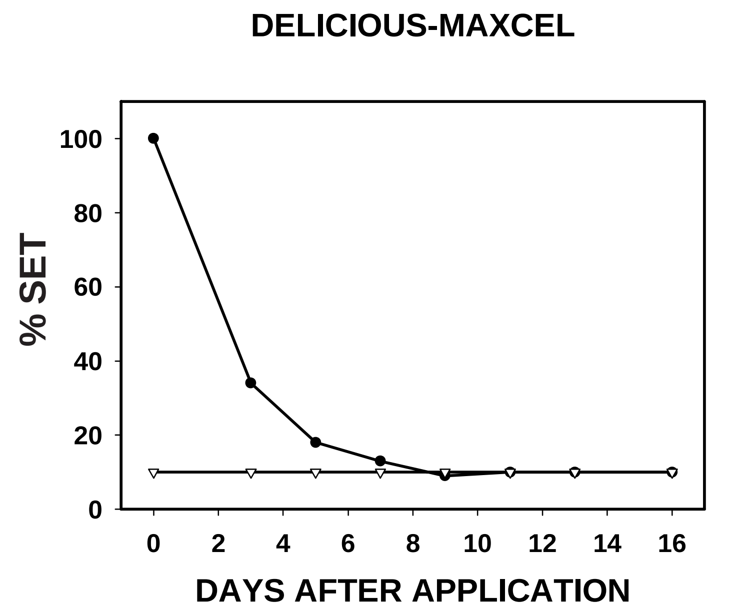

Figure 7. Predicted set of Delicious apples treated with 125 ppm MaxCel + 0.5 lb/100 gal carbaryl. Actual set line represents final set measured on spurs at the end of June drop.

Gala - New York. In a block of mature Gala/M.9, 4 blocks of 2 trees each were selected. Twenty spurs were selected and tagged and individual fruit marked and measured when fruit were about 11 mm in diameter. NAA at 7 ppm + carbaryl at 0.5 lb/100 gal was applied with an airblast sprayer at tree row volume dilute. Because of poor weather at bloom, initial set prior to thinner application was low (Figure 8). Weather conditions following application were conducive to good thinning so prediction of final set at 8 days after application is appropriate. Prediction made at his time was quite precise. This also showed that the poor weather before thinning had already caused many fruit to stop growing even before treatment. So in this case much of the final apparent "thinning" was actually

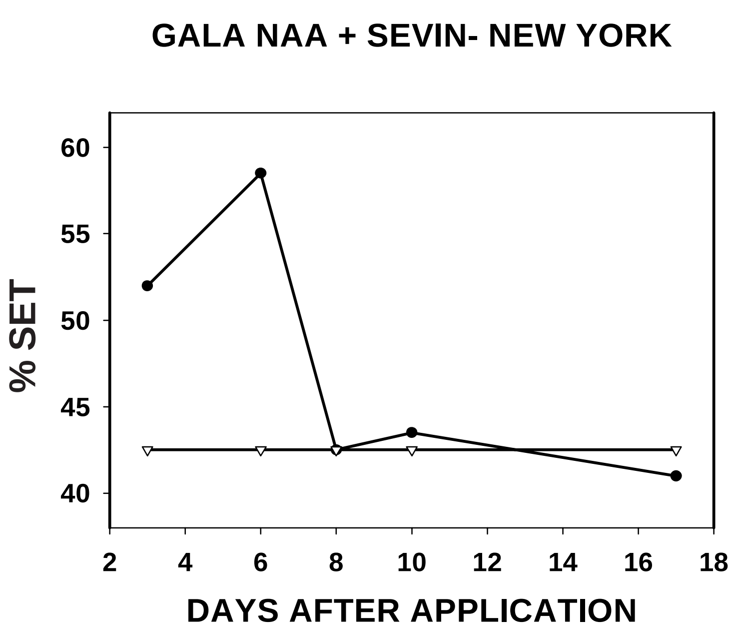

Figure 8. Predicted final set of Gala apples treated with 7 ppm NAA + 0.5 lb/100 gal carbaryl. Actual set represents final set measured on spurs at the end of June drop.

induced by poor weather with only a relatively small additional thinning by the chemical thinner. Showing these effects is another strength of this method.

What additional things need to be done to make this an effective, accurate, and grower-friendly system to predict thinner response?

1. Refine the selection of spurs to give an accurate representation of those on the tree. We are very close on spurs we monitor, but improved precision for the whole tree is needed.

2. Make the predictive system a user-friendly process. Currently, measurements are done at 2- to 3-day intervals starting at the time of application. A focus this coming year will be to make just two measurements: one about 4 days after application and a second at 7 to 9 days after application, depending on the temperature.

3. Develop a spreadsheet template into which to enter all information. We hope to build in as many automatic calculations as possible. Currently, calculations can be time consuming at a busy time.

4. Change the way we approach chemical thinning. This approach involves making an estimation of the number of fruit that you would like to have on a tree at harvest. Count bloom on a tree or tree unit. Calculate the number of fruit per spur that you need to get the ideal number of fruit that you would like to set. That calculated number is the one you will try to achieve in your percent set estimation.

5. Revive studies to improve thinning at the 12 mm to 15 mm stage. Supplemental thinning, if deemed necessary, will be done on fruit in this size range.

Acknowledgements

The authors are grateful to the support provided to this research by the Massachusetts Fruit Growers' Association and the Washington State Tree Fruit Research Commission.

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Fruit Set, Fruit Size, and Other Fruit Characteristics of Marshall McIntosh and Ace Spur Delicious Apples Are Affected By MaxCel®, 2004 Results

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The thinning capability of benzyladenine (BA) has been known for over a quarter of a century. It was demonstrated by many investigators that it was a consistent thinner, and unlike other commercially-available thinners, it could increase fruit size beyond that which could be attributed solely to crop load reduction. It was not until 1994, however, that a thinner containing the active thinning ingredient BA was registered for use as a thinner. This product, Accel®, was an altered formulation of Promalin®, and it contained a small amount of gibberellin (GA). Initially, the small amount of GA present was considered too small to be physiologically significant. It soon became apparent, however, that the GA present in Accel could result in undesirable effects, especially the production of small and frequently seedless fruit. Further, the GA in the Accel interacted with naphthaleneacetic acid (NAA), which frequently resulted in the production of a large number of pygmy fruit.

In 2003, a new BA product was introduced that contained no GA (MaxCel®). Initial studies with this product suggested that MaxCel may be a superior product for thinning apples. The purpose of this investigation was to evaluate the new BA formulation as a thinner on apples and to determine if additional thinning could be achieved by the addition of carbaryl of carbaryl and oil.

Materials & Methods

Marshall McIntosh. Eighty mature Marshall McIntosh/M.26 were selected at the University of Massachusetts Cold Spring Orchard Research and Education Center (Block K2). At the pink stage of flower development, two limbs per tree, 10 to 15 cm in diameter, were selected, tagged and measured. All spur blossom clusters were counted and recorded on the tagged limbs. Bloom density was calculated. Trees were blocked into 8 groups (replications) of 10 trees each, based upon blossom cluster density. Treatments were applied on 21 May when fruit size averaged between 8 and 9 mm. The weather was partly cloudy with temperatures during the time of application ranging from the upper 60’s into the mid 70’s, but ultimately the temperature rose to the lower 80’s later in the day. Treatments were applied as illustrated in Table 1 using a commercial airblast sprayer at a tree row volume of 135 gal/acre. Buffer trees were maintained between trees to assure that no tree received drift from an adjacent tree. At the end of June drop in July, the fruit on all tagged limbs were counted and recorded. On 16 September, five replications were harvested, and fruit were analyzed. The remaining three replications were harvested on 17 September and similarly processed. A 30-apple sample was harvested randomly from the periphery of each tree. Fruit were weighed, and red color was estimated to the nearest 10%. Further, the intensity of red color was evaluated to determine if fruit could be classified as US Extra Fancy. The percent of US Extra Fancy fruit was determined by counting all fruit that had at least 50% red color and had intensity that was great enough to meet the US Extra Fancy grade. A subsample of 10 fruit, representative of the harvested sample was selected. Flesh firmness was determined on two sides of each fruit using an Efegi penetrometer. Juice collected while doing the firmness determinations was pooled and the concentration of soluble solids was determined using a hand-held refractometer. Fruit were then cut at the equator, dipped in an iodine-potassium iodide solution, and starch reading made using the generic starch chart developed at Cornell University. The first four replications of treatments 1, 2, 3, and 10; Control, MaxCel 75 ppm , MaxCel 125 ppm, and NAA 7 ppm + carbaryl, respectively, were selected. All fruit were harvested from each tree (16 trees total) and separately identified. Fruit were taken to the laboratory where each fruit was measured with a hand-held caliper and placed in one of the following size categories: <2.25, 2.25,. 2.50, 2.75, 3.00, 3.25, 3.50, 3.75, and >3.75 inches. Fruit with a diameter of + 0.12 inches to - 0.13 inches of the sizes indicated above were placed into the indicated size categories. For example, a 3.00 inch fruit category would include all fruit with a diameter of 2.87 inches to 3.12 inches. Economic data were generated based upon prices that were received in the Boston Market in November 2004. The sizes of the fruit from each tree were known from caliper measurements. Dollar values were generated by dividing the box size into the number of fruit that were in each size category, then multiplying the price received for that box size in the market. These data were then adjusted to price received per acre by knowing the number of trees per acre. The cost of thinners is not included in the calculations.

Ace Spur Delicious. Seventy 16-year-old Ace Spur Delicious/M.26 were selected at the UMass Cold Spring Orchard Research & Educaion Center (Block K2). Bloom was assessed as previously described. Trees were organized in seven groups (replications) of ten trees each, based upon blossom-cluster density. Treatments were applied on 21 May 2004 when fruit size was approximately 7 mm in diameter. Treatments shown in Table 4 were applied at tree row volume dilute of 135 gal per acre, using a commercial airblast sprayer. Fruit set was determined at the end of June drop in July. On 4 October, a 30-apple sample was harvested randomly from the periphery of each tree. Fruit were weighed, and then the L/D ratio was determined on all 30 fruit by measuring collective length and then diameter in a V-shaped holder. Red color was not estimated, because all fruit had 90+% red color. Fruit quality evaluation was similar to that reported for McIntosh. The first four replications of treatments 1, 5, 6, and 10: Control, MaxCel 75 ppm + carbaryl, MaxCel 125 + carbaryl, NAA 7 ppm + carbaryl were

Table 1. Effects of MaxCel, carbaryl, oil and combinations on fruit set of Marshall McIntosh apples. 2004. Means within column not followed by the same letter are significantly different at odds of 19 to 1.

Treatment	Blossom clusters (no./ cm^2 limb x-sectional area)	Fruit set (no./cm^2 limb x-sectional area	Fruit set (no./ 100 blossom clusters)
Control	8.4 a	6.7 a	85 a
MaxCel 75 ppm	8.2 a	4.9 bc	62 bcd
MaxCel 125 ppm	8.4 a	4.6 bcd	49 cde
Carbaryl (1 lb/100 gal) (C)	8.4 a	5.9 b	75 ab
MaxCel 75 + C	8.0 a	3.2 cd	42 bc
MaxCel 125 + C	8.2 a	2.5 d	31 e
Carbaryl + 1 qt/100 gal oil	8.1 a	6.3 b	78 abc
MaxCel 75 + C + Oil	8.2 a	2.8 cd	37 e
MaxCel 125 + C + Oil	7.8 a	2.6 d	33 e
NAA 7 ppm + C	8.2 a	5.0 bc	60 bcd
Significance	NS	***	***
BA	NS	l***	l***
Carbaryl	NS	l**	l**
BA + Carbaryl	NS	NS	NS

Table 2. Effects of MaxCel, carbaryl, oil and combinations on fruit quality and fruit characteristics of Marshall McIntosh apples. 2004. Means within column not followed by the same letter are significantly different at odds of 19 to 1.

Treatment	Weight (g)	Firmness (lb)	Soluble solids (%)	Red color (%)	US Extra fancy (%)	Starch rating
Control	151 d	16.3 a	11.4 de	66 ab	79 a	5.0 a
MaxCel 75 ppm	166 bcd	16.9 a	11.4 de	62 b	67 abc	4.7 bc
MaxCel 125 ppm	181 ab	17.0 a	11.9 bcd	63 b	72 ab	4.6 bc
Carbaryl (1 lb/100 gal) (C)	155 cd	16.8 a	11.3 e	68 a	77 a	4.8 abc
MaxCel 75 + C	171 bc	17.0 a	12.2 ab	62 b	65 abc	4.5 c
MaxCel 125 + C	181 ab	17.1 a	12.5 ab	62 b	63 abc	4.7 abc
Carbaryl + 1 qt/100 gal oil	161 bcd	16.5 a	11.5 cde	66 ab	78 ab	4.8 abc
MaxCel 75 + C + Oil	171 bc	17.0 a	12.1 abc	62 b	54 c	4.6 bc
MaxCel 125 + C + Oil	188 a	16.8 a	12.7 a	61 b	58 bc	4.6 bc
NAA 7 ppm + C	155 cd	16.7 a	11.3 e	68 a	73 ab	4.8 ab
Significance	***	NS	***	**	*	*
BA	l***	l*	l***	l***	l***	l*
Carbaryl	NS	NS	l**	NS	l***	NS
BA + Carbaryl	NS	NS	NS	NS	NS	NS

Table 3. Effects of MaxCel and NAA plus carbaryl applied to Marshall McIntosh on the percent distribution of apples into specific fruit size classes. 2004. Means within column not followed by the same letter are significantly different at odds of 19 to 1.

	Fruit size (inches)						
Treatment	<2.50	2.50	2.75	3.00	3.25	3.50	3.75
Control	1.5 ab	6.8 ab	34.1 a	43.4 a	13.8 b	0.4 b	0.0 b
MaxCel 75 ppm	1.2 ab	5.7 ab	25.3 ab	43.2 a	22.7 ab	2.0 ab	0.0 b
MaxCel 125 ppm	0.9 b	3.5 b	18.8 b	41.2 a	30.4 a	5.1 a	0.3 a
NAA 7 ppm + carbaryl	2.3 a	8.3 a	33.7 a	41.7 a	13.7 b	0.4 b	0.0 b

selected. All fruit were harvested from each tree (16 trees total) and separately identified. Fruit were individually measured using a hand-held caliper and placed into size categories between <2.25 inches to >3.75 inches in 0.25 inch increments as previously described. Economic data were generated similar to those described for Marshall McIntosh.

Results & Discussion

McIntosh. Bloom was uniform before treatments were applied. MaxCel at 75 and 125 ppm thinned comparably and to an ideal level (Table 1). Carbaryl by itself was less effective than MaxCel although statistically different from the control. As is expected when carbaryl is combined with MaxCel, increased thinning was observed. In our estimation these treatments thinned too much. When oil was combined with either MaxCel or carbaryl, no additional thinning was observed. This was somewhat surprising since there are several references in the literature to increased thinning when oil is included. This is the second year in a row that oil has not increased thinning activity when included with MaxCel and carbaryl or carbaryl alone. NAA + carbaryl thinned and it was statistically comparable to MaxCel. There were no interactions be-

Table 4. Effects of MaxCel, carbaryl, oil and combinations on fruit set of Ace Spur Delicious apples. 200 Means within column not followed by the same letter are significantly different at odds of 19 to 1.

Treatment	Blossom clusters (no./ cm^2 limb x-sectional area)	Fruit set (no./cm^2 limb x-sectional area	Fruit set (no./ 100 blossom clusters)
Control	9.1 a	6.1 a	69 a
MaxCel 75 ppm	9.3 a	5.8 ab	66 ab
MaxCel 125 ppm	9.2 a	5.0 abcd	54 abc
Carbaryl (1 lb/100 gal) (C)	8.9 a	5.8 ab	67 ab
MaxCel 75 + C	9.3 a	3.8 cd	48 bc
MaxCel 125 + C	9.2 a	3.6 d	41 c
Carbaryl + 1 qt/100 gal oil	9.1 a	5.7 ab	67 ab
MaxCel 75 + C + Oil	9.2 a	4.3 bcd	48 bc
MaxCel 125 + C + 0il	8.9 a	3.7 cd	44 c
NAA 7 ppm + C	9.3 a	5.3 abc	60 abc
Significance	NS	**	**
BA	NS	l***	l**
Carbaryl	NS	NS	l*
BA + Carbaryl	NS	NS	NS

Table 5. Effects of MaxCel, carbaryl, oil and combinations on fruit quality and fruit characteristics of Ace Spur Delicious apples. 2004. Means within column not followed by the same letter are significantly different at odds of 19 to 1.

Treatment	Weight (g)	Firmness (lb)	Soluble solids (%)	L/D ratio	Starch rating
Control	161 c	17.5 a	10.6 c	0.940 c	3.5 a
MaxCel 75 ppm	179 bc	17.3 ab	10.5 c	0.959 bc	3.6 a
MaxCel 125 ppm	203 ab	17.2 abc	10.8 bc	0.958 bc	3.4 a
Carbaryl (1 lb/100 gal) (C)	185 bc	16.9 bc	10.7 c	0.943 c	3.6 a
MaxCel 75 + C	222 a	16.9 abc	11.2 ab	0.952 c	3.5 a
MaxCel 125 + C	224 a	17.0 abc	11.2 ab	0.984 a	3.7 a
Carbaryl + 1 qt/100 gal oil	181 bc	16.8 bc	10.7 c	0.960 bc	3.3 a
MaxCel 75 + C + Oil	203 ab	17.0 abc	10.9 abc	0.975 ab	3.4 a
MaxCel 125 + C + 0il	227 a	17.0 abc	11.3 a	0.981 a	3.3 a
NAA 7 ppm + C	192 b	16.6 c	10.7 c	0.954 c	3.5 a
Significance	***	NS	**	***	NS
BA	l***	NS	l*	l***	NS
Carbaryl	l*	l*	NS	l**	NS
BA + Carbaryl	NS	NS	NS	NS	NS

Table 6. Effects of MaxCel and NAA plus carbaryl applied to Ace Spur Delicious on the percent distribution of apples into specific fruit size classes. 2004. Means within column not followed by the same letter are significantly different at odds of 19 to 1.

	Fruit size (inches)								
Treatment	<2.25	2.25	2.50	2.75	3.00	3.25	3.50	3.75	>3.75
Control	3.4 a	8.7 a	27.8 a	35.0 a	22.6 b	2.5 c	0.0 b	0.0 b	0.0 a
MaxCel 75 ppm + carbaryl	0.0 c	0.5 b	4.1 b	12.3 c	25.7 b	31.6 a	21.9 a	3.5 a	0.3 a
MaxCel 125 ppm + carbaryl	1.3 bc	2.5 b	7.6 b	20.3 bc	31.4 ab	30.7 ab	6.6 b	0.0 b	0.0 a
NAA 7 ppm + carbaryl	2.3 ab	3.2 b	11.6 b	29.6 ab	35.6 a	16.3 bc	1.5 b	0.0 b	0.0 a

tween BA and carbaryl.

All MaxCel treatments increased fruit size (Table 2). It appears that the increase in fruit size is the result of reduced competition due to thinning and also to increased cell division due to MaxCel. There was no size benefit from thinning with NAA plus carbaryl. This is noteworthy since the NAA concentration is not excessive, and NAA was applied at a time when a negative effect on fruit size is generally not observed. NAA can reduce fruit size or have no effect even if thinning is done if NAA is applied when fruit are large (above 15 mm), a high rate of NAA is applied, or if hot temperature follows application. The amount of thinning with carbaryl may not be great enough to influence size. No treatment affected flesh firmness. MaxCel significantly increased soluble solids. Most likely this is due to a more favorable leaf to fruit ratio caused by thinning rather than a direct effect of MaxCel. MaxCel significantly and linearly reduced red color. This is most apparent when looking at the US Extra Fancy fruit where the quality or intensity of red color is also taken into account. Generally we do not recommend a MaxCel concentration over 100 ppm for color-sensitive varieties, such as McIntosh and Macoun, because of the possibility of reducing red color. This year, red color was reduced at 75 ppm. Interestingly, the addition of oil appeared to have an effect on reducing red color (although not significantly) even though it had no effect on thinning. This effect warrants watching in the future. No treatment influenced the time of ripening, based upon starch index values.

Thinning treatments had a large effect on size distribution of the fruit on a tree (Table 3). The majority of all fruit in all treatment peaked in the 3-inch size category. MaxCel shifted fruit that normally would fall in the 2.5- and 2.75-inch categories into larger size classes, and more fruit were in the 3.25- and 3.5-inch size categories. This shift involved a substantial portion of the crop and it was statistically significant. Another interesting observation is that NAA had no influence on size distribution relative to the untreated control. In fact, the size distribution between control and NAA-treated fruit were almost identical.

Projected gross income from sale of the fruit is illustrated in Table 8. The yield and size distribution from four trees for each treatment was used. The information was then extrapolated to a per-acre basis. It was assumed that there was 100% packout. Yield in

Table 7. Temperature at the University of Massachusetts Cold Spring Orchard Research & Education Center the day of application of thinners and for the following 14 days.

Date	Temp. Max. (°F)	Temp Min. (°F)
21 May	80.7	50.2
22 May	64.7	49.2
23 May	81.4	45.8
24 May	68.8	52.8
25 May	68.9	51.0
26 May	57.1	54.2
27 May	76.9	45.2
28 May	67.5	54.2
29 May	60.7	45.2
30 May	69.4	45.2
31 May	55.5	39.9
1 June	55.7	44.5
2 June	72.8	44.5
3 June	70.6	51.8

Table 8. Gross sales income adjusted to a per acre basis from the sale of fruit in all size categories. Marshall McIntosh.

Treatment	Gross income ($)
Control	9,233
MaxCel 75 ppm	7,365
MaxCel 125 ppm	9,647
NAA 7 ppm + carbaryl	9,246

this block was quite high and neared 800 bu/acre. The greatest return was from the MaxCel at 125 ppm and the least from MaxCel at 75 ppm. Since set in this block was not heavy and thinning was not great, these numbers are not too surprising.

Delicious. Bloom was uniform before treatments were applied. MaxCel alone at 75 ppm and 125 ppm and carbaryl alone appeared to thin only modestly and this amount was not statistically different from control levels (Table 4). The addition of carbaryl to the MaxCel significantly increased the thinning response as was the case with McIntosh. The addition of oil to either carbaryl or MaxCel plus carbaryl did not increase thinning further. NAA plus carbaryl appeared to thin comparably to MaxCel alone.

MaxCel alone dramatically increased fruit size alone even though it thinned modestly (Table 5). When carbaryl was included with MaxCel an additional increase in fruit size was realized which was most likely due to thinning and the increased cell division caused by MaxCel. It is unclear if treatments influence flesh firmness. Carbaryl, however, significantly reduced flesh firmness; whereas, MaxCel had no effect. Generally, there is a reduction in flesh firmness as fruit size increases. Frequently BA increases fruit size with no effect on firmness. We interpret these data to mean that the increased number of cells in the MaxCel-treated fruit, which undoubtedly affect firmness, counteracted any potential reduction in flesh firmness resulting from increased fruit size. MaxCel and combinations increased soluble solids. As with McIntosh, some, if not all of this effect, can be attributed to the reduction in crop load which leads to a more favorable leaf to fruit ratio. MaxCel increased the L/D ratio. The response was linear with concentration and was greater when oil was included. We interpret this to mean that oil increased the uptake of MaxCel into the fruit. No treatment influenced the time of ripening, based upon starch index values. Red color was not assessed on Delicious, since all fruit, regardless of treatment, were 90% red or more. At no time, however, was it apparent that MaxCel had any detrimental effect on red color.

All thinning treatments increased fruit size and shifted the mean fruit size of Delicious to the larger categories (Table 6). MaxCel was more effective at increasing fruit size. These data clearly show that MaxCel did not increase the number of fruit below 2.25 inches (pygmy fruit). Although the numbers are relatively low, these data show that MaxCel produced significantly fewer very small pygmy-like fruit.

Projected income from sales of the fruit is illustrated in Table 9. Yield from the four trees per treatment and size distribution of those fruit were used to generate these data. Yield from the four trees was extrapolated to a per-acre basis. It was assumed that packout was 100%. Total yield in this block was quite high and approached 1200 bu per acre, thus the very high numbers. MaxCel at 75 ppm + carbaryl had the greatest income whereas MaxCel at 125 ppm + carbaryl had the least. Differences between the two MaxCel rates are due to greater thinning with 125 ppm and to some tree-to-tree variability.

Temperature. The maximum and minimum temperatures for the day of application and the subsequent 14 days are presented in Table 7. The day of ap-

Table 9. Gross sales income adjusted to a per acre basis from the sale of fruit in all size categories. Ace Spur Delicious.

Treatment	Gross income ($)
Control	14,008
MaxCel 75 ppm + carbaryl	15,621
MaxCel 125 ppm + carbaryl	11,525
NAA 7 + carbaryl	14,369

plication was warm, but currently we dismiss the temperature at the time of application a having any significant effect on subsequent thinning. The day after application, the temperature was quite cool, but the next day the maximum temperature exceeded 80°F. Three and four days after application the temperature was acceptable for thinning but on the lower range of what we hope for. Our interpretation of the temperature profile is that the weather was acceptable to somewhat favorable for a good thinning response. Temperature may be important since previous experience with BA indicates that good thinning is dependent upon above-average temperatures following application. We interpret this, base not upon this year's data but previous years experience, that the current formulation of BA, MaxCel, is less influenced by unfavorable temperatures following application than experienced with Accel and other earlier BA formulations. Thus, we feel that MaxCel may thin well over a wider temperature range.

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The Last Chance for Chemical Thinning of Apples

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Chemical thinning is one of the most difficult practices in the orcharding year. Optimal chemical thinning, however, is often critical to the success of a year's crop. Weather, timing, choice of chemicals, and concentration come together to affect chemical thinning, as do the previous season's level of cropping, winter temperatures, and tree health. In recent years, to enhance the degree of success, growers have utilized petal-fall thinning treatments, followed by multiple additional treatments as needed. Most often, these multiple applications of thinners give adequate results. Occasionally, however, the weather does not cooperate, either preventing treatment applications or reducing the trees ability to respond to treatments. Once fruit exceed 0.6 inches (15 mm) in diameter, they do not respond to normal chemical thinners. Historically, the only viable option for reducing fruit set beyond this point is by hand, and we all know that this practice is costly with much less benefit than chemical thinning soon after bloom.

Ethephon is often used to advance apple harvest, because when it breaks down in plant tissue, ethylene is released, and ethylene triggers ripening. In some parts of the US, it also is used as a chemical thinner, the mode of action also hinging on ethylene release. We have had very limited experience with ethephon as a chemical thinner, because it has often been thought to be too potent and possibly too variable in effect in our climate. On the other hand, it is the only chemical thinner that can work when fruit are larger than 0.6 inches. Because of the latter, we began a study in 2003 with the following objectives: 1) to gain more experience using ethephon to thin apples, 2) to determine the appropriate range of concentrations to use in our climate, and 3) to determine if potential variability of the ethylene response could be controlled with AVG (ReTain®).

Materials & Methods

This study was conducted first in 2003 and repeated in 2004 in a block of 10-year-old Gatzke McIntosh/M.26 at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block E3). Sixty trees were allocated among five replications, based on initial fruit set. Within each replication, half the trees were treated with AVG (200 ppm with 0.125% Regulaid® in 2003 and 400 ppm with 0.1% Silwet® L-77 in 2004) six days prior to ethephon application (Figure 1). On June 16, 2003 (fruit 0.8 inches in diameter) and on June 10, 2004 (fruit 0.9 inches in diameter), six untreated and six AVG-treated trees within each rep were allocated randomly among six thinning treatments (untreated, 0 ppm ethephon plus carbaryl, 200 ppm ethephon plus carbaryl, 300 ppm ethephon plus carbaryl, 400 ppm ethephon plus carbaryl, and 500 ppm ethephon plus carbaryl) (Figure 1). Carbaryl was included as Sevin® 80S at a rate of 1.25 pounds per 100 gallons (1 pound a.i./ 100 gallons).

Beginning just before treatment, fruit and leaf samples were taken periodically from each tree until 10 days after treatment in 2003 and 11 days after in 2004. These samples were enclosed in Mason Jars equipped with a septum cap for removal of gas samples. Three hours after sealing samples in the jars, a sample of air was removed from each, and the ethylene concentration of that air was measured.

In August, final fruit set was assessed for each tree (utilizing two representative limbs per tree selected prior to assigning treatments). On September 8, 15, and 22, 2003 and September 10, 17, and 24, 2004, 4-apple samples were collected from each tree, and the internal ethylene concentration was assessed. On September 15, 2003 and September 17, 2004, 20-apple

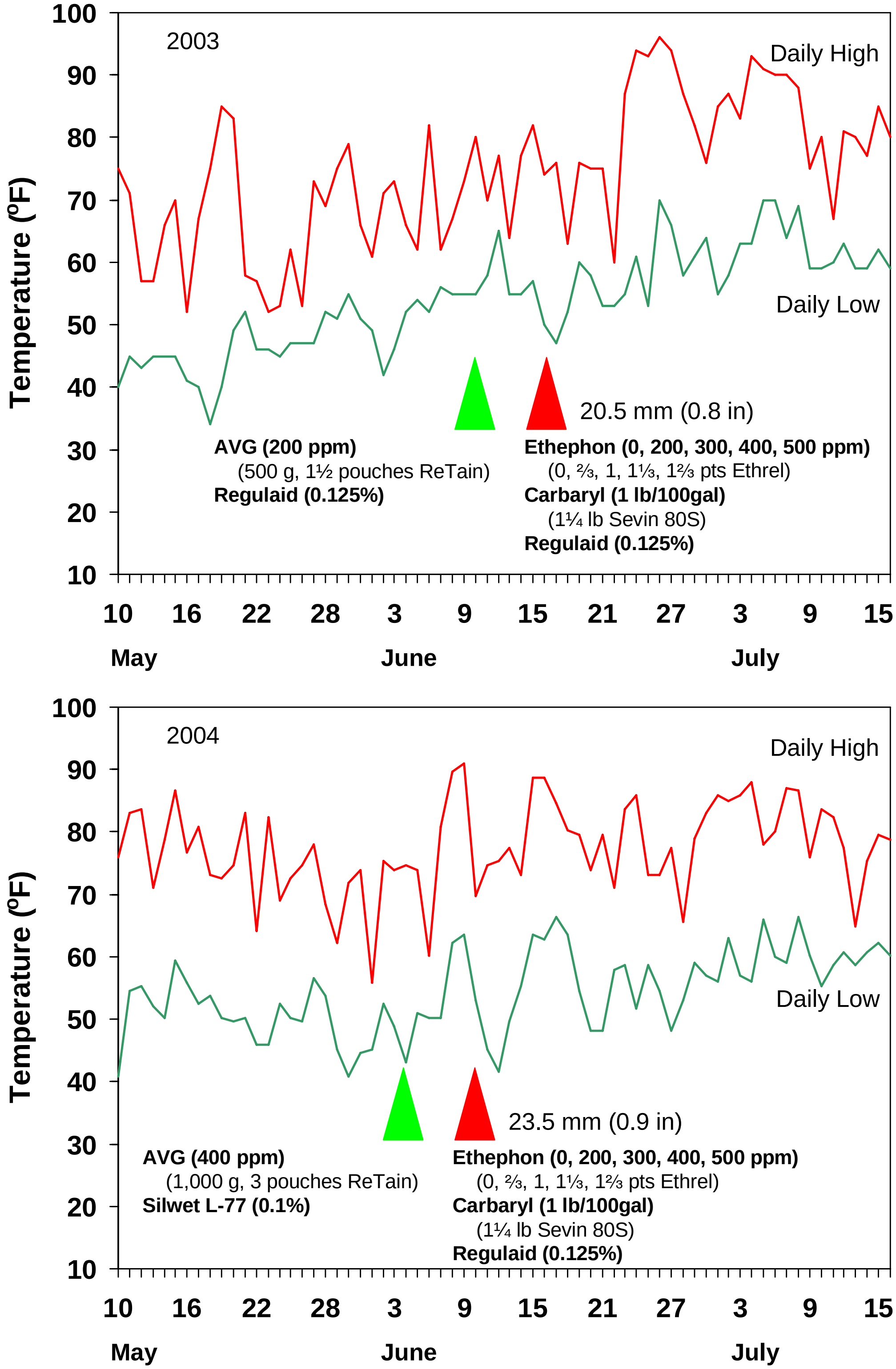

Figure 1. Temperature, timing, and concentrations of late-season thinning treatments to McIntosh in 2003 and 2004.

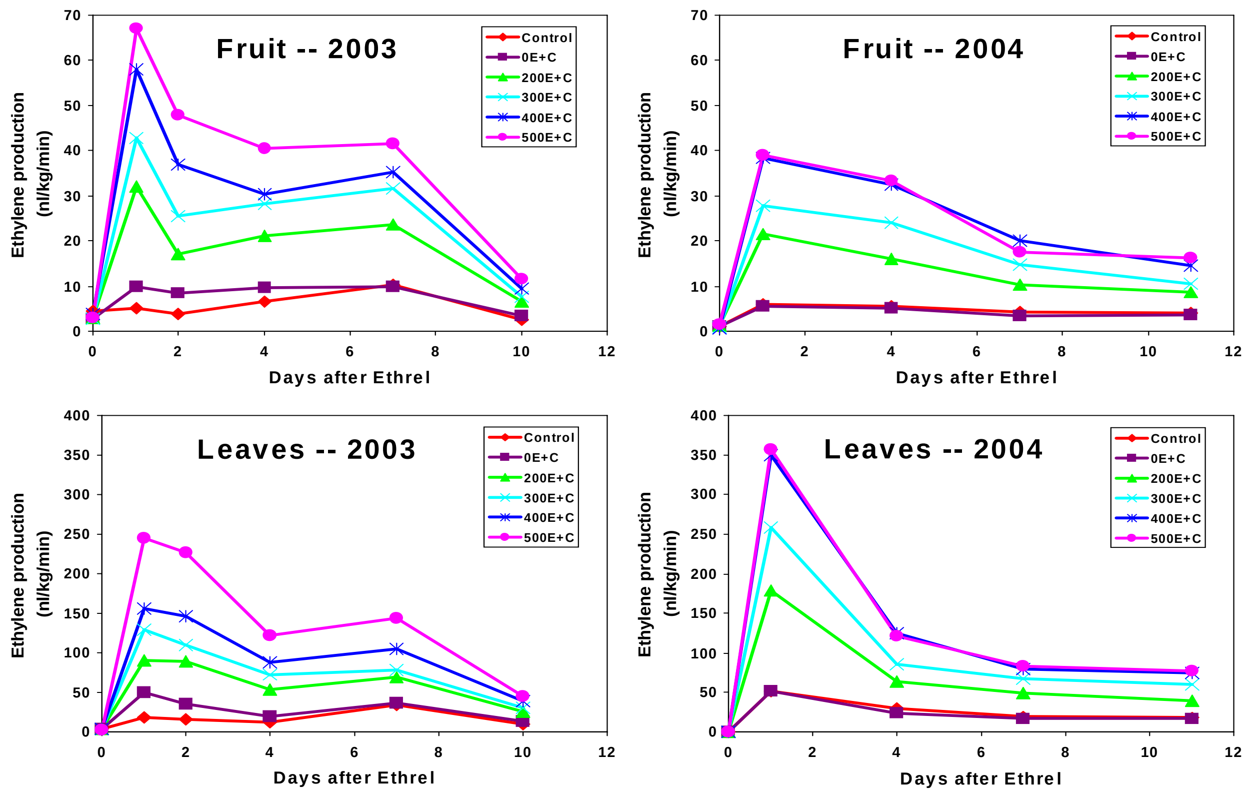

Figure 2. Ethylene production from fruitlets and leaves immediately following application of late-season thinning treatments to McIntosh in 2003 and 2004.

samples were collected from each tree and were weighed. Ten apples were selected at random from this sample for the measurement of flesh firmness (two punctures per fruit with Effegi penetrometer), soluble solids concentration (juice collected from firmness measurements assessed with hand refractometer), and starch pattern (equatorially cut fruit dipped in iodine-potassium iodide solution and compared to Cornell Universal Starch Chart).

Results

Daytime temperatures varied from 2003 to 2004 (Figure 1). In 2003, May and early June were relatively cool, with relatively few days greater than 80°F. Ethephon treatments were applied when temperatures were in the 70's, but about a week after application, we experienced several days in the 80's and 90's. The period leading up to application in 2004 was warmer than in 2003, three days in the 80's just prior to application. Just after application, temperatures were in the 70's, but rose to near 90 four days later.

Immediately following treatment, both fruit and leaves responded by dramatic increases in the production of ethylene (Figure 2). This increase in production began to dissipate very soon and reached near normal levels after 10 days. AVG had no consistent impact on ethylene evolution after treatment (data not shown) and did not have a substantive effect on any other measurement in this study, so no data on AVG's effects will be presented here.

Ethrel reduced final fruit set significantly each year, and the response was generally linear with concentration (Tables 1 and 2). Optimal set was obtained with between 200 and 300 ppm ethephon (plus carbaryl). Higher concentrations overthinned, and carbaryl alone (with 0 ppm ethephon) did not provide adequate thinning. Return bloom the spring after the 2003 treatments was increased considerably by 200, 300 and 400 ppm ethephon. In 2005,

Table 1. Effects of ethephon (Ethrel®) plus carbaryl (Sevin® 80S) on fruit set, fruit quality, and return bloom of Gatzke McIntosh in 2003. Ethephon and carbaryl (with 0.125% Regulaid®) were applied on June 16, when fruit were 0.8 inches (20.5 mm) in diameter.

Ethephon (ppm)	Carbaryl (lbs a.i./ 100 gal)	Initial fruit set (no./cm^2 LCA)	Final fruit set (no./cm^2 LCA)	Return bloom – 2004 (no./cm^2 LCA)	Internal ethylene (log ppm)	Flesh firmness (lbs)	Soluble solids (%)	Starch index value	Fruit weight (g)
0	0	19.0	8.6	9.2	-0.6	14.8	10.6	6.2	180
0	1	19.2	8.2	12.6	-0.8	15.1	11.1†	6.1	176
200	1	19.1	6.3	14.3†	-0.8	15.9	11.2†	5.7	168
300	1	19.2	5.6†	14.6†	-0.6	15.4	11.8†	5.6	185
400	1	18.7	3.7†	14.0†	-0.0	15.5	12.2†	5.7	184
500	1	19.1	2.5†	13.2	-0.4	15.1	12.6†	6.0	185
Significance[z]		ns	***L	*	ns	ns	***L	*	ns

†These means are significantly different from the untreated control at odds of 19:1 (Dunnett's Test, *P*=0.05).

[z] ***, *, ns: Differences among means are significant at odds of 999:1, 19:1, or nonsignificant, respectively (*P*=0.001, 0.05, or nonsignificant, respectively). L signifies that the relationship between ethrel concentration (with carbaryl) and the designated parameter is linear.

Table 2. Effects of ethephon (Ethrel®) plus carbaryl (Sevin® 80S) on fruit set, fruit quality, and return bloom of Gatzke McIntosh in 2004. Ethephon and carbaryl (with 0.125% Regulaid®) were applied on June 10, when fruit were 0.9 inches (23.5 mm) in diameter.

Ethephon (ppm)	Carbaryl (lbs a.i./ 100 gal)	Initial fruit set (no./cm^2 LCA)	Final fruit set (no./cm^2 LCA)	Return bloom -- 2005 (no./cm^2 LCA)	Internal ethylene (log ppm)	Flesh firmness (lbs)	Soluble solids (%)	Starch index value	Fruit weight (g)
0	0	14.1	9.5	11.1	0.2	16.0	11.4	6.3	154
0	1	14.1	8.9	10.2	0.3	15.5	11.1	6.2	161
200	1	14.1	6.7†	17.1†	0.4	15.7	12.1†	6.0	172†
300	1	13.8	5.3†	15.3	0.7	15.7	12.4†	6.2	167†
400	1	14.6	3.3†	19.1†	0.3	15.7	12.8†	6.1	164
500	1	14.6	2.6†	19.7†	1.1†	15.5	12.8†	6.3	163
Significance[z]		ns	***LQ	***L	*	ns	***LQ	ns	*

†These means are significantly different from the untreated control at odds of 19:1 (Dunnett's Test, *P*=0.05).

[z] ***, *, ns: Differences among means are significant at odds of 999:1, 19:1, or nonsignificant, respectively (*P*=0.001, 0.05, or nonsignificant, respectively). L signifies that the relationship between ethrel concentration (with carbaryl) and the designated parameter is linear. L and Q suggest that it is a quadratic relationship.

increasing concentrations of ethephon also resulted in greater return bloom (38-77% greater than the control). The level of set reduction resulting from ethephon treatment, even though considerably later in the season than normal chemical thinning, can positively effect flower-bud formation.

Average fruit size was increased by ethephon treatment in 2004 but not in 2003 (Tables 1 and 2). The lack of a statistically significant response in 2003 likely was due to variability from replication to replication. The sampled control fruit were inexplicably large in 2003. It is expected that thinning should result in greater size, but the highest concentrations of ethephon, with the lowest fruit set, did not increase fruit size. This lack of positive effect likely is related to the growth-inhibiting effects of ethephon at higher concentrations. It is imperative that we determine the lowest concentration of ethephon that can give adequate thinning, so as to avoid the potential negative effect of reducing fruit growth.

Fruit ripening seemed little effected by treatments (Tables 1 and 2). Internal ethylene was increased in fruit from only the 500-ppm treatment in 2004 but not from any treatment in 2003. Flesh firmness and starch index value were not affected, but soluble solids concentration was increased by ethephon each year. It is likely that reductions in fruit set will have more impact on fruit ripening than will any lingering, direct effects of June ethephon treatments.

Conclusions & Future Research

With McIntosh, ethephon provided consistent thinning in the two years of study. A concentration of between 200 and 300 ppm ethephon (2/3 and 1 pint Ethrel®/100 gallons, respectively) plus carbaryl (1 pound a.i./100 gallons) and Regulaid® (0.125%) gave optimal results. These two years of research, however, represent inadequate experience to recommend wide-scale use of ethephon for chemical thinning in Massachusetts; however, growers should consider applying ethephon to underthinned test blocks at a small scale. Research in 2005 will continue with McIntosh and additional varieties to gain more experience with the use of ethephon. Hand thinning will be included as an additional treatment, and economic comparisons also will be made between hand thinning and ethephon.

Acknowledgments

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Preharvest Ethylene Production in McIntosh Reduces Effectiveness of SmartFresh™ (1-MCP) in Maintaining Fruit Quality

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SmartFresh™, as 1-MCP is marketed, is a new postharvest treatment which helps maintain high quality of cold-stored apples. Consistent benefit, as measured by firmness retention, has been documented on a number of cultivars. McIntosh is not among them. Some years, some lots of McIntosh have maintained firmness much longer when treated with 1-MCP, but in other situations no benefit has been found. It would be useful to know why some fruit respond well and others do not. It would be even more useful to know prior to treatment which McIntosh would benefit from 1-MCP. This chemical acts through disabling ethylene's ripening effects, so effect on ethylene production has been a focus of research.

This research was conducted in order to determine if McIntosh's inconsistent response to 1-MCP treatment could be attributed primarily to ethylene production and action already occurring in the fruit at the time of harvest. A secondary objective was to determine whether or not fruit stored in controlled atmospheres (CA) would demonstrate preharvest, ethylene-related differences similar to those found in refrigerated air (RA) stored fruit.

Materials & Methods

Gatzke McIntosh from a block of trees growing at the UMass Cold Spring Orchard Research & Education Center (Block E3) were harvested on September 9, 2004 and September 16, 2004. At each harvest, internal ethylene was measured on approximately 300 apples. Ethylene was measured on a 1 ml sample taken from the core cavity of the apple. The sample was taken by poking into the calyx a bent needle and removing a gas sample with a syringe. Ethylene detection was by gas chromatography with an activated alumina column. Fruit were categorized according to internal ethylene concentration. Fruit from each internal ethylene category were further divided into groups for RA and groups for CA storage. Some non-ethylene-measured fruit were also stored and 1-MCP treated with each group. Half the fruit destined for RA storage were

Table 1. Distribution of fruit by ethylene category at each harvest.

Harvest date	Internal ethylene concentration (ppm)	Internal ethylene concentration category	Number of fruit	Percent of harvested fruit
9/9/04	0	0	249	83
Harvest 1	0.5-7	1	15	5
	10-100	4	12	4
	>100	7	24	8
9/16/04	0	0	193	64
Harvest 2	1-10	2	9	3
	10-31.6	3	7	2
	31.6-100	5	16	5
	100-316	6	69	23
	>316	8	9	3

Table 2. Effects of calyx "poking" at harvest (to measure ethylene) and harvest date on post-storage ethylene concentration and flesh firmness. All fruit were removed from 32^{o}F cold storage to 68^{o}F air on 11/16/04.

		Two days at 68^{o}F		Seven days at 68^{o}F	
Treatment grouping	1-MCP treatment	Harvest 1	Harvest 2	Harvest 1	Harvest 2
		Post-storage ethylene concentration (ppm)			
Fruit "poked", no ethylene production at harvest	- 1-MCP	480	320	530	260
	+ 1-MCP	7	4	12	5
Non-poked fruit, harvest ethylene unmeasured	- 1-MCP	710	260	630	630
	+ 1-MCP	23	20	26	12
		Post-storage flesh firmness (lbs)			
Fruit "poked", no ethylene production at harvest	-1-MCP	10.3	10.5	10.3	11.0
	+1-MCP	10.7	12.3	11.2	11.7
Non-poked fruit, harvest ethylene unmeasured	- 1-MCP	10.7	10.8	10.9	10.6
	+ 1-MCP	12.2	11.8	11.8	12.4

treated at room temperature with 1 ppm 1-MCP for 24 hours prior to cold storage. Treatment with 1-MCP began approximately 24 hours after harvest. Following the 1-MCP treatment, the treated and untreated fruit were stored together in 36^{o}F RA. All fruit which were CA stored received 1ppm 1-MCP treatment as the treatment was applied to the entire CA room before the controlled atmosphere was applied. The CA-stored fruit from the two harvests were in separate CA rooms, so all could be treated within 2 to 3 days of harvest. Half the RA fruit from both harvests was removed from cold storage on November 11, 2004 and the other half was removed from storage on December 21, 2004. The CA fruit from the first harvest were removed from storage on February 3, 2005, and the CA fruit from the second harvest were removed from storage on March 15, 2005.

Assessment of stored fruit was similar for all groups. Fruit were allowed to sit at room temperature for 24 hours before ratings began. The day after removal from storage, up to ten fruit from each (harvest ethylene by 1-MCP treatment) category were weighed, ethylene was measured as at harvest, fruit firmness was measured (using EP1 pressure tester), and fruit were halved to look for internal disorders, primarily brown core. If superficial scald was present, it was noted. If a category of fruit contained more than ten apples, the excess fruit were left at room temperature for one or two weeks, and then assessed as the other fruit had been assessed the day following removal from storage.

Results

Fruit were placed in groups according to ethylene production. Categories were defined based on internal ethylene measured at harvest. Table 1 shows how the measured fruit from the two harvests were categorized. On the whole, more fruit were producing more ethylene at the second harvest than at the first. It is of some interest to note that the majority of fruit which were producing any ethylene were producing a great deal of ethylene, in excess of 100 ppm measured in the core cavity.

At the first removal from storage, only fruit which had no measurable ethylene and fruit which had not had ethylene measured were removed from storage and assessed. This was done to determine 1) if the "poking" of the needle used to sample the core ethylene at harvest had a lasting effect on the fruit and 2) if the "poking" had an effect, if it was different on the 1-MCP treated fruit. The assumption was made that the distribution of harvest ethylene concentrations in the unmeasured fruit would be similar to those in the measured group. Because some of the "unpoked" fruit likely produced ethylene at harvest, a truly fair comparison of poststorage ethylene production changes cannot be made, but it should be possible to see if there was a very large "poking" effect on ethylene production or firmness. Approximately 83% of measured fruit from the first harvest and 64% of measured fruit from the second harvest had no ethylene detectable in the.

Table 3. Effects of preharvest ethylene level on efficacy of 1-MCP on McIntosh in 32°F cold storage from harvest through 2/21/04. Measurements were taken on 12/23/04 following 2 days of 68°F air.

Preharvest internal ethylene concentration (ppm)	1-MCP treatment	Ethylene (ppm)	Firmness (lbs)
0-100	none	230	10.4
>100	none	250	10.1
0-100	1 ppm	40	10.9
>100	1 ppm	250	10.2

Table 2 shows very nicely that the "poked" fruit did not produce more ethylene than the unmeasured fruit. The higher ethylene concentrations in the unmeasured fruit may be attributed to (at least some of) those fruit having some ethylene at harvest. In any case, it is clear that poking the fruit in order to measure ethylene did not cause fruit to respond by producing a great deal of ethylene, and that is what we wished to confirm. The dramatic differences in ethylene production were between the 1-MCP-treated fruit and those not treated with 1-MCP. The 1-MCP-treated fruit were about a pound firmer than the non-treated fruit.

In the absence of 1-MCP treatment, preharvest ethylene in McIntosh did not have a substantial effect on either ethylene production or firmness of stored fruit in December (Table 3); however, there was a marked reduction in ethylene production and an increase in firmness retention in 1-MCP-treated fruit which had not been producing a large amount of ethylene at harvest. Note that 1-MCP appears to have had no effect on either ethylene production or fruit firmness when fruit had ethylene concentrations in excess of 100 ppm ethylene at the time of harvest. Note from Table 1 above that 8% of fruit from the first harvest and 26 % of fruit from the second harvest had at least 100 ppm internal ethylene at harvest. Those fruit would not appear to be good candidates for 1-MCP treatment.

A third removal of fruit from storage was made in February. This removal included some fruit in controlled atmosphere (CA) storage. A fourth removal from CA was made in March. Observations of the effect of 1-MCP as influenced by preharvest ethylene on these fruit will be reported later.

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Survey Results from Consumer Evaluations of Some of the Most Promising Apple Varieties Under Trial in the NE-183 Apple Cultivar Regional Project

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In recent years, there has developed an increased interest in new apple varieties. Part of this resurgent interest can be attributed to the introduction of and strong consumer acceptance of first Granny Smith, followed by Gala, Braeburn, and Fuji. Consumers liked the added variety, different tastes, and the apparent improvement in overall internal quality. It is now well documented that consumers are increasingly making their decision of the purchase of apples based more on taste, flavor, crispness, and internal quality than on size, color, or cosmetics. Shelf space in the produce section of stores, however, is not unlimited, thus only the most heavily planted varieties will be regularly available to the consumers.

An observation that we made in the past few years is that some consumers can become quite enthusiastic about being able to purchase and eat high-quality, unique apples. Individual growers have the ability to plant and harvest many more varieties than are available in a normal grocery store. There is the potential that fruit farms, roadside stands, and grower-operated retails stands could become destinations for consumers if unique, good-tasting apples could be grown and sold. It was the purpose of this survey to obtain feedback from customers about which apples they liked, what they like about them and if these new varieties could change their apple buying habits.

Methods

Nine of the most promising varieties being evaluated in either the 1995 (Block E2) or 1999 (Block H6) NE-183 Regional Project were selected to be included in the survey. NE-183 was a Regional Project that originated to evaluate new and unique apple varieties for quality, horticultural characteristics, and insect and disease susceptibility. Between 1 and 3 bushels of fruit were harvested at an appropriate maturity for at-harvest evaluation. Fruit were immediately placed in regular air storage at 32° F. When the retail stand at the University of Massachusetts Cold Spring Orchard Research & Education Center was opened in the morning, a portion of the fruit in a box was placed prominently on a table in the sales area. Additional fruit were brought in from the cold storage area as the box was emptied. A sign was place above the box that informed customers that we were asking for their help in evaluating new apples. The results of the responses would be used as a guide in helping to decide which apples we plant and which apples that we encourage growers in Massachusetts to plant. They were given an apple to taste and eat with the understanding that they would fill out the Variety Evaluation Form. We did not have a person at the stand whose sole responsibility was to monitor tasting. Thus, many enjoyed eating the apple but neglected to fill out the form. Others were so impressed with the apple they tasted that they put apples under evaluation in the bag of mixed fruit they were selecting to buy. We received 482 completed forms, which represents about a 35% return rate. At the end of the season, all data were analyzed. Numerical data are expressed as means or percent of the total responses.

Variety Descriptions

Ambrosia. This attractive red variety originated in British Columbia as a chance seedling. Since it was

VARIETY EVALUATION FORM

Variety___________________________

Please sample the apple(s) on display and provide us with an evaluation of the variety by filling out this short form. Please circle the appropriate number.

Appearance

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Taste

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Crispness

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Juiciness

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Texture

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Overall

Like very much	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Dislike**

Additional comments on this variety:

What variety do you usually purchase _____________________________?

Would you purchase this variety? Yes No

Would you purchase this variety in preference to your normal variety? Yes No

What type of apple do you usually like (circle one)

Sweet Sweet/tart Tart/sweet Tart

discovered in an area where Golden Delicious and Starking Delicious were growing, some speculate that these were its parents. It is a medium-sized, somewhat-conical apple that is very attractive. It is firm and has a very pleasant taste with a good sugar-to-acid ratio. The right to grow this variety has been purchased. Special permission appears to be necessary to grow this apple.

Arlet (Swiss Gourmet). Arlet is a red, slightly tart, medium-sized apple that ripens slightly later than Gala. Quality is good. The skin becomes greasy if harvest is delayed. Use of a preharvest-drop-control compound is appropriate, since Arlet is prone to preharvest drop before fruit becomes fully red. Fruit have a tendency to develop russet, especially at the calyx end, on as much as 25% of the surface. Red color can mask much of the russet if fruits remain on the tree long enough to develop good red color. It stores quite well if it is harvested at an appropriate time.

Creston. This variety originated in British Columbia. Frequently Creston is compared with Jonagold, a variety with which it shares many characteristics including large size, only moderately good color, firmness, time of ripening, and fruit quality. Fruit are medium to large, crisp and juicy, pleasant and refreshing with a good sugar-to-acid ratio. It lacks good red color and can be stored for 3 to 4 months. It is considered an alternative to Jonagold with a different and pleasant taste.

Hampshire. This is a very attractive seedling selection that originated in New Hampshire. It has medium and very uniform size. It ripens with Delicious with nearly 100% red color. It has white flesh and a good, mild flavor. It stores well, especially in CA storage. Hampshire is a grower-friendly tree, and it appears to be somewhat annual.

NJ 90. A unique taste characterizes this McIntosh-type apple. It is medium-sized, extremely attractive apple that has a deep ebony-red color that may be masked by a very heavy bloom on the surface of the apple. It has some preharvest drop tendencies. The skin is thick and, when eaten, it gives the impression of being tough.

Pinova. This has been a difficult apple to follow since it has gone through several name changes in the past five years: Pinova, Corail, Sonata, and most recently, and perhaps finally, Pinata. It is a medium-sized, somewhat-red apple. It is slightly tart and the Cox's Orange Pippin in its parentage is quite evident in the taste. It ripens in late September. The taste of Pinova may improve after a period of cold storage. The rights to plant and sell this apple have been purchased. Special permission is necessary to grow Pinova.

Sansa. Fruit can be harvested from Sansa starting about 3 weeks before Gala, a variety that is resembles in size, shape, color, and taste. When ripe, it has an aromatic and tropical-fruit taste that is rivaled by few apples. Good light exposure is required to achieve good red color. Fruit will store up to 2 months. It is a moderate- to weak-growing tree, and the leaves have a mottled appearance that resemble but is not apple mosiac virus.

Shizuka. Mutsu and Shizuka have the same parents, Golden Delicious and Indo, and consequently they are very similar apples. Shizuka is an alternative to Mutsu, and under some circumstances, it may be a better choice. Shizuka is smaller, ripens about 5 to 7 days before Mutsu, and it is reported not to be susceptible to infection by the bacterial disease blister spot. Its flesh is a little softer than Mutsu, and it does not store as well.

Zestar. This is a medium-sized, somewhat-attractive apple that was released from the Minnesota breeding program. It has pinkish red color on up to 50% of the surface. Zestar ripens with Ginger Gold or perhaps slightly earlier. It has a very unique flavor with and excellent sugar-to-acid ratio where both sugar and acids are quite evident and pleasant. It has a somewhat columnar shape but with branches that have a wide crotch angle. It is precocious and a grower friendly tree. Fruit stores well for several weeks. It is an extremely attractive tree.

Results

Each participant was asked to rate the apple being tested for appearance, taste, crispness, juiciness, texture, and overall on a scale for 1 to 10, where 1 was the best score and 10 was the lowest score. Overall the ratings for all varieties in each category were high, and the responses appeared to be clustered such that rarely did one variety differ from one another numerically by more than 1.0 on the 1-10 scale (Table 1). I interpret this to mean that participants liked the selections that were provided.

Another and perhaps more valid method to evaluate new varieties is to ask participants if they would buy these apples (Table 2). All apples in this survey were well received and well liked by participants. Approximately 75% of the participants said that they would purchase Shizuka, Ambrosia, or NJ 90, between 80 and 85 % said that they would purchase Arlet, Pinova, and Sansa, while over 90% said that they would purchase Zestar, Creston, or Hampshire. Respondents were also asked to indicate if they would purchase this apple in preference to the apple(s) that they normally purchase. The differences among varieties in response to this question were quite large. Only 22% of the individuals indicated that they would purchase Shizuka in preference to their normal variety, whereas between 61% and 71% indicated that they would purchase Zestar, Sansa, or Creston, respectively. Regardless of the actual percentage, it is noteworthy and significant that a substantial number of people liked these new varieties, and many liked them sufficiently well to change their apple buying habits.

Table 1. Sensory rating on a scale from 1 to 10 of apples evaluated survey participants at the University of Massachusetts CSOREC. 1 = likes very much; 10 = dislikes.

Cultivar	Appearance	Taste	Crispness	Juiciness	Texture	Overall
Ambrosia	2.4	3.5	2.7	2.4	3.3	3.2
Arlet	3.2	3.2	2.8	2.7	3.0	3.1
Creston	3.3	2.5	2.4	2.3	2.6	2.4
Hampshire	2.4	3.1	2.5	2.3	2.3	2.7
NJ 90	2.5	3.5	2.4	2.4	2.7	2.9
Pinova[1]	2.7	2.1	2.1	1.5	3.2	2.1
Sansa	3.1	2.4	2.3	2.0	2.3	2.2
Shizuka	3.0	3.5	2.7	2.3	2.7	3.3
Zestar	3.2	2.7	2.7	2.1	2.9	2.6

[1]Also known as Corail, Sonata, and Pinata.

Each respondent was asked to indicate the variety or varieties that they normally purchase (Table 3). The variety most frequently mentioned was Macoun, followed by McIntosh and Cortland. Clearly, these preferences which represents over 50% of the total responses are regional and differ significantly from national sales figures. This stands in stark contrast to US apple production statistics where Delicious is now the #1 apple in productions, representing 28% of total apple produced in the US (Table 4). The fact that only 2% of the respondents normally buy Delicious is an indication that taste and quality are a major component in their buying decisions. It also indicates that the respondents were a very eclectic group that liked a wide range in colors and tastes. Another reason for deviation from the national average may be that this was not a random survey. Only individuals interested in tasting new apple varieties took the time to participate in the survey. My

Table 2. Survey results of consumer tastes evaluation of new apple cultivars.

	Would you purchase this variety?		Would you purchase this variety in preference to you normal variety?	
Cultivar	Yes	No	Yes	No
Ambrosia	75	25	38	62
Arlet	80	20	44	56
Creston	92	8	71	29
Hampshire	91	9	57	43
NJ 90	76	24	44	56
Pinova[1]	85	15	45	55
Sansa	84	16	64	36
Shizuka	73	27	22	78
Zestar	90	10	61	39

[1]Also known as Corail, Sonata, and Pinata.

Table 3. Summary of the apple cultivar that survey participants listed they normally buy.

Cultivar	Percent of Total
Macoun	23
McIntosh	16
Cortland	14
Gala	9
Ginger Gold	4
Honeycrisp	4
Jonagold	4
Granny Smith	4
Golden Delicious	3
Empire	3
Mutsu	3
Delicious	2
Other	11
Total	100

Table 4. Top 10 apple varieties produced in the United States in 2003. Source: US Apple.

Variety	Percent of total US Production
Delicious	28
Golden Delicious	13
Gala	9
Fuji	9
Granny Smith	8
McIntosh	5
Rome	5
Idared	3
Jonathan	3
Empire	2

interpretation of these data is that individuals purchasing fruit at a roadside stand represent a different group of individuals from those that regularly purchases apples in a grocery store. They like different varieties as indicated by the wide range of varieties that they normally purchase. They also will buy new varieties if the quality is good, and with some of the preferred varieties you can change their buying habits. I also feel that introduction and the sale of new varieties will be far more effective when done at a roadside stand. If these apples are in relatively short supply, then orchardists who grow these and roadside stands that sell them may be destinations for purchasers who are looking for special new varieties and unique tastes.

Individuals were asked what taste preference they have and results are shown in Table 5. Of those responding, 14% like sweet apples, 54% sweet/tart, 28% tart/sweet, and only 4% like tart apples. The preferred distribution is surprisingly similar to a survey published by Bob Stebbins in Oregon where 5% liked very sweet apples, 24% sweet apples, 65% sweet/tart, and only 6% like tart apples.

The parents or suspected parents of the varieties in this evaluation are listed in Table 6. One very obvious observation is that Golden Delicious appears to be a very good breeding

Table 5. Summary of consumer preference of participants in the apple cultivar evaluation.

Type of apple	Percent of total respondents
Sweet	14
Sweet/tart	54
Tart/sweet	28
Tart	4

Table 6. Parentage of cultivars evaluated at the University of Massachusetts Cold Spring Orchard Research and Education Center.

Cultivar	Parentage
Ambrosia	??? (Golden Delicious x Starking Delicious)
Arlet	Golden Delicious x Idared
Creston	Golden Delicious x BC381049
Hampshire	??? (McIntosh x Delicious)
NJ 90	Spartan x 136055
Pinova[1]	Golden Delicious (Dutchess of Oldenburg x Cox Orange Pippin)
Sansa	Gala x Akane
Shizuka	Golden Delicious x Indo
Zestar	State Fair x Mn. 1691

[1]Also known as Corail, Sonata, and Pinata.

parent since is or is suspected of being one of the parents in over half of the selections.

Summary

A substantial number of participants in this survey indicated that they would buy these new varieties. They also indicated that they would buy several of these in preference to the varieties that they normally purchase. Planting and selling new apple varieties may be a unique opportunity for New England growers to increase apple sales in their retail stands.

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1999 NE-183 Apple Cultivar Trial: Disease Evaluation Planting

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As part of the NE-183 Apple Cultivar Evaluation Project (http://www.ne183.org), an ongoing study that is evaluating the disease susceptibility of new cultivars is being conducted in conjunction with the horticultural evaluation of these apples. Trees were planted at the UMass Cold Spring Orchard Research & Education Center in 1999 (Block H6).

For the disease planting, five replicates of twenty-one apple cultivars were evaluated on June 29, 2004 for disease symptoms on leaves. Six terminals on each tree were examined for the presence or absence of symptoms of four diseases: scab, cedar apple rust, frog-eye leaf spot, and powdery mildew. For scab, rust, and leaf spot, the numbers of leaves containing lesions were determined. The percentage of leaves infected in each terminal was then calculated. Mildew was counted as either present or absent for the entire terminal. Trees received one pre-bloom fungicide (Thiram) and one post-bloom fungicide (Flint and Manzate) only.

Table 1. Foliar disease incidence of apples in the 1999 NE-183 disease planting in 2004.

Cultivar	Leaves with scab (%)	Leaves with rust (%)	Leaves with frog-eye leaf spot (%)	Terminals with mildew (%)
Ambrosia	<1	2	1	0
BC-8S-26-50	<1	2	1	0
Co-op 25	0	<1	<1	43
Co-op 29	0	<1	3	23
Co-op 39	1	<1	2	17
CQR 10-T-17	0	<1	1	0
CQR 12-T-50	<1	1	13	10
Delblush	1	<1	<1	37
Golden Delicious	0	<1	2	12
Hampshire	<1	<1	2	10
Jubilee Fuji	<1	5	3	0
NJ 109	<1	<1	0	0
NJ 90	0	<1	3	7
NY 65707-19	0	<1	3	0
NY 75907-49	0	<1	2	17
NY 79507-72	0	<1	<1	7
Pinova	0	<1	1	20
Rogers McIntosh	5	<1	2	0
Runkel	0	0	6	0
Silken	2	1	2	0
Zestar!	3	<1	6	0

Disease incidence on foliage is presented in Table 1. Leaf scab symptoms were generally negligible. Rogers McIntosh leaves had the most scab (5%), followed by Zestar! and Silken (3% and 2%, respectively). All other cultivars had less than 1% leaf scab. Rust lesions were also minimal, with Jubilee Fuji having the most rust (5%). Frog-eye leaf spot was more prevalent than either scab or rust. CQR 12-T-50 had the most (13%) leaf spot, followed by Zestar!, Runkel, NY 65707-19, Co-op 29, and Jubilee Fuji with from 3–6% leaf spot. Mildew symptoms on terminals were prevalent, with Co-op 25 having the most terminals infected (43%). Golden Delicious, NY 75907-49, Co-op 39, Pinova, and Delblush all had from 10 to 37% mildew-infested terminals.

Twenty-five fruit (harvested over three weeks on four dates (September 2, 9, 16, and 23) from each cultivar were evaluated for

Table 2. Disease incidence of apples in the 1999 NE-183 disease planting in 2004. A dash denotes no fruit.

Cultivar	Fruit with scab (%)	Fruit with fly speck (%)	Fruit with sooty blotch (%)	Fruit with fly speck and sooty blotch (%)	Fruit with rot (%)	Clean fruit (%)
Ambrosia	0	24	12	0	0	64
BC-8S-26-50	-	-	-	-	-	-
Co-op 25	0	31	0	0	2	67
Co-op 29	0	36	1	1	1	61
Co-op 39	0	11	0	0	<1	87
CQR 10-T-17	<1	33	0	0	0	67
CQR 12-T-50	0	52	0	0	0	44
Delblush	1	27	5	11	0	56
Golden Delicious	-	-	-	-	-	-
Hampshire	0	50	0	0	0	50
Jubilee Fuji	2	4	4	2	2	86
NJ 109	0	7	0	0	0	93
NJ 90	0	29	0	0	0	51
NY 65707-19	-	-	-	-	-	-
NY 75907-49	0	39	0	0	1	60
NY 79507-72	0	14	<1	0	0	85
Pinova	0	13	<1	<1	3	83
Rogers McIntosh	7	38	0	<1	0	54
Runkel	-	-	-	-	-	-
Silken	0	10	0	0	0	90
Zestar!	0	3	0	0	<1	96

disease incidence (scab, rust, flyspeck, sooty blotch, and rots). Results are presented in Table 2. Of most interest is fruit susceptibility or resistance to scab. Only Rogers McIntosh had significant fruit scab (6%). Jubilee Fuji had 2%, Delblush and CQR 10-T-17 had 1% or less fruit scab, while all other cultivars had no fruit scab. Flyspeck incidence ranged from 3 to 52% of fruit infected. Cultivars with the highest amount of flyspeck included CQR 12-T-50, Hampshire, NY 79507-49, Rogers McIntosh, Co-op 29, CQR 10-T-17, and Co-op 25 (> 30%), followed by NJ 90, Delblush, Ambrosia, NY 79507-72, Pinova, Co-op 39, and Silken (10–30%). Fruit with sooty blotch or flyspeck and sooty blotch were less common, however, Ambrosia and Delblush had the most (12% sooty blotch and 11% flyspeck and sooty blotch respectively). Fruit rots were uncommon and unclassified, and there were no differences in incidence among cultivars. Finally, the earlier harvested cultivars Zestar, NJ-109, and Silken had the highest percentage of clean fruit (Table 2), which can be attributed to their earlier harvest date and low incidence of flyspeck and sooty blotch.

As a result of these disease evaluations, and combined with disease incidence data from other states, a chart will be developed that rates relative susceptibility or resistance of these cultivars to the most common diseases. Growers can use the information to choose cultivars that are more resistant to diseases, hence likely reducing their fungicide use and reducing their risk of crop quality loss because of disease.

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New Peach Variety/Selection Plantings and Evaluation When Grown to the Perpendicular-V

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From 2000 through 2002 over 40 named and numbered peach varieties and numbered selections from the James Friday 'Fruit Acres' (FA) breeding program were planted at the UMass Cold Spring Orchard Research & Education Center (Block M2). These are being casually evaluated for cold hardiness, yield, and fruit quality for International Plant Management with an objective of testing them at the limit of their northern growing range. Many of these varieties are purported to have superior red color and size to make them good candidates for retail sales. They are also being grown to the perpendicular-V peach pruning system that originated in California and has become more popular in the East. In 2003, a small crop was picked from these varieties, however, extreme cold in January 2004 (-12°F. on two nights in January) left them virtually cropless in 2004. During the spring and summer of 2004, the trees were casually evaluated for bloom quantity and crop load. Results of the bloom evaluation are presented in Table 1. Most of these peach varieties and selections from Michigan are not very bud hardy. All had either no crop or a very light crop (RisingStar, among a few others) in 2004. Growers that plant these varieties can expect a full or partial crop loss in the coldest winters, but, some of them appear to do better than others, and are worthy of grower trial.

In 2002 and 2003 in cooperation with the Orchard sales, a block of four named 'super-sweet' varieties from Zaiger breeding program in California was planted in Orchard block H4 with the objective of seeing how these varieties perform under our conditions. These are also being trained to the perpendicular-V. Already over

Table 1. May 2004 flower/fruit bud injury rating of Fruit Acres (FA) peach varieties and selections, UMass Cold Spring Orchard Research & Education Center

Variety/selection	Year planted	Number of trees	Flower/fruit bud injury rating[z]
StarFire (FA-11)	2001	2	+
BlazingStar (FA-12)	2001	2	+
GlowingStar (FA-17)	2001	2	–
BlushingStar (FA-18)	2001	2	+
FA-32	2002	2	–
RisingStar (FA-47)	2001	2	+
RedStar (FA-52)	2001	2	+
CoralStar (FA-59)	2001	2	–
FA-65	2002	2	–
FA-68	2002	2	–
FA-71	2002	2	–
AllStar (FA-80)	2001	2	+
FA-81	2002	3	–
FA-86	2000	1	–
FA-100	2000	2	–
FA-101	2000	2	–
FA-102	2000	2	+
FA-116	2002	2	–
FA-117	2002	3	–
FA-118	2002	2	–
FA-119	2002	3	–
FA-133	2000	1	–
FA-134	2000	1	–
FA-135	2000	1	–
FA-136	2000	1	–
FA-138	2000	1	–
FA-140	2002	2	–
FA-142	2000	1	–
FA-143	2000	1	+
FA-144	2000	1	–
FA-145	2000	1	–
FA-147	2000	1	–
FA-220	2002	3	–
FA-222	2002	2	–
FA-232	2002	1	–
FA-236	2002	2	–
FA-237	2002	3	–
FA-238	2002	1	–
FA-240	2002	3	–
FA-241	2002	2	–
FA-242	2002	2	–
FA-243	2002	3	–
MSU-26	2002	5	–
Summer Beauty nectarine	2000	26	–
JL 1024 (apricot)	2000	1	–

[z] Rating at bloom, – = no bloom; + = light bloom, not enough for a full crop.

Table 2. May 2004 flower/fruit bud injury rating of super-sweet peaches, UMass Cold Spring Orchard Research & Education Center.

Variety	Year planted	Number of trees	Flower/fruit bud injury rating[z]
Jade	2003	8	NR
HoneyKist	2002	9	+
HoneyBlaze	2002	12	–
CountrySweet	2002	12	+
Jonasweet	2002	19	–

[z] Rating at bloom, May 2004; NR = not rated, trees too young; – = no bloom; + = very light bloom, potential very light crop.

the winter of 2002-2003 some trees planted in 2002 died, and were replaced in 2003. Table 2 lists the varieties and our first impression of how winter hardy these are going to be. Initial impressions suggest that Countrysweet and Honeykist may be bud hardy enough to bear a crop in some years. A few fruit from each of these varieties were picked in 2004, and they will be an excellent addition to retail sales for Massachusetts tree-fruit growers because of their sweetness (lack of acidity). Jonasweet and Honeyblaze have already experienced tree mortality and no crop, so they are already not recommended for planting. Not enough data on Jade are available at this time.

Acknowledgements

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Observations on Winter Flower-bud Damage and Crop Load of Several Peach Varieties

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The cold winter of 2004 resulted in an excellent chance to evaluate existing peach varieties at the UMass Cold Spring Orchard Research & Education Center in several blocks being used for sales (Blocks K1, H1, H2) for fruit bud injury, flowering, and crop load in the spring and summer of 2004. Results of this casual evaluation are presented in Table 1. Ultimately, the crop-load rating is what peach growers would be most interested in. In this case, a crop-load rating or 2.5 and up was a good, moderate crop and would not be a problem. Varieties with a crop load rating of less than 2 had significant winter injury of flower buds and should be planted with caution. This information will eventually be used to produce a list of recommended peach varieties for Massachusetts growers based on bud hardiness and other characteristics.

* * * * *

Table 1. Bloom and crop-load evaluation of named peach varieties at UMass Cold Spring Orchard Research & Education Center in 2004.

Variety	Year planted	Percent flower injury[z]	Crop load rating[y]
Arctic Glow	1994	20	2.5
Arctic Rose	1994	50	2
Arctic Queen	1994	65	1
BlazingStar	1999	70	1.5
Bounty	1990	50	3.5
Earlired	1994	75	0.5
Earliscarlet	1990	25	4.5
Easternglo	1994	95	0
Encore	1990	10	4
Fantasia- young	1994	60	1
Fantasia- old	1990	30	3
Fayette	1990	85	1
Flavorcrest	1990	95	1.5
Garnet Beauty	2000	99	0.25
Glowhaven	1999	60	2.5
Harcrest	1990	20	3.5
Harrow Beauty	1994	25	4.5
Harrow Beauty	1990	35	3.5
Jerseydawn	1990	30	5
Jim Dandy	1990	30	5
John Boy	1994	90	1.5
Lady Nancy	1994	75	1
Madison	1990	15	4
Newhaven	1990	40	4.5
NJ 275	1990	50	2
PF 1	1994	95	0
PF 15A	1994	50	5
PF 17	1994	85	2.5
Raritan Rose	1994	40	5
Redgold	1990	60	3.5
Redhaven	1990	30	5
RisingStar	1999	60	3
Salem	1994	90	3
Salem	1990	75	1
Sentry	1994	95	1.5
Sugar Lady	1994	90	1.5
Summer Beauty	1994	99	0
Summer Beauty	1990	35	4
Summer Pearl	1990	25	3
Sunglo	1994	30	3.5
White Lady	1990	70	2.5

[z] 0% = no injury, 100% = all flower buds injured (no bloom)
[y] relative scale, 0 (no crop) to 5 (full crop)

2001 Sweet Cherry Variety Trial on Gisela 5 and Gisela 6 Rootstocks

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A dwarf sweet cherry orchard (98 trees) was planted in Spring 2001 at the UMass Cold Spring Orchard Research & Education Center (Block A15). Included are 16 sweet cherry cultivars, including: Cavalier, Chelan, Jubileum (tart cherry), Rainier, Regina, Sweetheart, Lapins, Royal Ann, Sandra Rose, Black Gold, Hartland, Hedelfingen, Sam, Schmidt, Ulster, and White Gold. All are on Gisela 5 and/or 6 rootstocks, which provide app. 50% and 70% (respectively) dwarfing, compared to standard cherries on Mazzard or similar rootstock(s).

Objectives of the research include are to 1) evaluate the overall performance of sweet cherries grown on dwarfing rootstocks under Massachusetts growing conditions; 2) identify obstacles and solutions to sweet cherry production, such as birds, cracking, and canker; and 3) evaluate sweet cherry varieties for harvest date, fruit size, fruit sugar content, cracking susceptibility, and marketability.

Tree growth has been excellent for most cultivar/rootstock combinations. Emphasis was placed on growing and training the trees to a modified 'Vogel' central-leader. Data collected to date includes trunk circumference at planting and at the end of the each growing season (2001-2004). Preliminary statistical analysis of the data (Table 1) has shown that in terms of trunk cross-sectional area, trees on G.6 were larger than those on G.5, and that there was a significant difference in size between cherry cultivars. There was also a significant interaction between rootstock and cultivar. Several years of growth data will be necessary before final conclusions can be made but it is safe to say Gisela 6 will make a significantly larger tree than Gisela 5 with any cultivar.

Table 1. Trunk cross-sectional area at the end of the 2004 growing season for selected sweet cherry cultivar/rootstock combination

Cultivar/Rootstock	Trunk cross-sectional area 2004 (cm^2)
Chelan/Gisela 5	25.3
Chelan/Gisela 6	98.1
Ranier/Gisela 5	41.4
Rainier/Gisela 6	72.2
Regina/Gisela 5	23.7
Regina Gisela 6	59.9
Jubileum/Gisela 5	69.8
Jubileun/Gisela 6	109.8

Significance
Cultivar *** ($P < 0.001$)
Rootstock ***
Cultivar x rootstock * ($P < 0.05$)

In 2003, a light crop of cherries was harvested, too few to collect any data. It was expected that the trees would begin cropping more heavily in 2004, however, low temperatures of -12 F. in January 2004 killed all of the fruit buds on most cultivars. The sweet cherry variety Chelan and sweet-tart cherry Balaton were notable exceptions. About 15 pints of cherries from both were harvested in 2004. Chelan was susceptible to cracking and was well-liked by a flock of cedar waxwings that moved in just as they were ripening. This bird species is going to be a challenge to manage in the future. Balaton has some very positive traits for a sweet-tart cherry and is already recommended for planting. As of this writing, there are many fruit buds on the trees for 2005, and barring spring frost, there should be a good crop of fruit in 2005 to harvest and collect data.

Acknowledgements

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Do McIntosh, Pioneer Mac, Cortland, and Macoun Respond Differently to Rootstocks? -- The 1995 Massachusetts-Maine-Nova Scotia Scion/Rootstock Trial

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In 1995, a trial was established at three locations (Belchertown, MA, Monmouth, ME, and Kentville, NS) including Rogers Red McIntosh, Cortland, Macoun, and Pioneer Mac on 11 different rootstocks. Each site included seven replications of each combination of rootstock and variety. Only Massachusetts

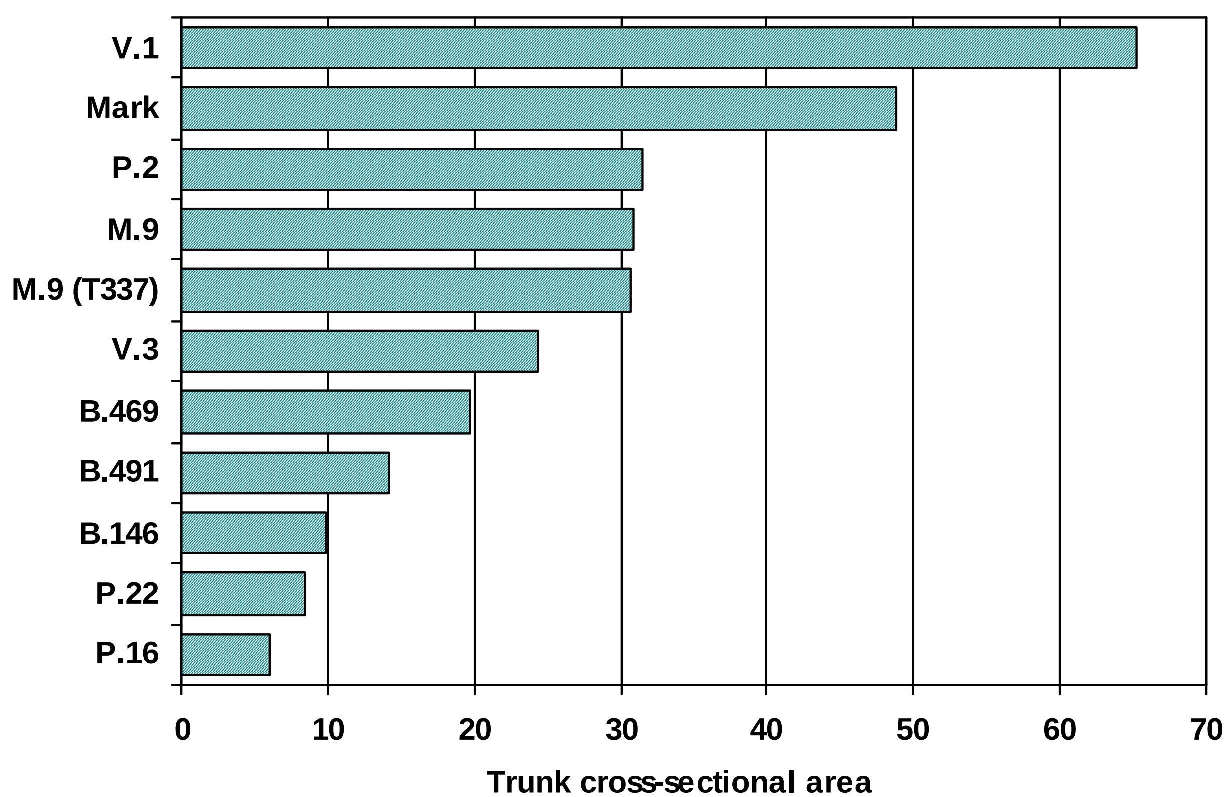

Figure 1. Trunk cross-sectional area after ten growing seasons of trees on various rootstocks planted in 1995.

data (Block Y3) from 2004 (10th and last growing season) and on a cumulative basis are presented in this report.

The intent of this trial was to determine whether or not the relative effects of rootstocks varied among our common, New England/Atlantic Canada varieties. After 10 years of study, the rootstock effects were very consistent from variety to variety. This article, therefore, will focus only on the average rootstock effects. Rootstock data are included for each variety for completeness.

V.1 resulted in the largest trees in this trial, likely in the semidwarf category. Trees on Mark were about 20% smaller than those on V.1, and trees on the two M.9 strains and on P.2 were about half the size of those on V.1(Figure 1, Table 1). Trees on V.3 were numerically but not significantly smaller than those on M.9, M.9 NAKBT337, or P.2. Next in order of decreasing size were trees on B.469, B.491, and B.146. Trees on P.22 and P.16 were the smallest in the trial. The four most dwarfing rootstocks resulted in trees too weak in vigor to be of commercial potential.

Yield per tree in 2004 was affected by rootstock, but it is more interesting to look at cumulative yield (1997-2002) over the fruiting life of the planting (Table 2). Trees on V.1 and Mark yielded the most and similarly. Trees on M.9, M.9 NAKBT337, P.2, and V.3 were the next most yielding and also yielded similarly. Trees on B.469 and B.491 were similar and in the next lower group, and the lowest yielding trees were on B.146, P.16, and P.22.

As with yield per tree, yield efficiency in 2004 was affected by rootstock, but the cumulative yield efficiency is a more reliable way to study long-term rootstock effects (Table 3). Generally, the ultradwarf trees were the most cumulatively yield efficient (1997-2004), but as noted above, these trees are too small for commercial production. B.491, M.9, M.9 NAKBT337, P.2, and V.3 all produced similarly yield efficient trees. The least efficient trees were on V.1, and those on Mark were intermediate between the two groups.

Averaged across all fruiting years (1997-2004),

Table 1. Trunk cross-sectional area in 2004 of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995.[z]

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
			Trunk cross-sectional area (cm^2)		
B.146	9.0	13.1	3.2	14.2	9.9 ef
B.469	19.6	18.1	20.6	20.4	19.7 de
B.491	12.5	15.7	15.0	13.2	14.1 ef
M.9	33.5	29.0	34.3	26.8	30.9 c
M.9 NAKBT337	28.3	23.1	32.9	38.5	30.7 c
Mark	49.9	51.5	43.4	50.8	48.9 b
P.2	31.8	32.0	26.3	36.1	31.5 c
P.16	4.2	6.3	4.7	8.7	6.0 f
P.22	7.4	11.0	8.1	7.2	8.4 f
V.1	56.3	67.2	67.4	69.9	65.2 a
V.3	23.7	23.9	23.3	26.8	24.4 cd
Average	25.1 a	26.4 a	25.4 a	28.4 a	

[z] Rootstock means within columns not followed by the same letter are significantly different at odds of 19 to 1, and overall cultivar means not followed by the same letter are different at odds of 19 to 1.

Table 2. Yield in 2004 and cumulative yield of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995.[z]

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
			Yield per tree (2004, kg)		
B.146	2.1 e	0.6 b	0.8 d	7.0 cde	2.4 d
B.469	10.9 cde	11.5 ab	16.7 bcd	15.6 bcd	13.6 bc
B.491	5.6 de	11.5 ab	13.2 cd	9.4 cde	9.8 cd
M.9	17.0 bc	15.8 ab	21.9 abc	20.5 b	18.8 b
M.9 NAKBT337	14.0 bcd	9.1 b	20.2 bc	19.6 bc	15.7 bc
Mark	28.9 a	14.9 ab	28.1 ab	31.7 a	26.0 a
P.2	14.9 bc	16.6 ab	14.0 cd	19.9 bc	16.3 b
P.16	3.9 e	1.3 b	2.7 d	5.5 de	3.3 d
P.22	4.0 e	2.1 b	5.7 d	4.5 e	4.4 d
V.1	22.9 ab	28.3 a	32.6 a	38.9 a	30.7 a
V.3	12.4 cde	9.5 b	21.1 abc	17.1 bc	15.0 bc
Average	12.4 ab	11.1 b	16.1 ab	17.2 a	
			Cumulative yield per tree (1997-2004, kg)		
B.146	19 d	26 d	10 f	29 de	21 d
B.469	59 cd	57 cd	65 cde	65 cd	61 c
B.491	39 d	74 cd	53 def	44 de	52 c
M.9	88 bc	97 bc	104 abc	86 c	94 b
M.9 NAKBT337	81 c	67 cd	93 abcd	95 bc	84 b
Mark	156 a	131 ab	129 a	122 ab	134 a
P.2	91 bc	96 bc	75 bcde	91 bc	88 b
P.16	26 d	29 d	27 ef	40 de	31 d
P.22	30 d	22 d	32 ef	28 e	28 d
V.1	116 b	159 a	117 ab	130 a	130 a
V.3	73 c	86 bc	94 abcd	79 c	83 b
Average	71 a	77 a	73 a	74 a	

[z] Rootstock means within columns not followed by the same letter are significantly different at odds of 19 to 1, and overall cultivar means not followed by the same letter are different at odds of 19 to 1.

rootstock affected fruit size (Table 4). V.1, M.9, and M.9 NAKBT337 resulted in the largest fruit. Mark, V.3, and P.2 also resulted in good fruit size. The ultradwarfs all resulted in small fruit size.

This trial showed that rootstocks were consistent from variety to variety. Across all varieties, B.491, B.146, P.22, and P.16 all produced very small trees (ultradwarfs), likely too small for commercial use. Trees tended to be yield efficient, but fruit size on average was small. P.2, M.9, M.9 NAKBT337, and V.3 produced trees of similar size (all moderate dwarfs) and yield efficiency. Among these four, however, the two M.9 strains resulted in larger fruit than did P.2, with V.3 resulting in intermediate size. The largest trees in the trial were on Mark and V.1. It is uncertain why Mark resulted in trees as large as was observed, but it may be because of relatively high soil moisture in the site of this trial. It produced a large dwarf tree which was moderately yield efficient, with reasonable fruit size. V.1 produced a semidwarf tree. It had low efficiency relative to the other rootstocks in the trial but likely would compare favorably to other semidwarfs. Fruit size was large from trees on V.1. Overall, no rootstock in the trial provided a great advantage over M.9 or M.9 NAKBT337.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

Table 3. Yield efficiency in 2004 and cumulative yield efficiency of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995.[z]

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
	Yield efficiency (2004, kg/cm² TCA)				
B.146	0.29	0.05	0.31	0.49	0.27 b
B.469	0.57	0.54	0.85	0.78	0.69 a
B.491	0.50	0.68	0.84	0.74	0.69 a
M.9	0.52	0.56	0.65	0.76	0.62 ab
M.9 NAKBT337	0.46	0.33	0.60	0.57	0.49 ab
Mark	0.60	0.34	0.65	0.62	0.55 ab
P.2	0.49	0.48	0.68	0.61	0.56 ab
P.16	0.86	0.27	0.42	0.50	0.51 ab
P.22	0.56	0.16	0.74	0.56	0.50 ab
V.1	0.43	0.41	0.50	0.55	0.47 ab
V.3	0.54	0.39	0.91	0.72	0.64 ab
Average	0.53 ab	0.38 b	0.65 a	0.62 a	
	Cumulative yield efficiency (1997-2004, kg/cm² TCA)				
B.146	2.25	2.01	2.54	2.14	2.23 cd
B.469	3.22	3.12	3.27	3.32	3.23 bc
B.491	3.58	4.45	3.54	3.45	3.75 b
M.9	2.76	3.42	3.04	3.32	3.14 bc
M.9 NAKBT337	2.76	3.30	3.06	2.79	2.97 bc
Mark	3.23	2.75	2.95	2.46	2.85 bcd
P.2	3.00	3.13	4.11	2.74	3.25 bc
P.16	5.38	5.31	5.26	4.68	5.16 a
P.22	4.18	2.93	4.14	3.80	3.76 b
V.1	2.13	2.43	1.74	1.87	2.04 d
V.3	3.15	3.60	4.09	3.12	3.49 bc
Average	3.24 a	3.31 a	3.43 a	3.06 a	

[z] Rootstock means within columns not followed by the same letter are significantly different at odds of 19 to 1, and overall cultivar means not followed by the same letter are different at odds of 19 to 1.

Table 4. Fruit weight in 2004 and average fruit weight of Cortland, Rogers Red McIntosh, Macoun, and Pioneer Mac trees on several rootstocks planted in 1995.[z]

Rootstock	Cortland	Macoun	McIntosh	Pioneer Mac	Average
			Fruit weight (2004, g)		
B.146	214	119	113	131	144 f
B.469	243	152	176	155	182 de
B.491	231	156	175	147	177 def
M.9	277	205	186	177	211 ab
M.9 NAKBT337	241	177	183	175	194 bcd
Mark	269	200	191	166	206 abc
P.2	247	171	162	162	186 cde
P.16	246	114	167	144	168 ef
P.22	204	158	157	133	163 ef
V.1	290	218	196	197	225 a
V.3	257	164	187	161	192 bcd
Average	247 a	167 bc	172 b	159 c	
			Average fruit weight (1997-2004, g)		
B.146	169 e	122 c	120 d	139 de	137 e
B.469	200 cd	143 bc	160 ab	147 de	163 d
B.491	209 bcd	142 bc	163 ab	149 cde	165 cd
M.9	237 a	156 ab	177 a	166 abc	184 ab
M.9 NAKBT337	227 ab	159 ab	170 a	171 ab	182 ab
Mark	227 ab	155 ab	168 a	157 abcde	177 bc
P.2	225 abc	145 bc	159 abc	154 bcde	171 cd
P.16	195 de	130 c	136 cd	138 e	150 e
P.22	172 e	139 bc	146 bc	138 e	149 e
V.1	237 a	165 a	177 a	174 a	188 a
V.3	231 ab	149 ab	167 a	160 abcd	177 bc
Average	212 a	146 c	158 b	154 bc	

[z] Rootstock means within columns not followed by the same letter are significantly different at odds of 19 to 1, and overall cultivar means not followed by the same letter are different at odds of 19 to 1.

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A Comparison of a Few of the Vineland Series Apple Rootstocks

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In 1996, a trial was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block H7) including Rogers Red McIntosh on V.1, V.2, V.3, V.7, and M.26 EMLA. The experiment was a randomized-complete-block design with seven replications. Means from 2004 (9th growing season) and cumulative means are included in Table 1 and Figure 1. Please note that V.4 was eliminated from this trial due to excessive vigor.

At the end of 2004, the largest trees were on V.7 and V.2, and the smallest were on V.3 (Figure 1, Table 1). Trees of M.26 EMLA and V.1 were statistically similar and intermediate between the groups. It is interesting to note that trees on V.1 were not as vigorous in this trial as they appear to have been in the 1995 trial reported in the previous article.

Yield per tree in 2004 was greatest from trees on M.26 EMLA and least from trees on V.3. V.1, V.2, and V.7 resulted in intermediate yields. Cumulatively (1998-2004), differences among rootstocks with re-

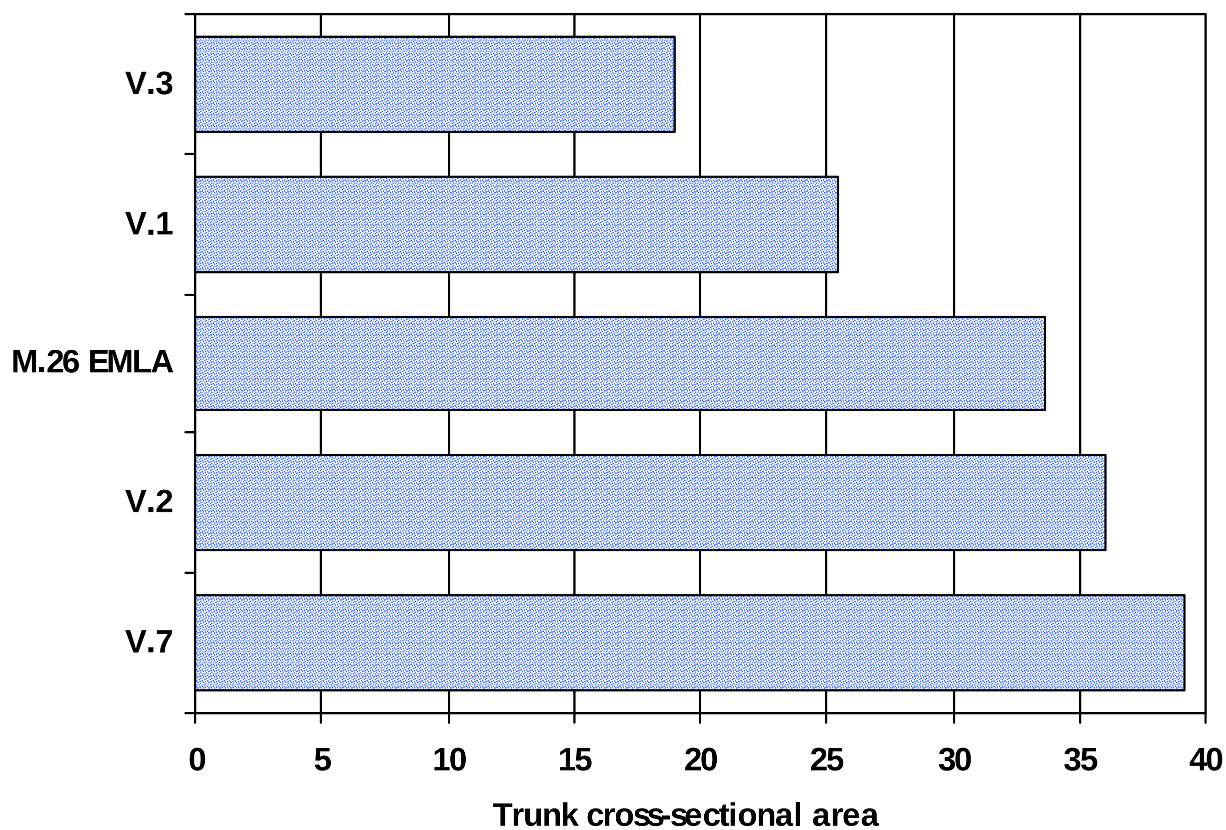

Figure 1. Trunk cross-sectional area of Rogers Red McIntosh trees on several rootstocks planted in 1996.

spects to yield per tree were nonsignificant.

Yield efficiency in 2004 was not affected by rootstock, but cumulatively (1998-2004), V.3 resulted in the greatest efficiency, and V.2 the lowest. Other rootstocks resulted in intermediate efficiency.

Rootstock did not affect fruit weight in 2004 or on average (1998-2004).

The Vineland series of rootstock are from Vineland, Ontario and are reported to be winter hardy. This trial does not point to any outstanding rootstocks from this portion of the Vineland series. V.3, possibly, could be considered for further trial, since in both this trial and the one reported in the previous article, it produces a moderately dwarfed, reasonably yield efficient tree.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

Table 1. Trunk cross-sectional area, yield, yield efficiency, and fruit weight in 2004 of Rogers Red McIntosh trees on several rootstocks planted in 1996.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Yield per tree (kg)		Yield efficiency (kg/cm^2 TCA)		Fruit weight (g)	
		2004	Cumulative (1998-2004)	2004	Cumulative (1998-2004)	2004	Average (1998-2004)
V.1	25.4 bc	12.7 ab	75 a	0.52 a	2.96 ab	179 a	132 a
V.2	36.0 a	13.1 ab	91 a	0.38 a	2.43 b	177 a	142 a
V.3	19.0 c	8.8 b	63 a	0.46 a	3.50 a	163 a	128 a
V.7	39.2 a	18.3 ab	97 a	0.47 a	2.55 ab	185 a	142 a
M.26 EMLA	33.6 ab	21.9 a	100 a	0.67 a	3.00 ab	182 a	142 a

[z] Means within not followed by the same letter are different at odds of 19 to 1.

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How Does G.16 Differ from M.9? -- The 1998 NC-140 Apple Rootstock Trial

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As part of the 1998 NC-140 Apple Rootstock Trial, a planting of Gala on three rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block H7) in 1998. The experiment was a randomized-complete-block design with ten replications. This trial was planted at several locations throughout North America, but only Massachusetts data are reported here. Means from 2004 (seventh growing season) and cumulative means are included in Table 1 and Figure 1.

Rootstock significantly affected trunk cross-sectional area, with trees on G.16 significantly larger than those on M.9 or M.9 EMLA (Figure 1). Trees did not produce many root suckers, and cumulative (1998-2004) root suckering was similar among the three rootstocks. Yields per tree in 2004 and cumulatively were not different among trees on the three rootstocks In 2004, trees on the M.9 strains were more yield efficient than trees on G.16. Cumulatively (2000-04), however, the two M.9 strains resulted in numerically more but statistically similar yield efficiency to G.16 (Figure 1). In 2004 and on average (2000-04), G.16 resulted in smaller fruit size than did M.9 or M.9 EMLA.

As a new rootstock introduciton, primary interest is in how G.16 compares to M.9. This trial suggests that G.16 results in large dwarf trees, which are some-

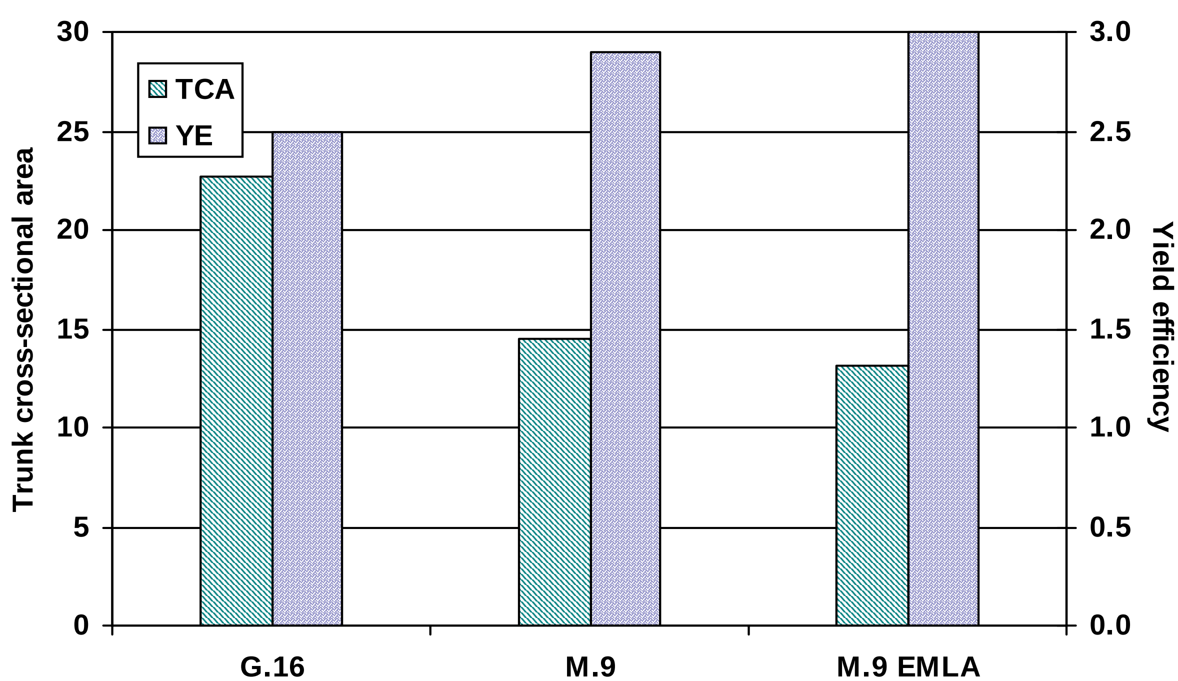

Figure 1. Trunk cross-sectional area and cumulative yield efficiency (2000-04) of Gala trees on M.9, G.16, and M.9 EMLA.

Table 1. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2004 of Gala trees on various rootstocks in the Massachusetts planting of the 1998 NC-140 Apple Rootstock Trial.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Root suckers (no./tree, 1998-2004)	Yield per tree (kg)		Yield efficiency (kg/cm^2 TCA)		Fruit weight (g)	
			2004	Cumulative (1999-2004)	2004	Cumulative (1999-2004)	2004	Average (1999-2004)
G.16	22.7 a	0.7 a	18.7 a	58 a	0.77 b	2.52 a	155 b	116 b
M.9	14.5 b	0.7 a	18.0 a	42 a	1.25 a	2.89 a	204 a	157 a
M.9 EMLA	13.2 b	0.3 a	20.9 a	40 a	1.56 a	2.99 a	194 a	156 a

[z] Means within not followed by the same letter are different at odds of 19 to 1.

what less yield efficient than M.9 and with smaller fruit size. Results from younger trials with McIntosh, Cameo, and Golden Delicious as the scion cultivars are also reported in this issue.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

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New Dwarf Apple Rootstocks from the Geneva (NY) and Pillnitz (Germany) Breeding Programs -- The 1999 NC-140 Dwarf Apple Rootstock Trial

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As part of the 1999 NC-140 Dwarf Apple Rootstock Trial, a planting of McIntosh on 11 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block H7) in 1999. The planting included six replications in a randomized-complete-block design. This trial was planted in several locations throughout the United States and Canada, but only Massachusetts data are reported here. Means from 2004 (6th growing season) and cumulative means are included in Table 1 and Figure 1.

Largest trees were on CG.4013 and CG.5202; trees on both were significantly larger than comparable trees on M.26 EMLA. The smallest were on M.9 NAKBT337 and Supporter 1. Trees on CG.3041, CG.5179, G.16N, G.16T, Supporter 1, and Supporter 2 were intermediate between those on M.9 NAKBT337 and those on M.26 EMLA.

Cumulative suckering (1999-2004) was greatest from CG.4013 and least from CG.5202, G.16N, M.26 EMLA, and Supporter 1, but no rootstock resulted in large numbers of root suckers, as will be seen in the next article from the semidwarf rootstock trial.

CG.4013, CG.5202, and CG.5179 resulted in the greatest yield per tree in 2003 and cumulatively (2001-04), and M.9 NAKBT337, M.26 EMLA, G.16N, and CG.3041 resulted in the lowest. Yield efficiency presents yield relative to tree size and gives an index to

Table 1. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2004 of McIntosh trees on several rootstocks in the Massachusetts planting of the 1999 NC-140 Dwarf Apple Rootstock Trial.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Root suckers (no./tree, 1999-2004)	Yield per tree (kg)		Yield efficiency (kg/cm^2 TCA)		Fruit weight (g)	
			2004	Cumulative (2001-04)	2004	Cumulative (2001-04)	2004	Average (2001-04)
CG.3041	25.2 bcd	1.2 ab	11.1 bcd	46 bcd	0.42 a	1.81 abc	217 ab	165 ab
CG.4013	42.9 a	3.5 a	24.8 a	90 a	0.58 a	2.14 ab	174 b	164 ab
CG.5179	32.1 abc	1.0 ab	21.3 ab	70 ab	0.68 a	2.21 ab	206 ab	170 ab
CG.5202	37.0 ab	0.0 b	20.7 abc	69 ab	0.56 a	1.94 abc	184 ab	167 ab
G.16N	20.5 cde	0.0 b	8.9 cd	35 cd	0.43 a	1.60 bc	196 ab	170 ab
G.16T	21.1 cde	0.5 ab	14.0 abcd	42 bcd	0.69 a	2.06 abc	180 b	153 ab
M.26 EMLA	24.6 cd	0.0 b	11.1 bcd	31 cd	0.46 a	1.27 c	191 ab	170 ab
M.9 NAKBT337	13.6 e	0.3 ab	8.5 d	25 d	0.71 a	1.99 abc	211 ab	181 a
Supporter 1	16.9 de	0.0 b	13.9 bcd	43 bcd	0.80 a	2.50 ab	225 a	157 ab
Supporter 2	20.5 cde	1.3 ab	17.1 abcd	55 bcd	0.83 a	2.68 a	194 ab	146 b
Supporter 3	22.1 cde	0.3 ab	15.9 abcd	57 bc	0.77 a	2.64 a	195 ab	155 ab

[z] Means within columns not followed by the same letter are different at odds of 19 to 1.

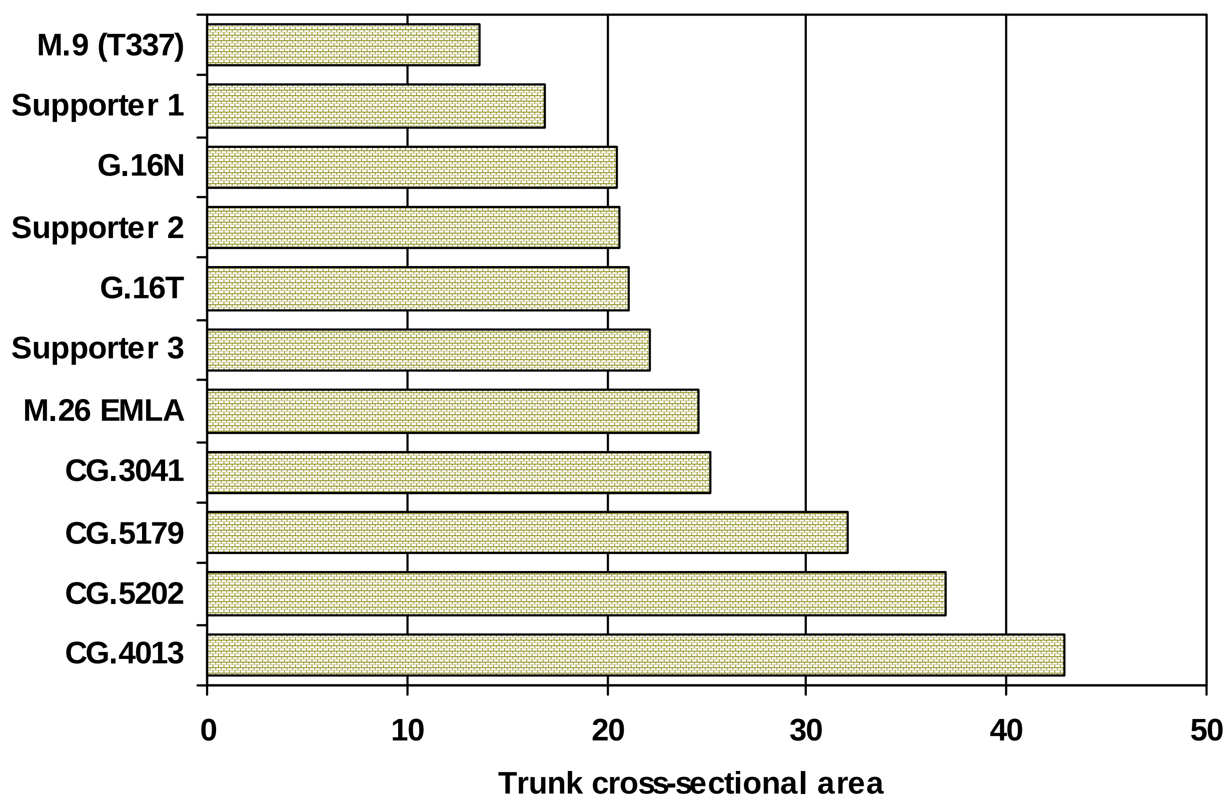

Figure 1. Trunk cross-sectional area of McIntosh trees on several rootstocks in the 1999 NC-140 Dwarf Apple Rootstock Trial (after six growing seasons).

estimate relative yield at an appropriate planting density. In 2004, rootstock did not affect yield efficiency, but cumulatively (2001-04), the most efficient trees were on Supporter 2 and Supporter 3, and the least efficient were on M.26 EMLA. Most other rootstocks were not significantly different from either the most or least efficient treatments.

Largest fruit in 2004 were harvested from trees on Supporter 1, and the smallests were from trees on CG.4013 and G.16T. All fruit were large in 2004, with CG.4013 (smallest average size) and Supporter 1 (largest average size) resulting in average packed size of 109 and 84, respectively. On average (2001-94), largest fruit were from trees on M.9 NAKBT337, and smallest were from trees on Supporter 2. All other rootstocks resulted in intermediate size.

As a new introduction, G.16 is performing reasonably well, producing a tree intermediate to those on M.9 NAKBT337 and M.26, but at this point in the trial not significantly more yield efficient. CG.3041 (soon to be named G.41) performed very similarly to G.16 over the six years of this trial, but trees are more similar in size to those on M.26. CG.4013, CG.5179, and CG.5202 produced trees too large at this point to be considered full dwarfs, but they were reasonably yield efficient and had good fruit size. The Supporter series produced trees between M.9 NAKBT337 and M.26 in size and that were very yield efficient. Fruit size was good in 2004, but has been small overall. All of these rootstocks need further testing before definitive recommendations can be made.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

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New Semidwarf Apple Rootstocks from the Geneva (NY) and Pillnitz (Germany) Breeding Programs -- The 1999 NC-140 Semidwarf Apple Rootstock Trial

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As part of the 1999 NC-140 Semidwarf Apple Rootstock Trial, a planting of McIntosh on six rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block H7) in 1999. The planting included six replications in a randomized-complete-block design. This trial was planted in several locations throughout the United States and Canada, but only Massachusetts data are reported here. Means from 2004 (6th growing season) and cumulative means are included in Table 1 and Figure 1.

Largest trees were on G.30N, M.7 EMLA, and

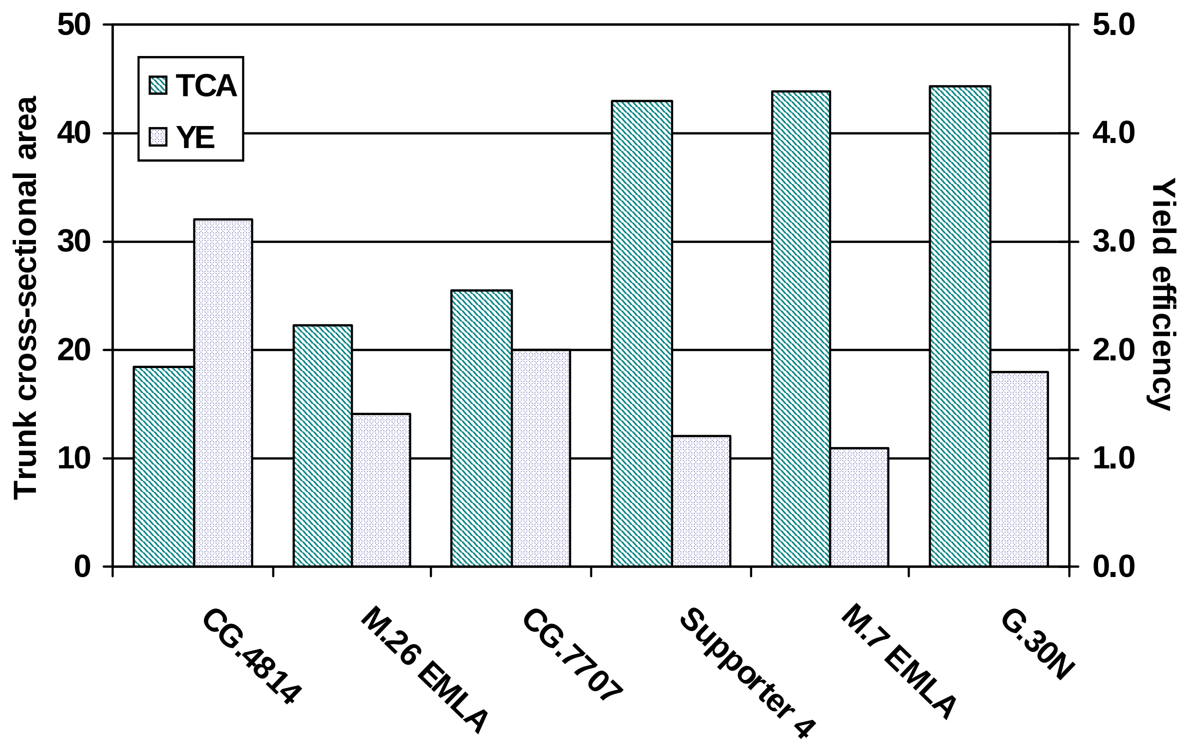

Figure 1. Trunk cross-sectional area and cumulative yield efficiency of McIntosh trees on several rootstocks in the 1999 NC-140 Semidwarf Apple Rootstock Trial (after six growing seasons).

Table 1. Trunk cross-sectional area, suckering, yield, yield efficiency, and fruit weight in 2004 of McIntosh trees on several rootstocks in the Massachusetts planting of the 1999 NC-140 Semidwarf Apple Rootstock Trial.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Root suckers (no./tree, 1999-2004)	Yield per tree (kg)		Yield efficiency (kg/cm^2 TCA)		Fruit weight (g)	
			2004	Cumulative (2001-04)	2004	Cumulative (2001-04)	2004	Average (2001-04)
CG.4814	18.5 b	13.0 ab	21.8 ab	59 ab	1.19 a	3.16 a	219 a	172 a
CG.7707	25.5 b	2.4 b	19.8 ab	50 bc	0.79 ab	1.96 b	201 a	186 a
G.30N	44.4 a	1.3 b	26.7 a	80 a	0.58 b	1.83 b	186 a	174 a
M.26 EMLA	22.2 b	0.0 b	12.4 b	31 c	0.55 b	1.41 b	202 a	179 a
M.7 EMLA	43.9 a	21.8 a	20.6 ab	50 bc	0.46 b	1.14 b	197 a	175 a
Supporter 4	43.0 a	2.2 b	15.2 ab	47 bc	0.37 b	1.15 b	199 a	176 a

[z] Means within columns not followed by the same letter are different at odds of 19 to 1.

Supporter 4, and the smallest were on M.26 EMLA, CG.4814, and CG.7707 (Figure 1, Table 1). Greatest cumulative (1999-2004) root suckering was observed from trees on CG.4814 and M.7 EMLA. G.30N resulted in the most yield per tree in 2004 and cumulatively (2001-04), and M.26 EMLA resulted in the least. Trees on CG.4814 were the most yield efficient in 2004 and cumulatively (2001-04) (Figure 1, Table 1). Those on CG.7707 and G.30N had numerically greater yield efficiency than trees on M.26 EMLA, M.7 EMLA, or Supporter 4, but additional years of data will be required to determine if the difference can become significant. Fruit weight was not affected by rootstock in 2004 or on average (2001-04).

G.30 likely is the rootstock of most interest in this trial. It produced a tree similar in size and greater yielding than those on M.7. Note should made of CG.4814. It produced a large dwarf tree, similar in size to those on M.26, but yielding nearly double. The only drawback may be its propensity for root suckering.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

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Strains of B.9, M.9, and M.26 Compared to New Polish and Pillnitz Rootstocks -- The 2002 NC-140 Apple Rootstock Trial

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As part of the 2002 NC-140 Apple Rootstock Trial, a planting of Gala on 11 rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block A6) in 2002. The planting included seven replications in a randomized-complete-block design. This trial was planted in several locations throughout the United States, Canada, and Mexico, but only Massachusetts data are reported here. Means from 2004 (3rd growing season) are included in Table 1 and Figure 1.

Largest trees were on PiAu51-4 and M.26 NAKB, and smallest were on B.9 (Europe), B.9 (Treco), M.9 NAKBT337, and Supporter 4. Root suckering, yield, yield efficiency, and fruit size were not affected significantly by rootstock in 2004.

Obviously, data from the third growing season do not provide much useful information to compare rootstock performance; however, it is interesting to follow these trees as they develop. This trial was planted with several objectives in mind. There are two strains of

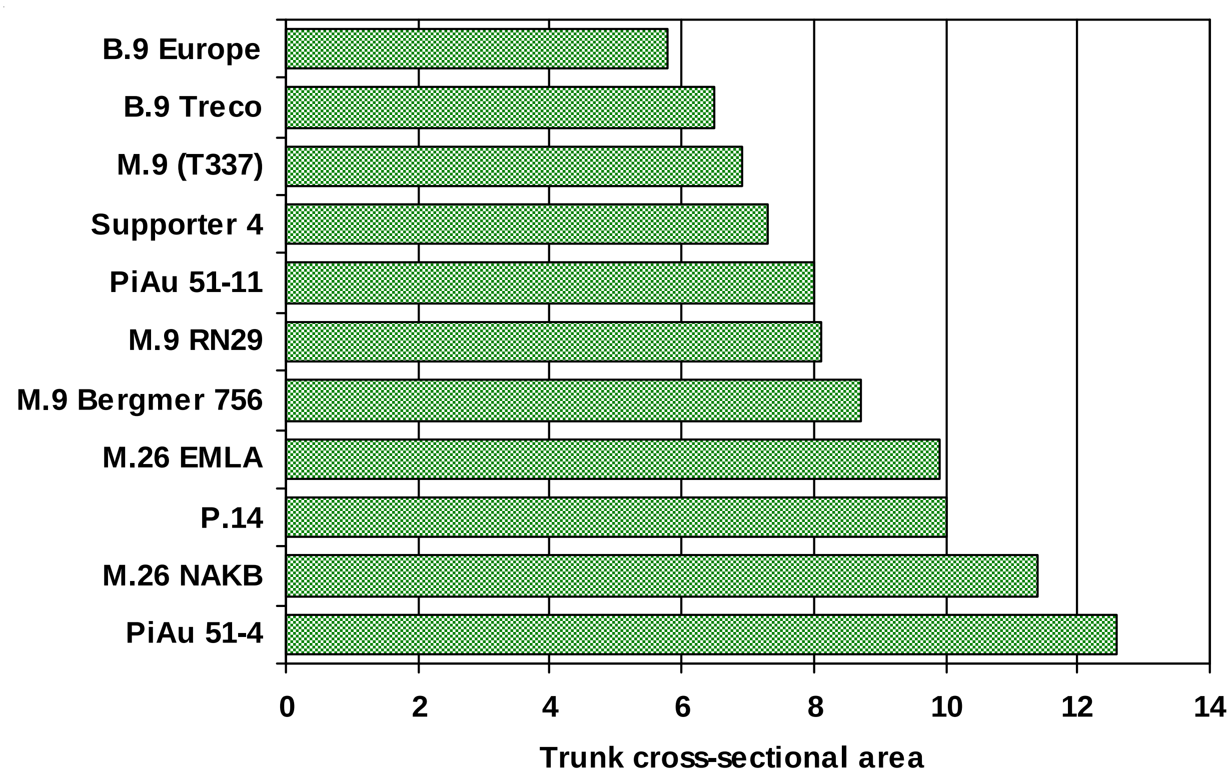

Figure 1. Trunk cross-sectional area in 2004 of Gala trees on several rootstocks in the Massachusetts planting of the 2002 NC-140 Apple Rootstock Trial.

Table 1. Trunk cross-sectional area in October and cumulative suckering in 2004 of Gala trees on several rootstocks in the Massachusetts planting of the 2002 NC-140 Apple Rootstock Trial.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Root suckers (no./tree, 2002-04)	Yield per tree (kg)	Yield efficiency (kg/cm2 TCA)	Fruit weight (g)
B.9 (Europe)	5.8 d	0.0 a	3.0 a	0.51 a	149 a
B.9 (Treco)	6.5 cd	0.0 a	2.3 a	0.37 a	163 a
M.26 EMLA	9.9 abc	0.2 a	1.6 a	0.17 a	144 a
M.26 NAKB	11.4 ab	0.1 a	2.6 a	0.24 a	121 a
M.9 Bergmer 756	8.7 abcd	0.1 a	1.9 a	0.23 a	172 a
M.9 RN29	8.1 bcd	2.3 a	2.7 a	0.34 a	180 a
M.9 NAKBT337	6.9 cd	0.0 a	1.3 a	0.19 a	155 a
P.14	10.0 abc	0.3 a	0.6 a	0.12 a	135 a
PiAu51-11	8.0 bcd	0.2 a	0.6 a	0.09 a	159 a
PiAu51-4	12.6 a	0.0 a	0.2 a	0.03 a	128 a
Supporter 4	7.3 cd	0.0 a	0.9 a	0.22 a	155 a

Means within columns not followed by the same letter are different at odds of 19 to 1.

B.9 in commerce, and it is hoped to begin understanding differences between them with this trial. Also, an alternative strain of M.26 (NAKB) must be compared to the standard M.26 EMLA. The Bergmer 756 strain of M.9 may have value and is compared to other strains in this trial. Further, newly available rootstocks, P.14, PiAu51-11, PiAu 51-4 are included in this trial for their first NC-140 evaluation. In future years, this trial will providing interesting data from which to make rootstock selection decisions.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

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G.16 Produces Trees Larger Than Those on M.9 or B.9 -- The 2002 Massachusetts-New Jersey Cameo Rootstock Trial

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In 2002, a trial was established at he UMass Cold Spring Orchard Research & Education Center (Block B3) and Pittstown, NJ including Cameo on B.9, G.16, and M.9 NAKBT337. The experiment was a randomized-complete-block design with ten replications at each site. Only data from 2004 (3rd growing season) and cumulative data from Massachusetts are presented here (Table 1). Please note that the cover photo of this issue of *Fruit Notes* is from this trial.

After three growing seasons, trees on G.16 had larger trunk cross-sectional area than did those on either B.9 or M.9 NAKBT337. Greatest yields per tree in 2004 were harvested from trees on G.16, and the lowest were from trees on B.9. Cumulatively for the first two fruiting seasons, yields were similar among the trees on the three rootstocks. Yield efficiency in 2004 and cumulatively (2003-04) were similar for trees on the three rootstocks. Fruit size, however, was greater in 2004 for fruit from trees on M.9 NAKBT337 than from trees on G.16. Average fruit size (2003-04) was not different among trees on the three rootstocks.

Although these data are very early in the life of these trees, they are consistent with other trials reported in this issue, in that trees on G.16 are larger with smaller fruit size than those on M.9.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

Table 1. Trunk cross-sectional area, root suckering, bloom density, yield, yield efficiency, and fruit weight in 2004 of Cameo trees on three rootstocks planted in 2002.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Yield per tree (kg)		Yield efficiency (kg/cm^2 TCA)		Fruit weight (g)	
		2004	Cumulative (2003-04)	2004	Cumulative (2003-04)	2004	Average (2003-04)
B.9	5.5 b	5.2 b	6.8 a	0.92 a	1.20 a	184 ab	187 a
G.16	8.6 a	7.5 a	8.9 a	0.89 a	1.05 a	169 b	174 a
M.9 NAKBT337	6.2 b	5.8 ab	6.7 a	0.92 a	1.05 a	190 a	187 a

[z] Means within not followed by the same letter are different at odds of 19 to 1.

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Do Different Rootstocks Respond Differently to Variation in Crop Load? -- The 2003 NC-140 Apple Rootstock Physiology Trial

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As part of the 2003 NC-140 Apple Rootstock Physiology Trial, a planting of Gibson Golden Delicious on three rootstocks was established at the University of Massachusetts Cold Spring Orchard Research & Education Center (Block A6) in 2003. The planting included ten trees of each rootstock in a completely random design. This trial was planted in several locations throughout the United States and Canada, but only Massachusetts data are reported here. Means from 2004 (2nd growing season) are included in Table 1.

This trial is not intended to compare rootstock performance directly (to date rootstock has not affected trunk cross-sectional area or root suckering). Instead, it was established to study the varying effects of crop load on different rootstocks. Beginning in either 2005 or 2006 and continuing for three years, crop load will be adjusted to varying levels. Effects on yield per tree and fruit size will be studied. It is supposed that rootstocks respond to crop load in different ways. These data are presented only to introduce this trial. Future years will begin to present the relative crop load effects.

Table 6. Trunk cross-sectional area and root suckering in 2004 of Gibson Golden Delicious trees on three rootstocks in the Massachusetts planting of the 2003 NC-140 Apple Rootstock Physiology Trial.[z]

Rootstock	Trunk cross-sectional area (cm^2)	Root suckers (no./tree)
G.16	2.4 a	0.0 a
M.26 EMLA	2.7 a	0.0 a
M.9 NAKBT337	2.0 a	0.0 a

[z] Means within columns not followed by the same letter are different at odds of 19 to 1.

Acknowledgments

The authors are grateful to the Massachusetts Fruit Growers' Association for providing the funding for this project.

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2002 Super Spindle Apple Planting

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In 2002 an apple block with 19 cultivars and 5 rootstocks was planted and trained to the super-spindle (SS) or vertical-axis (VA) systems in a non-replicated design at the UMass Cold Spring Orchard Research & Education Center (Block B3). Tree spacing is 2 X 12 ft (SS) or 4 X 12 ft (VA). A sub-set of the trees is part of an NC-140 planting (See 'G.16 Produces Trees Larger Than Those on M.9 or B.9 – The 2002 Massachusetts-New Jersey Cameo Rootstock Trial'). This planting is mostly replicated at the Snyder Research and Extension Farm in Pittston, New Jersey, and is a collaborative effort with Win Cowgill of Rutgers Cooperative Research and Extension. Details of the planting are outlined in Table 1. Objectives are to evaluate yields, fruit quality, and inputs of the super-spindle apple system to see if it makes sense for New England and Northeast growers. In 2004, yield data and some fruit quality data were collected on harvested

Table 1. Planting details of the 2002 Super-spindle Apple Planting, UMass Cold Spring Orchard, Belchertown, MA

Cultivar	Rootstock	No. trees	Spacing (ft)	Trees/acre	Training[z]
Braeburn, Joburn	B.9	30	2 X 12	1.815	SS
Cameo	B.9	20	2 X 12	1.815	SS
Cameo	M.9 NAKBT337	20	2 X 12	1,815	SS
Cameo	G.16	20	2 X 12	1,815	SS
Cameo	B.9	10	4 X 12	908	VA
Cameo	M.9 NAKBT337	10	4 X 12	908	VA
Cameo	G.16	10	4 X12	908	VA
Cortland, Redcort	M.9 Pajam 2	30	2 X 12	1,815	SS
Empire, Royal	B.9	30	2 X 12	1,815	SS
Fuji, Autumn Rose	B.9	30	2 X 12	1,815	SS
Fuji, Desert Rose	B.9	30	2 X 12	1,815	SS
Gala, Brookfield	M.9 NAKBT337	30	2 X 12	1,815	SS
Gala, Buckeye	G.16	30	2 X 12	1,815	SS
Gala, Buckeye	M.9 NAKBT337	30	2 X 12	1,815	SS
Golden Delicious, Gibson	B.9	30	2 X 12	1.81	SS
Golden Supreme	M.9 Pajam 2	30	2 X12	1,815	SS
Goldrush	M.9 RN29	30	2 X 12	1.815	SS
Granny Smith	G.16	30	2 X 12	1,815	SS
Honeycrisp	B.9	30	2 X 12	1,815	SS
Jonagold, Morren's Supra	B.9	30	2 X 12	1,815	SS
Lindamac	M.9	20	4 X 12	908	VA
Macoun	M.9 RN29	30	2 X 12	1,815	SS
McIntosh, Redmax	B 9	30	2 X 12	1.815	SS
Mutsu	M.9-RN29	30	2 X 12	1,815	SS
Suncrisp	B.9	30	2 X 12	1,815	SS

[z]VA = Vertical Axis; SS = Super Spindle

Table 2. 2004 harvest date, fruit quality characteristics, and yield of the 2002 Super-spindle Apple Planting, UMass Cold Spring Orchard, Belchertown, MA

Cultivar	Harvest date	Diameter (in)	Color (% red)	Firmness (lbs)	Sol solids (%)	Starch index	Yield (40 lb box)	Yield per acre (40 lb box)
Lindamac	2-Sept	3.3	95	14.3	13.5	4.5	5.5	250
Buckeye Gala	7-Sept	2.9	95	18	13	4.5	4	240
Golden Supreme/	7-Sept	3.2	NA	17.2	12	2.9	1.5	90
Redmax McIntosh	7-Sept	3.1	85	14	13	5.1	5.5	330
Buckeye Gala/M.9	7-Sept	2.9	95	18	13	4.5	4	240
Brookfield Gala	8-Sept	3.0	90	17.6	13	5	4	240
Honeycrisp	10-Sept	3.6	50	14.5	15	6	4	240
Buckeye Gala/G.16	15-Sept	2.9	100	18	13.5	5.3	2	120
Brookfield Gala	15-Sept	2.8	80 striped	19	14	5.5	1	60
Honeycrisp	16-Sept	3.6	45	13	15	6.9	0.5	30
Macoun	24-Sept	3.5	70	14.7	13.5	3.3	5	300
Morren's Jonagold	24-Sept	3.4	65	14	13.8	6	4	240
Royal Empire	27-Sept	3.1	95	16.7	14.8	4.1	3	180
Cameo	4-Oct	3.2	50 striped	15	14	4	12	360
Gibson Gold. Del.	5-Oct	3.3	yellow	15.2	16.4	6.1	0.5	30
Mutsu	7-Oct	3.7	green	16.6	15	4	5	300
Cameo	11-Oct	3.0	55 striped	17	14	4	9	270
Suncrisp	14-Oct	3.4	10-50%	16.3	15.8	4	5	300
Desert Rose Fuji	14-Oct	3.0	85	17.1	14	4.9	3	180
Autumn Rose Fuji	14-Oct	3.0	80	17.7	14.6	4.9	3	180
Suncrisp	20-Oct	3.1	25	13.2	14.5	5	1	60
Joburn Braeburn	28-Oct	3.0	90	19.6	13.8	3.5	3	180
Goldrush	28-Oct	3.2	yellow	19.9	14.8	4	4	240

fruit. Results are presented in Table 2. Yields were impressive – as high as 340 boxes per acre (in third leaf). Although the cost of establishing such an orchard is high, early returns quickly offset some of the costs. As the planting matures, we will have a better idea if it is a viable orchard system for our growing conditions.

Acknowledgements

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Controlling Growth in the Top of Dwarf Trees

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Successful growing of dwarf apple trees requires control of both vegetative and reproductive growth. If trees grow too tall, it seems natural to remove the excessive growth with dormant pruning. The result often is a vigorous, vegetative response and no fruiting in the top of the tree. Over the last several years, we have studied some alternatives, including bending, scoring, and ringing. All work to some degree to reduce vegetative growth and potentially reduce the need for pruning and the subsequent disruption of the balance of vegetative and reproductive growth in the top of the tree.

A few Massachusetts growers and Jon Clements attended the IDFTA-sponsored tour to the tree-fruit-growing regions of Italy in the winter of 2004. They noticed that orchardists were using naphthalene acetic acid (NAA) mixed in a flexible pruning paint as a way to suppress growth in the top of high-density, dwarf apple trees. Mo Tougas (Tougas Family Farm) was on the tour and suggested that we give it a try under our conditions. Therefore, four trials at the UMass Cold Spring Orchard Research & Education Center began in 2004, with the objective of determining the best way to control vegetative growth in the tops of dwarf trees and to particularly determine if high concentrations of NAA may be effective.

Materials & Methods

All trees used in these studies were planted in May 2002 (Block B3) and trained as super spindles. Spacing was 2 feet x 10 feet. The year of treatment (2004) was the third leaf of these trees. See the previous article to see additional details of this super-spindle block. At the initiation of the experiments, each tree was marked with a dot of red paint at about 5.5 feet from the ground (in 2-year old wood). All treatments were applied immediately above this point or to the whole tree above. Trunk cross-sectional area was also determined at this point, and all growth, set, and bloom were assessed above this height. Total growth produced in 2003 above the treatment point was used to allocate trees in to blocks in the spring of 2004.

The first experiment utilized 20 Cameo/G.16 trees. Treatments included an untreated control. NAA was applied at 1.5% in standard, interior, white, latex paint as a 3-inch wide band completely around the trunk. The source of NAA was Tre-hold Sprout Inhibitor A112 (15.1% NAA) provided by Amvac Chemical Corporation (also sold by Monterey Chemical Company as Sucker Stopper Concentrate). Ethephon was applied to the top of trees at 500 ppm (1.7 pints/100 gallons) with 0.1% Regulaid. Apogee was applied to the top of trees at 250 ppm (12 ounces/100 gallons) with 0.1% Regulaid and 0.25% Choice (1 quart/100 gallons). The last treatment was a single score made with a linoleum knife completely through the bark (to the wood) and encircling the trunk. NAA, Apogee, and scoring were applied at full bloom on May 13, 2004, and ethephon was applied 1 week later on May 20, 2004.

The second experiment utilized 30 Brookfield Gala/M.9 NAKBT337. Treatments included an untreated control and four NAA treatments, all at 1.5%. All NAA treatments were applied as 3-inch bands encircling the trunk. The first was NAA in water with 0.1% Regulaid. The second was in water with 1% Pentra-Bark (a bark penetrating surfactant). The third was in standard, interior, white, latex paint, and the last was in interior, texture, latex paint (used to create textured surfaces). All treatments were applied at full bloom on May 13, 2004.

The third experiment utilized 30 Buckeye Gala/G.16. Treatments included an untreated control and four NAA treatments, all at 1.5% in standard, interior, white, latex paint. Differences were in the width of the band applied to the trunk: 1 inch, 2 inches, 3 inches, and 4 inches wide. Applications were all made at full

Table 1. Fruit set and growth in 2004 and bloom in 2005 as affected by treatments applied to the tops of super spindle apple trees at or near bloom in 2004 (third leaf).

Treatment	Fruit set 2004 (no./cm^2 TCA)	Leader growth (cm)	Total growth (cm)	Return bloom (2005, no./cm^2 TCA)		
				Spur	Lateral	Total
Cameo/G.16						
Control	3.8 bc	56 a	643 a	4.1 b	1.5 a	5.6 a
NAA in latex paint – 3" band	5.1 ab	51 ab	420 ab	4.9 b	4.5 a	9.4 a
Ethephon in water with Regulaid	6.8 ab	51 ab	476 a	4.1 b	0.3 a	4.4 a
Apogee in water with Regulaid & Choice	1.0 c	13 c	236 b	9.3 a	0.2 a	9.5 a
Score	8.5 a	43 b	480 a	3.7 b	0.7 a	4.4 a
Brookfield Gala/M.9 NAKBT337						
Control	5.0 a	34 a	503 a	19.4 a	39.0 a	58.4 a
NAA in water with Regulaid – 3" band	7.2 a	35 a	435 a	15.7 a	30.1 a	45.7 b
NAA in water with Pentra-Bark – 3" band	5.2 a	38 a	448 a	13.6 a	30.2 a	43.8 b
NAA in latex paint – 3" band	6.8 a	35 a	352 a	16.7 a	29.3 a	46.0 b
NAA in texture latex paint – 3" band	7.4 a	33 a	465 a	14.3 a	29.1 a	43.4 b
Buckeye Gala/G.16						
Control	2.8 a	42 a	580 a	11.2 a	15.3 a	26.5 a
NAA in latex paint – 1" band	3.3 a	38 a	596 a	13.8 a	24.0 a	38.9 a
NAA in latex paint – 2" band	3.0 a	44 a	488 a	12.5 a	15.6 a	28.2 a
NAA in latex paint – 3" band	3.8 a	34 a	440 a	12.1 a	17.9 a	30.1 a
NAA in latex paint – 4" band	2.1 a	35 a	452 a	11.9 a	14.4 a	26.3 a
Redmax/B.9						
Control	8.3 a	41 a	284 a	23.2 a	12.8 a	36.0 a
NAA in water with Regulaid – 3" band	6.3 a	31 a	252 a	18.8 a	8.2 a	27.0 a
NAA in water with Sylwet – 3" band	7.1 a	35 a	199 a	21.5 a	9.2 a	30.7 a
NAA in latex paint – 3" band	7.4 a	29 a	152 a	23.7 a	9.2 a	33.0 a
NAA in grafting compound – 3" band	5.8 a	32 a	178 a	14.2 a	7.5 a	21.7 a
Cultivars Combined						
Control	5.1 a	42 a	490 a	15.4 a	18.6 a	34.0 a
NAA in latex paint – 3" band	5.8 a	36 b	334 b	15.2 a	16.2 a	31.4 a

All NAA treatments were at 1.5% and were applied at full bloom (May 13, 2004). Regulaid and Sylwet were at 0.1%, and Pentra-Bark was at 1%. Latex paint was standard, white, interior latex, and texture latex was white, interior paint used to create textured surfaces. Apogee was applied at full bloom at 250 ppm (12 ounce/100 gallons) along with Choice at 0.25% (1quart/100 gallons). Ethephon was applied one week after full bloom (May 20, 2004) at 500 ppm (1.67 pints/100 gallons). All treatment bands were applied at about 5.5 feet above ground in 2-year-old wood. Scoring was performed at the same point, and Apogee and ethephon were applied to all foliage above the same point. Means within cultivar and column not followed by the same letter are significantly different at odds of 19 to 1.

bloom on May 13, 2004.

The fourth experiment utilized 30 Redmax/B.9. Treatments included an untreated control and four NAA treatments, all at 1.5% and applied as 3-inch bands around the trunk. The first was in water with 0.1% Regulaid. The second was in water with 0.1% Sylwet. The third was in standard, interior, white, latex paint, and the fourth was in black grafting compound. All were applied at full bloom on May 13, 2004.

Final fruit set was assessed in the summer of 2004. During the winter of 2005, all shoot growth was measured, and bloom was counted in the spring of 2005.

Results & Discussion

Table 1 presents all of the results from these four experiments. In the Cameo experiment, Apogee reduced fruit set, leader growth, and total shoot growth and increased return bloom on spurs. Scoring enhanced fruit set and reduced leader growth. In the Brookfield Gala experiment, the NAA treatments did not affect fruit set or growth significantly, but reduced total return bloom, primarily through a reduction in lateral bloom (on 1-year-old wood). In the Buckeye Gala and Redmax experiments, NAA treatments did not affect any measurement significantly.

Looking at these experiments individually, it is possible to take home the message that NAA does not have an impact on growth, at least when applied in the manners used here. If you study the means, however, there appears to be a numerical, even though not statistically significant, reduction in growth caused by the NAA treatments. The lack of statistical significance likely occurred due to a relatively high degree of variability and small number of replications in all of these experiments. In an attempt to come to terms with this trend and variability, data for the control treatment and NAA in latex paint (3-inch band) were combined across cultivar, since every experiment had these two treatments. When assessed in total, the NAA treatment significantly reduced leader growth (-14%) and total growth (-32%) in the tops of these trees. Set and bloom were not affected. The effect on total growth is likely substantial enough to make the treatment worthwhile, but it is also possible that the primary effect on growth occurs in subsequent years rather than the year of treatment (as suggested by Mo Tougas). One of the visible responses to these treatments is that the trunk under the application swells. The swelling is occurring primarily in the bark and phloem area. It is conceivable that the altered tissues disturb normal flow of materials through the vascular system at the point of application, possibly acting like a score or ring.

Additional work is beginning in 2005, first of all to follow the trees' responses to 2004 treatments, but additional treatments are also planned, including application to 1-year-old wood versus 2-year-old wood and use of materials that may enhance absorption of NAA.

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Effects of Ethephon on Vegetative Growth of Nectarine Trees

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During the winter of 2004, peaches at the University of Massachusetts Cold Spring Orchard Research & Education Center experienced significant amounts of flower bud damage (see "New Peach Variety/Selection Plantings and Evaluation When Grown to the Perpendicular V" and "Observations on Winter Flower-bud Damage and Crop Load of Several Peach Varieties" in this issue). We know that peach trees without a crop produce a great amount of vegetative growth. The objective of this study was to use trees where the flower buds were frozen during the winter to determine if ethephon could be used to reduce excessive vegetative growth.

A block of 24 Summer Beauty nectarine trees were used for this study. Trees were planted at the UMass Cold Spring Orchard Research & Education Center (Block M2) in 2000 and trained to a perpendicular V system. When shoot growth was between 2 and 4 inches long (May 20, 2004), ethephon at 0, 50, 100, or 150 ppm was applied. All treatments included 0.1% Regulaid as a surfactant. Trunk cross-sectional area was assessed before treatment and again in the winter of 2005. Also, 10 shoots per tree were selected at random and measured during the winter of 2005.

Table 1. Effects of ethephon treatment on trunk and shoot growth of Summer Beauty nectarine in 2004. All treatments included 0.1% Regulaid as a surfactant.

Ethephon treatment (ppm)	Trunk cross-sectional area before treatment (cm^2)	Trunk growth in 2004 (cm^2)	Average shoot growth (cm)
0	54.5	17.1	78
50	56.0	19.1	69
100	55.7	14.6	68
150	54.8	15.3	69
Significance[z]	ns	*L	ns

[z] *, ns: Differences among means are significant at odds of 19 to 1 or nonsignificant, respectively. L. Signifies that the relationship between ethephon concentration and the designated parameter is linear.

Research elsewhere, studying the potential use of ethephon as a fruit thinner on peach, suggested that 50 to 100 ppm was the highest usable concentration of ethephon because of effects on leaf quality and premature leaf drop. In this study, we so no such leaf responses, even at 150 ppm ethephon. Also, we saw very little impact on growth (Table 1). Trunk growth was reduced slightly by ethephon, but shoot growth was not affected significantly (although there was a numerical reduction).

In 2005, this research will continue in a similar block of non-fruiting trees, but the maximum concentration used will be increased to 300 ppm.

* * * * *

Predicting Plum Curculio Immigration into Apple Orchards in Massachusetts: Degree Days versus Tree Phenology

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Determining need for and timing of insecticide applications that will protect fruit from injury by plum curculio (PC) based on presence of adults on host trees has been a critical aspect for managing populations. In concept, a reduction in amount of insecticide used against PC, from the current norm in Massachusetts of three spray applications during May and June to an amount that is precise according to need should be accompanied with an effective approach to monitoring the course of PC immigration into apple orchards. Limb jarring, an approach that involves tapping tree limbs using a pole to dislodge PCs onto an underlying ground cloth is one of the methods traditionally used to determine the time of first appearance, location, and relative abundance of PCs within an orchard. However, limb jarring has several shortcomings: (1) it is labor intensive; (2) it is not very accurate (its effectiveness is highly dependent upon tree size, weather, and other factors); (3) it cannot be used to study immigration, because PCs that are able to overwinter beneath perimeter-row trees will be confounded with true immigrants that overwintered in the woods; and (4) it cannot be performed at night, the time of day when PCs are most active on trees.

In the 2000 combined issue of *Fruit Notes* we reported that panel and pyramid traps baited with attractive odor and deployed in close proximity to the forested areas that are the main overwintering sites of adult PCs offered great potential for monitoring the onset and extent of PC immigration into apple orchards. Here, we investigated, over a five-year period, temporal dynamics of PC immigration into an unsprayed section of a commercial apple orchard using odor-baited traps. In particular, our objectives were: (1) characterizing the overall pattern of PC immigration; (2) determining the relationships among trap captures, tree phenology, and weather; (3) estimating thermal constants, expressed in Degree Days, for different stages (onset, 50^{th} and 80^{th} percentiles of cumulative captures) of PC immigration; and (4) determining the relative predictability of different stages of PC immigration by comparing tree phenology versus thermal constants.

Materials & Methods

Study site and trap deployment. We conducted this study over a period of five years (2000-2004) at the University of Massachusetts Cold Spring Orchard Research & Education Center utilizing a 1.4-acre unsprayed block comprised of a section having 216 small (M.26 rootstock) McIntosh and Delicious trees located on the eastern side (Block X1), and two smaller sections having 145 medium-sized (M.26 rootstock) trees of various disease-resistant varieties located on the western side (Blocks X2, X3, Figure 1). The perimeter of the entire block, bordered almost entirely by mixed deciduous forest, was about 500 yards.

Traps utilized for the study were of two different types: (a) clear sticky Plexiglas panels (2 x 2 feet), which capture PCs in flight, and (b) a trunk-mimicking black pyramid traps, which capture PCs approaching host trees primarily by crawling. The woods-facing side of each panel was coated with Tangletrap glue to capture PCs that were presumably immigrating from the woods into the orchard block.

For each of the five years, traps were deployed in pairs along the periphery of the orchard, in close proximity to the woods. Each pair of traps was spaced 10 yards from other trap pairs on either side except in 2004, when the distance between each trap pair was 35 yards. For each of the five years, trap captures were pooled across all traps of the same type deployed in the orchard. The predominant bait used for luring PCs to traps was composed of benzaldehyde (attractive,

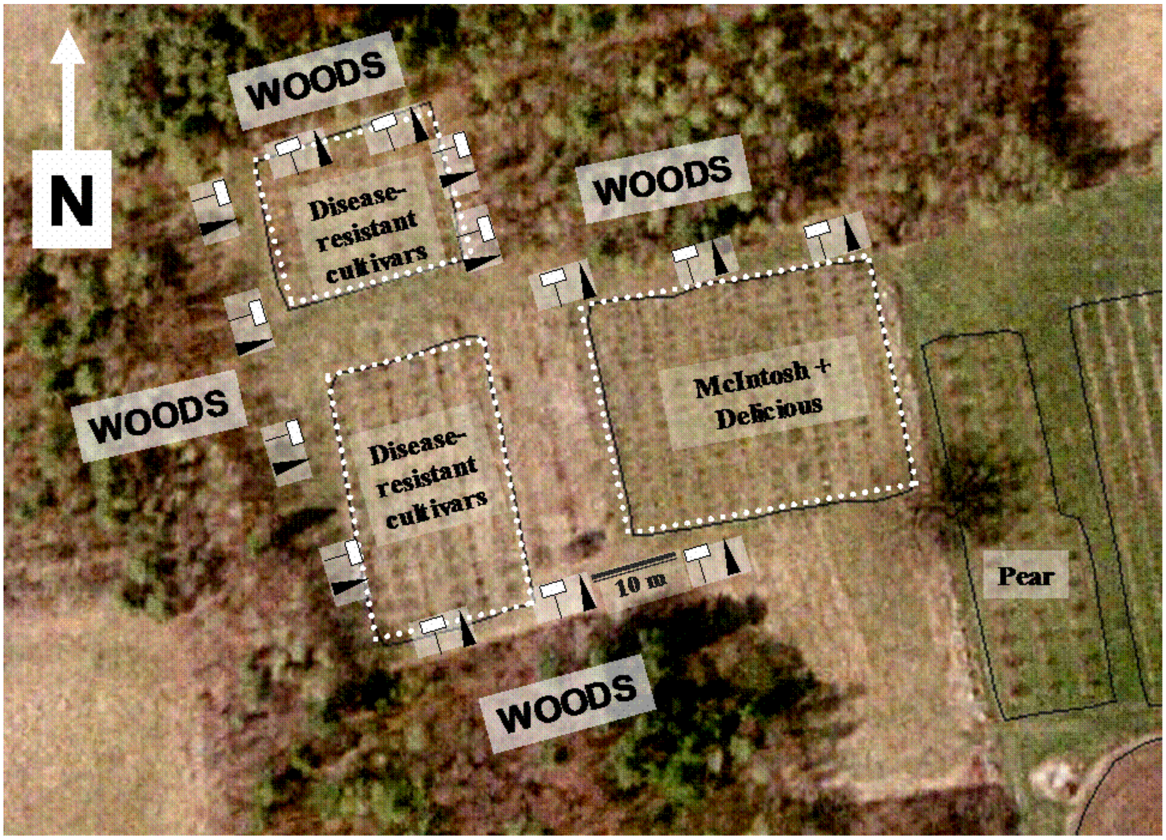

Figure 1. Unsprayed section of the apple orchard used for this study (UMass Cold Spring Orchard; Belchertown, MA). Panel and pyramid traps were deployed in pairs along the periphery of the orchard block, in close proximity to woods, the main overwintering sites of adult PCs. The perimeter of the block was about 500 yards. Picture: courtesy of Jon Clements (UMass Extension).

synthetic, host-plant odor) in association with and grandisoic acid (PC aggregation pheromone). For each trapping year, trap deployment and baiting took place approximately during the silver-tip stage of bud development. Traps were inspected for PC captures on a daily basis (7:30-10:00 AM) from the moment of trap deployment until fruit reached 1.2 inches in diameter (by late June/early July). All adult PCs captured were brought to the laboratory, where they were sexed. All females captured were dissected under a stereomicroscope to determine the sexual maturity stage (presence of mature eggs) and mating status (presence of sperm in the spermatheca).

Characterizing PC immigration. The process of PC immigration into the apple orchard was characterized beginning with the day of first captures by traps. The next important stages of PC immigration were the 50th and 80th percentiles of cumulative captures. The latter occurred around petal fall, the stage of tree phenology at which PCs have shown the highest activity and dispersal and the time at which the first insecticide is commonly applied against PC. We ended the studies by late June/early July, when no captures occurred for 3-4 consecutive days with relatively high temperatures.

Classification of tree phenology. We monitored and characterized, on a daily basis, the different stages of bud and fruit development on the McIntosh trees using the following numerical code: (1) silver tip, (2) green tip, (3) half-inch tip, (4) tight cluster, (5) first pink, (6) full pink, (7) first bloom, (8) full bloom, (9) petal fall, (10) within a week after petal fall, and (11) 2-6 wks after petal fall (depending on the year). Stages 1-9 were considered as pre-petal fall, whereas stages

10-11 were post-petal fall.

Calculating Thermal Constants. Thermal constants for the initiation of PC immigration (START), and the 50th and 80th percentiles of cumulative captures were estimated using a temperature threshold of 43°F for the resumption of adult PC activity after overwintering. On each trapping year, Degree Days started to accumulate on January 1.

Relative Predictability of PC Immigration: Tree Phenology versus Thermal Constants. To determine whether the onset of immigration was better explained by accumulation of Degree Days or by tree phenology, two coefficients of variation (CV) were constructed. A coefficient of variation is a relative measure of variability (it uses the standard deviation [SD]) around a mean value, therefore a low CV (relative to the other CV estimated) suggested greater reliability of the particular method used to predict onset of PC immigration. Our first CV involved mean thermal constants (using the mean DD and SD obtained across the five trapping years), whereas the second CV involved the particular phenological tree stage at which PCs started immigrating into the orchard block (using the mean and SD of the numerical codes used on each year).

Results

Overall pattern of PC immigration. In all, 4,279 PCs were captured by traps across all five trapping years (Table 1). On average, the entire period of PC immigration lasted 63 days, with the shortest and longest periods encompassing 51 days in 2000 and 85 days in 2002, respectively. The earliest start of PC immigration occurred in 2002 (on 14 April), whereas the latest start of immigration took place in 2001 (on 2 May). PCs started immigrating when trees were either at the silver tip stage (stage 1) (in 2004), at the tight cluster tree stage (stage 4) (in 2000, 2002, and 2003) or at the first pink tree stage (stage 5) (in 2001). Fifty percent cumulative captures occurred when trees were either in full bloom (stage 8) in 2000 and 2001, by petal fall (stage 9) in 2003 and 2004, or during the first week of fruit development (stage 10) in 2002. Eighty percent cumulative captures took place during stage 10 (i.e., first week of fruit development) in four of the five years (2000-2003) or during stage 11 (i.e. after one week of fruit development) in 2004.

Table 1 shows that of the total number of PC immigrants captured by traps (potentially colonizing host trees), on average, 59% have already done so by petal fall, with the remaining 41% being captured by traps after petal fall. A statistical test revealed that numbers of PCs being captured by traps before and after petal fall differed significantly across years. The period of time required from the last day of petal fall to achieve 80% cumulative PC captures was one week in 2000 and 2004, two weeks in 2003, and three weeks in 2001 and 2002.

Relationships among trap captures, tree phenology, and weather. Correlation analyses revealed a strong positive influence of mean daily air

Table 1. For each of the five trapping years, PC captures (by panel and pyramid traps combined) occurring before petal fall (PF) (phenological tree stages 1-9) and after petal fall (phenological tree stages 10-11).

EVENT	2000	2001	2002	2003	2004	Average
Total PCs captured	430	544	1,354	485	1,366	
Last day PF	05/24	05/16	05/17	05/22	05/14	
Cum. captures last day PF	307	303	575	289	877	
Percent of total	71.4	55.7	42.5	59.6	64.2	58.7 ± 4.8

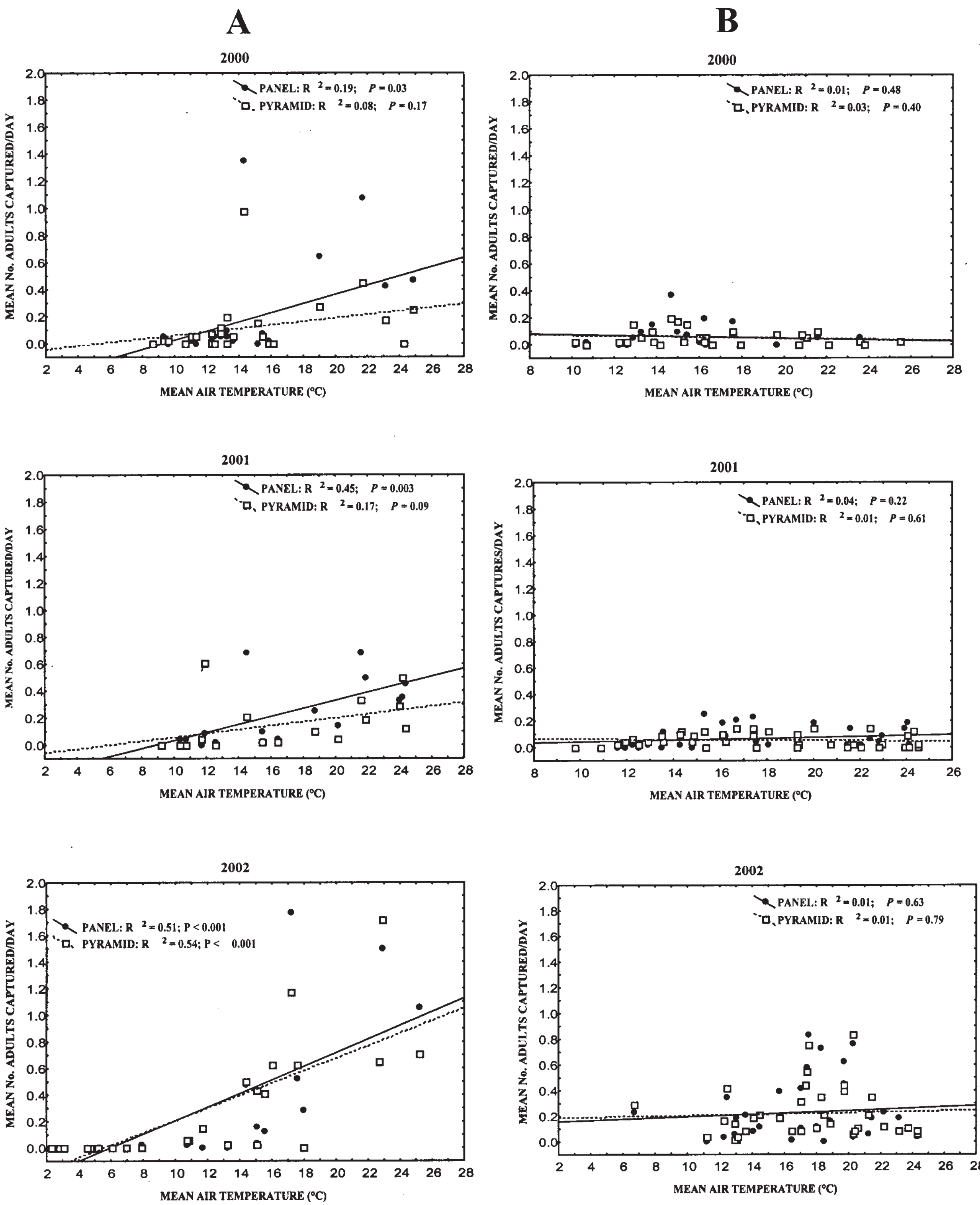

Figure 2. For each of the five trapping years, relationships between daily PC captures by panel and pyramid traps and mean air temperature either (A) before or (B) after petal fall. The number of days before/after petal fall was 23/52 in 2000, 17/43 in 2001, 33/51 in 2002, 24/30 in 2003, and 29/37 in 2004, respectively. R^2 values denote, on a scale of 0 to 1, the amount of common variation between the two variables. An R^2= 1 indicates a perfect correlation.

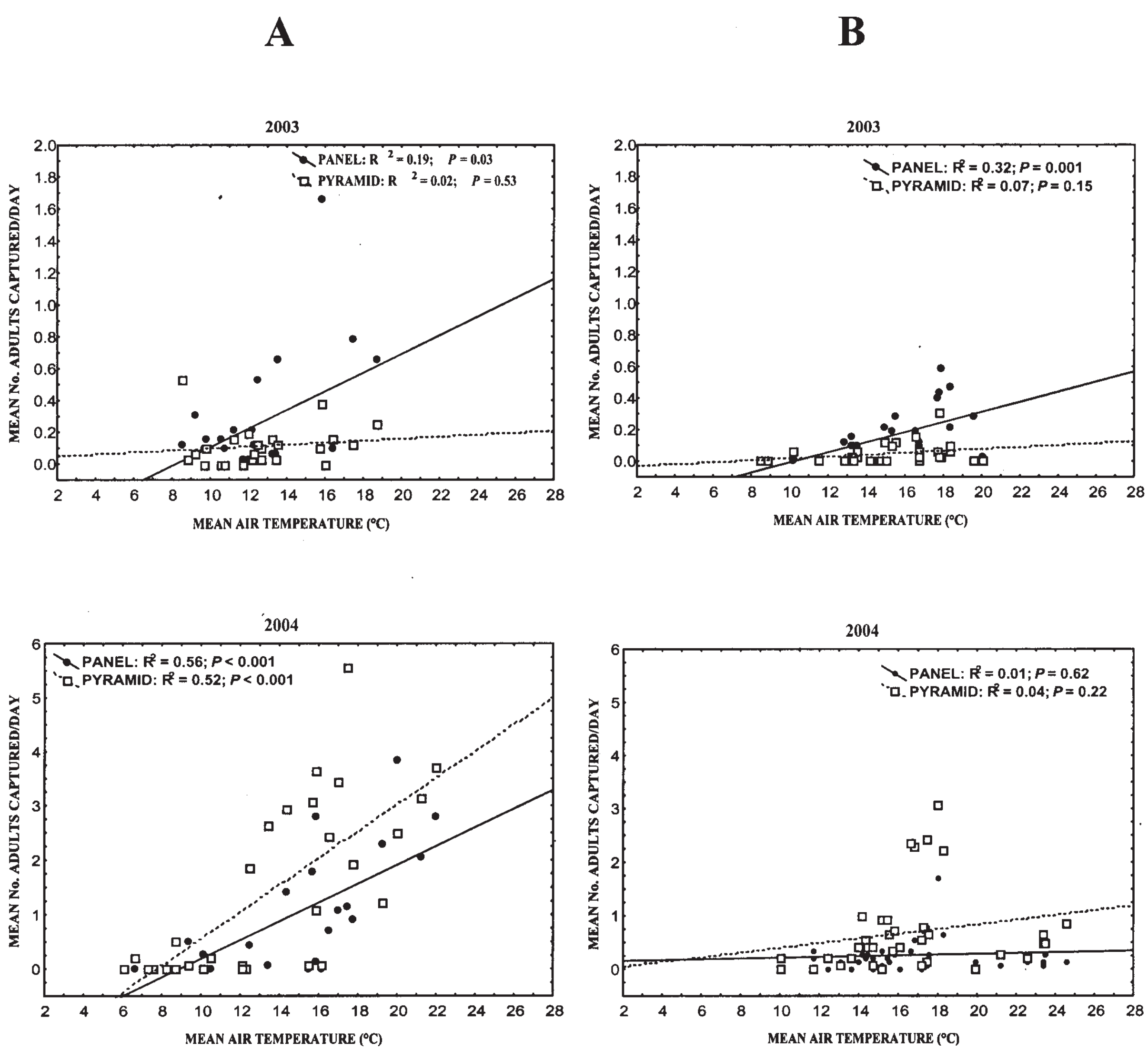

Figure 2. Continued.

temperature on PC captures by panel traps before petal fall for each of the five trapping years. Captures by pyramid traps were less influenced by temperature than panel traps (Figure 2A). In contrast, the relationship between mean air temperature and captures by either panel or pyramid traps after petal fall was rather weak, except in 2003 for panel traps (Figure 2B). The proclivity of adults to either fly or crawl was independent of sex.

Thermal constants for different stages of PC immigration. Table 2 shows the thermal constants (base 43°F) for different stages of PC immigration. On average, PC immigration started when 235 DD had accumulated since January 1. The number of DD accumulated since January 1 to attain 50% and 80% cumulative captures was 480 and 775, respectively.

Relative predictability of PC immigration: Tree phenology versus thermal constants. Using CV's, we determined that initiation of PC immigration was better explained by accumulation of Degree Days (CV= 13.2) than by tree phenology (CV= 42.2).

Female sexual maturity stage and mating status. Figure 3 (A-E) reveals that, except for 2003, all females captured by traps were already sexually mature and/or

Table 2. For each of the five trapping years, date and stage of tree phenology for the first captures, and thermal constants (expressed in Degree Days [DD]) estimated for different stages of PC immigration (START, 50th and 80th percentiles of cumulative captures). See Materials and Methods for a description of numerical ranks used to characterize phenological tree stage.

EVENT	2000	2001	2002	2003	2004	Mean ± SE
START (date)	05/02	04/30	04/15	04/29	04/17	
START (rank of tree phenology)	(4)	(5)	(4)	(4)	(1)	3.6 ± 0.7
START ($DD_{43°F}$)	283	212	209	248	222	235 ± 14
50^{th} percentile (date)	05/07	05/11	05/24	05/19	05/12	
50^{th} percentile ($DD_{43°F}$)	404	450	556	462	526	480 ± 27
80^{th} percentile (date)	06/01	06/08	06/05	06/08	05/21	
80^{th} percentile ($DD_{43°F}$)	785	853	789	732	713	775 ± 25

had been mated by the end of the petal-fall period. These findings will be discussed in the next article of *Fruit Notes*.

Conclusions

In this study we focused on the relative importance of weather factors and tree phenology on the timing of PC immigration into an apple orchard as determined by trap captures. Because odor-baited traps were deployed along the periphery of the orchard block and inspected on a daily basis for the entire period of PC immigration, we believe this study examined timing and extent of PC immigration from overwintering sites (which primarily are woods) more accurately than previous studies that have relied on branch-tapping.

Based on our combined data, we propose the occurrence of a pre- and a post-petal-fall period of PC immigration, each of which is influenced to a different extent by temperatures prevailing in spring. The relative influence of temperature on patterns of PC immigration was very strong during the pre-petal-fall period of immigration, whereas immigration taking place during the post-petal-fall period depended to a lesser extent on temperature. In almost all cases, captures by panel traps were more strongly influenced by air temperature than captures by pyramid traps.

Historically, the timing of PC immigration was related to either soil and air temperatures or to host-plant phenology, but the relative influence of these two environmental factors had not been quantified in detail before. Here, we determined that the onset of immigration was better explained by accumulation of DD (base 43°C) than by tree phenology. This finding means that examination of the stages of bud development in spring is a poor tool for forecasting onset of PC immigration.

Our trap-capture patterns obtained over a five-year period allow us to characterize PC immigration as follows. First, stretches of hot weather occurring during the pre-petal-fall period (as in our 2000 season) are conducive to concentrated PC emergence and immigration. Under these conditions, most adults may be present within orchards before the end of the pre-petal-fall period and thus a petal-fall spray covering the entire orchard block is recommended and should yield excellent control of the majority of the population. Second, during the post-petal-fall period, PC immigration continues but with a lesser influence of weather, unless cool temperatures (such as in our 2002 season) have prevailed during the pre-petal-fall period, which would lead to an extended period of PC emergence and immigration.

We recommend that, depending on the type of weather (primarily temperature) prevalent during the pre-petal-fall period of PC immigration, the first spray of insecticide (commonly applied by the time of petal fall) be delayed either (1) by one week if the pre-petal-

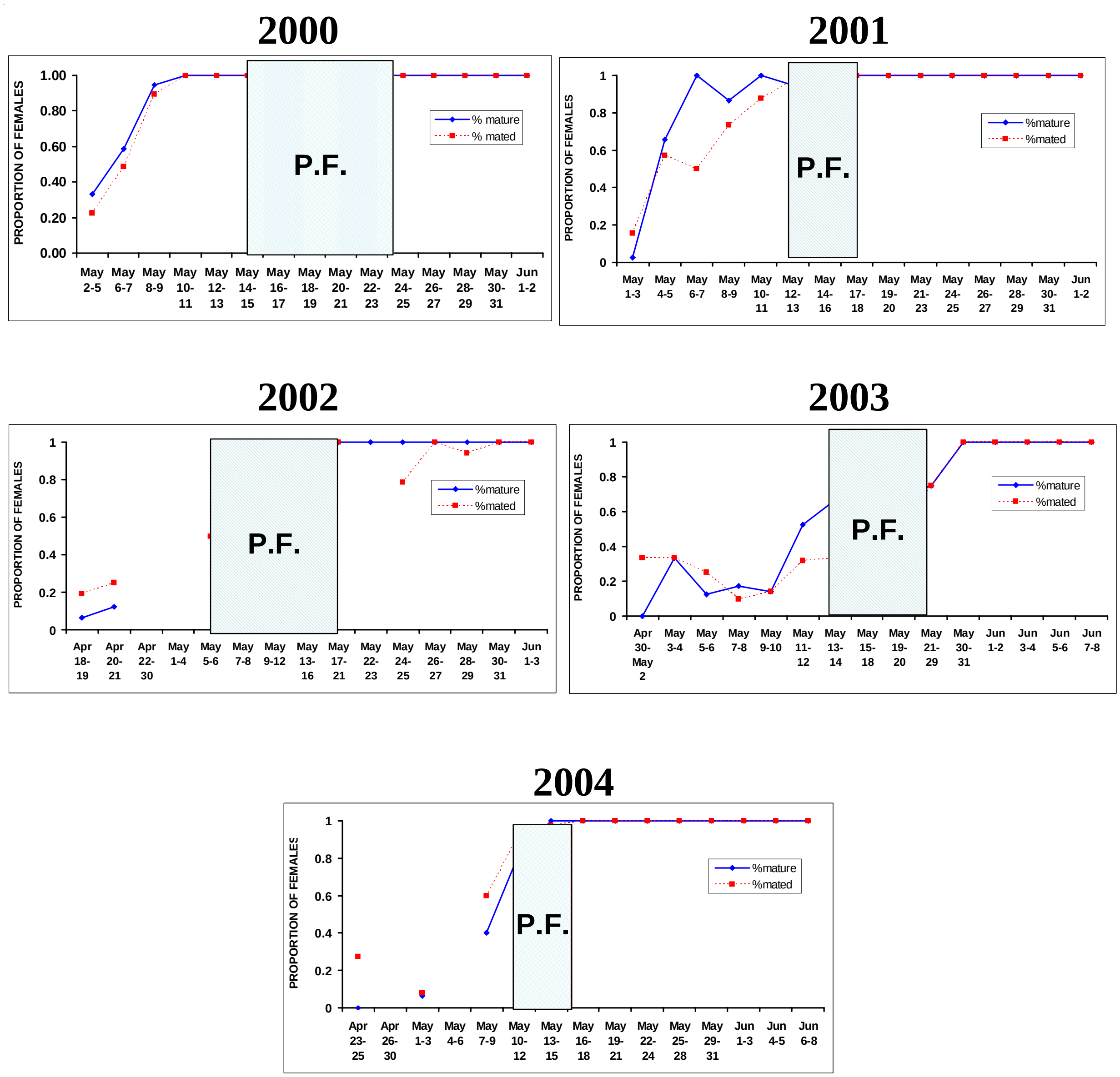

Figure 3. For each of the five trapping years, proportions of PC females captured by traps that were either sexually mature or mated, according to date. For each year, a box with diagonal lines indicates the petal-fall period.

fall period is characterized by high temperatures (as in our 2002 season), or (2) by 10-14 days if cool, rainy weather prevails during the pre-petal-fall period. By doing this, a grower can maximize PC control as a higher proportion of immigrants may be killed, while costs and exposure to insecticide would be minimized given the fewer applications that might be needed. This is analogous to the temperature model developed at Cornell University by Reissig et al. (1998) to control PC, which involves use of cumulative heat unit models to predict, in particular, termination of PC oviposition activity.

Acknowledgments

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Immigrants or Re-colonizers? Studying Plum Curculio Movement Using Odor-baited Traps

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In the preceding article, we presented results of a 5-year study aimed at establishing the relationships between timing of plum curculio (PC) immigration, weather factors, and phenological tree stage. One of our findings was that most PCs (59% on average) were captured by traps by the end of the petal-fall period, with the remaining 41% being captured after petal fall. Therefore, an important aspect to consider because of its implications for management is whether those PCs captured after petal fall are either immigrants or re-colonizers. One way of addressing this and other questions concerning PC immigration and movement

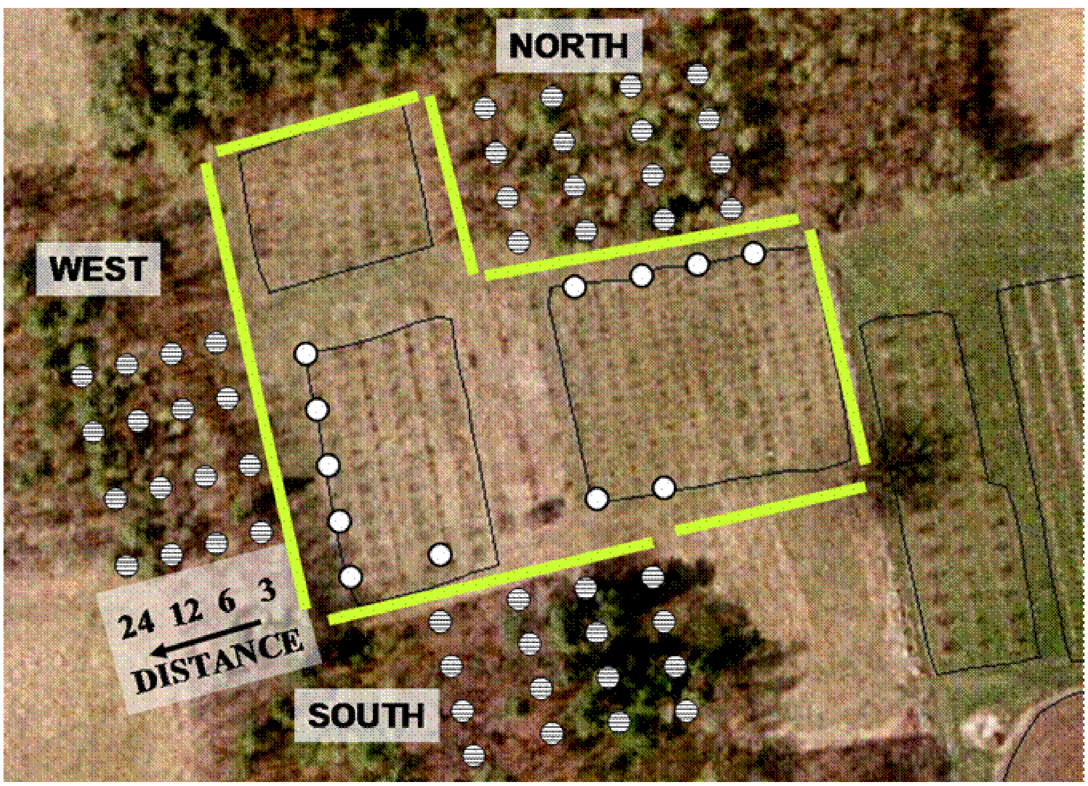

Figure 1. Unsprayed section of the commercial orchard used for this study (UMass Cold Spring Orchard Research & Education Center, Belchertown, MA). Hollow circles represent the 12 release points of color-marked PCs beneath perimeter-row trees. Dashed circles represent the 48 points at which color-marked PCs were released (at 3, 6, 13, and 24 yards inside the woods) in 2002. Picture courtesy of Jon Clements (UMass Extension).

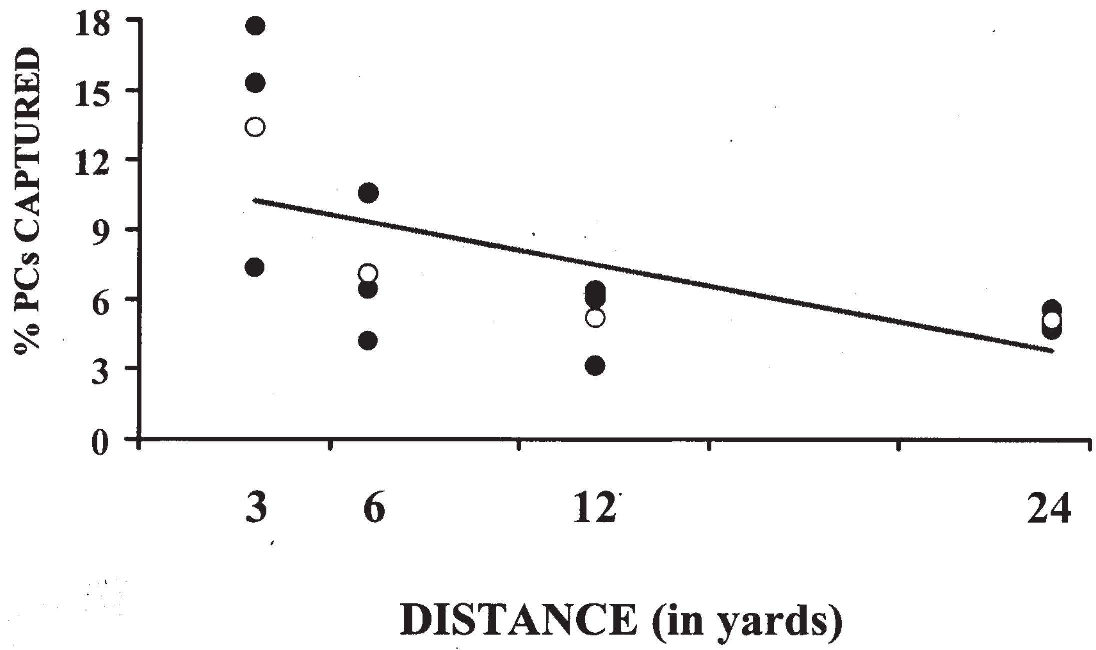

Figure 2. For the 2002 study, percentages of color-marked adult PCs captured by panel and pyramid traps at different distances (3, 6, 12, and 24 yards) from the woods edge. For each distance, solid circles denote PC captures occurring at each of the three release areas (N, W, and S). Hollow circles represent the mean percent value.

is by means of mark-capture studies using odor-baited traps.

Here, our objectives were to determine (1) the distance from which odor-baited traps are attractive to overwintered PCs immigrating into an apple orchard block from forested areas; (2) the relative attractiveness of odor-baited traps to PCs immigrating from woods versus PCs already present on orchard trees; and (3) the extent of back-and-forth PC movement between orchard trees and woods as determined by trap captures. In this article, we also discuss the findings presented in the preceding *Fruit Notes* article, in relation to the female maturity stage and mating status of the PC females captured by odor-baited traps over a 5-year period.

Materials & Methods

This study was conducted during 2002 and 2004 at the University of Massachusetts Cold Spring Orchard Research & Education Center located in Belchertown, MA (Blocks X1, X2, X3).

The first two questions were addressed in 2002. For the 2002 study we used adult PCs that were raised from infested fruit collected in Amherst area in the summer of 2001 and kept over the winter in plastic containers with a layer of soil (5 inches), overlaid by 5 inches of maple leaves. Containers were then buried into the ground outdoors and protected from rainfall. Before being overwintered, adult PCs were separated by sex and marked on the elytra with different color combinations using acrylic paint.

Of the 938 color-marked PCs that were recovered in the spring of 2002 after overwintering, 168 were released beneath 12 perimeter-row trees (14 PCs per tree) next to the tree trunks, and 770 PCs were released in the woods, at 3, 6, 12, and 24 yards from the woods edge (Figure 1). Color-marked PCs were released in the woods in the northern, southern, and western areas of the orchard block. Within each release area, 16 different release points of about 48 color-marked PCs each were established (Figure 1). Overwintered PCs were not fed prior to release. For the releases, each group of PCs was placed on the ground after removing some leaves and then were covered with a boll weevil trap top that was slightly buried into the ground. This protected PCs from potential predators and at the same time allowed them to exit from the open end of the funnel whenever they chose to do so. To assess the extent of response of wood-released versus orchard-released PCs to synthetic odors, 48 panel and 48 pyramid traps were baited with benzaldehyde (attractive synthetic host plant odor) in association with grandisoic acid (attractive PC pheromone). Traps were deployed at the periphery of the orchard block and were inspected for PC captures on a ~daily basis for a 8-week period starting on May 16 (at bloom).

Our third question, concerning the extent to which PCs exhibit some sort of back-and-forth movement between orchard trees and woods, was addressed in 2004 in a straightforward way by putting sticky on both sides of 14 panel traps deployed along the periphery of the orchard block. We then contrasted numbers of wild PCs captured on a daily basis in the wood-facing side or in the orchard-facing side of the panels.

Results

For the first question, Figure 2 shows that the greater capture rates (13.4%) of color-marked PCs occurred for PCs released 3 yards from the traps (which also correspond to the wood's edge). Fewer PCs were captured as the distance from traps (i.e., woods edge) progressed. A capture rate of 5.1% was achieved for PCs released 24 yards inside the woods.

For the second question, Figure 3 reveals that, without taking into account the distance at which color-marked PCs were released inside the woods, substantially more PCs (almost seven times more) were captured by panel and pyramid traps when they were released from the woods (7.9% on average) than from orchard trees (1.2%).

For the third question, Figure 4 shows that before petal fall, most wild PCs were captured by the woods-facing side of panel traps and very few PCs were captured in the back of panels. However, during and about 2 weeks after petal fall, PC captures in the back of panels increased substantially, suggesting that during this period there were high rates of back-and-forth movement between woods and orchard trees. PC captures beyond the 2-week period after petal fall period were in general low.

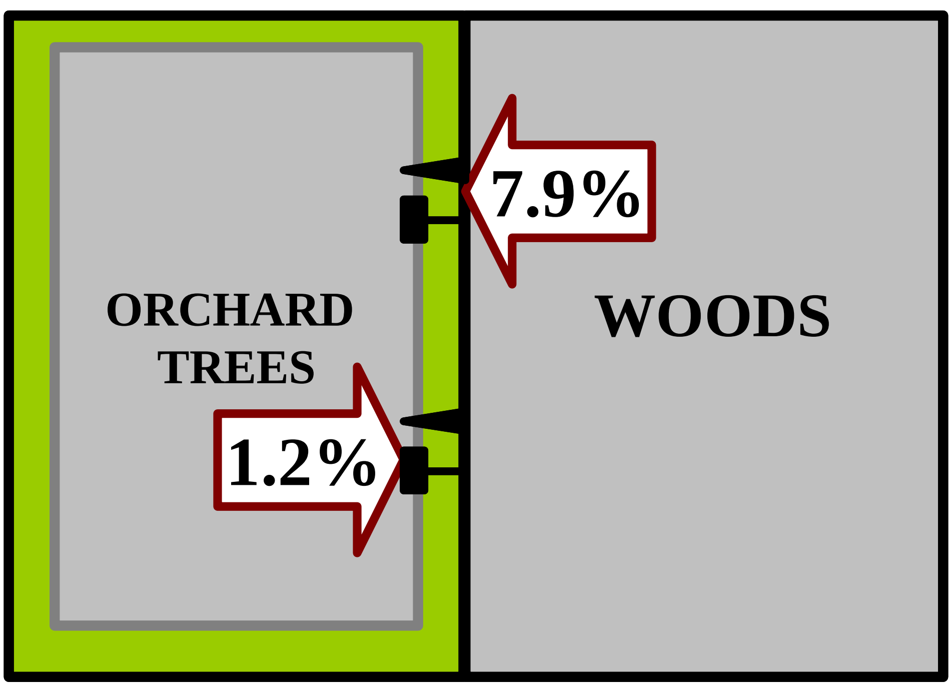

Figure 3. For the 2002 study, overall capture rates (in %, shown inside the arrows) of color-marked PCs released in the woods (n= 770) and beneath perimeter-row trees (n= 168).

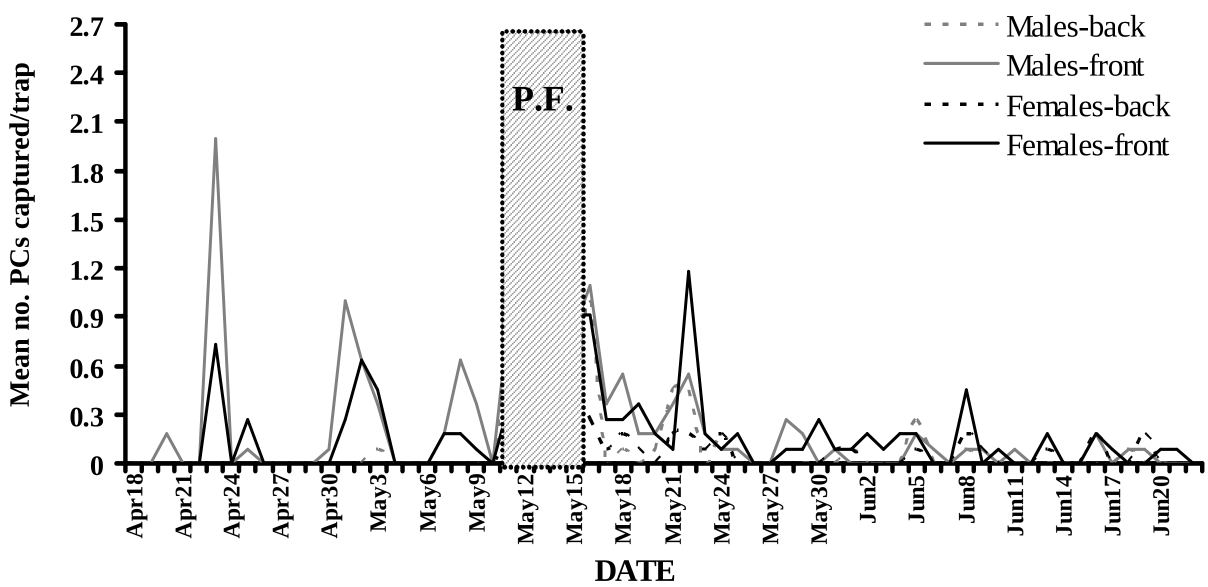

Figure 4. For the 2004 study, mean number of male and female PCs captured per trap (only panel traps) according to date. Panel traps were coated with Tangletrap in the woods-facing side (i.e., front) as well as in the orchard-facing side (i.e., back). The area delimited by a dashed line and filled with diagonal lines represents the duration of the petal-fall period in 2004.

Conclusions

From the 2002 study, we learned that adult PCs are attracted to the odor emitted by traps baited with benzaldehyde and grandisoic acid from at least 24 yards inside the woods. The maximum distance considered for this study represents the area more likely to be serving as overwintering sites for PCs (Lafleur and Hill 1987). From the 2002 study, we also determined that, once PCs are present on orchard trees, their degree of responsiveness to odor-baited traps decreases substantially, compared to PCs released in the woods that had not been exposed to stimuli provided by a host tree. Similarly, Leskey and Wright (2004) also determined that the responsiveness of southern-race PCs to traps baited with benzaldehyde and grandisoic acid decreased significantly in the presence of apple trees.

From the 2004 study we determined that, before petal fall, nearly all overwintered PCs trapped were captured in the woods-facing side of panel traps. This supports the notion that, early in the season, overwintered PCs moving into the orchard by means of flight are, most likely, immigrants. We also determined that, during and about two weeks after petal fall, there seem to be high rates of movement by PCs from host trees to woods and vice versa. This finding suggests that some PCs may be moving from orchard trees to woods (and vice versa) by the time of petal fall onwards. However, the exact proportion of PCs that may exhibit this behavior has yet to be determined.

In the preceding *Fruit Notes* article we reported that nearly all females captured by traps by the end of petal fall were already mated and ready to lay eggs. If PCs captured by traps after petal fall were actually immigrants that had just emerged from overwintering sites and were moving into the orchard block, then we would expect some of those trapped females to be sexually immature or unmated. Results from another study that involved use of pyramidal emergence traps in the same orchard block showed no emergence of PCs beyond two weeks after petal fall.

Altogether, the evidence presented above, gathered under unsprayed conditions, lead us to the conclusion that some of the PCs potentially found inside orchard blocks immediately after petal fall may be re-colonizers rather than true immigrants, although the exact proportion is still unknown. Under this scenario, some of the damage by PC to fruit sampled at harvest may be as a consequence of re-infestations that occurred after the petal-fall spray of insecticide. It would be very important to determine, under sprayed conditions, the extent to which PCs show this type of back-and-forth movement after the petal-fall application of insecticide. More research is also needed to determine what type of factors (e.g., weatherand tree size) influence this behavior.

Acknowledgments

We thank Paul Appleton, Everardo Bigurra, Sara Hoffmann, and Isabel Jácome for assistance. This study was supported with funds provided by a Hatch grant, a grant from USDA Crops at Risk program, and the New England Tree Fruit Research Committee.

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* * * * *

Penetration of Overwintered Plum Curculio into Commercial Apple Blocks of Differing Tree Size

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To confirm findings from our 2003 Hatch-funded studies, in 2004 we continued to study the extent to which overwintered plum curculio (PC) adults penetrate into interior rows of sprayed sections of commercial apple orchards before petal fall. In 2004, however, we were also interested in determining the influence of tree size on the outcome. In 2004, 160 Circle traps, made of aluminum screen with a PC-capturing device integrated on top, were used for this study. For each of the 12 blocks used, 20 Circle traps, distributed in four transects of five traps each, were deployed on perimeter-row and interior-row trees. One block was located at the UMass Cold Spring Orchard Research & Education Center (CSOREC). Figure 1 shows that, by petal fall, for blocks having large trees (M.7 rootstock) most PCs were found on perimeter-row trees compared to interior-row trees; however, PCs were more likely to be found inside orchard blocks rather on perimeter-row trees if trees were small in size (M.9 rootstock). Regardless of tree size, at least a few PCs were found up to 40 m inside of blocks.

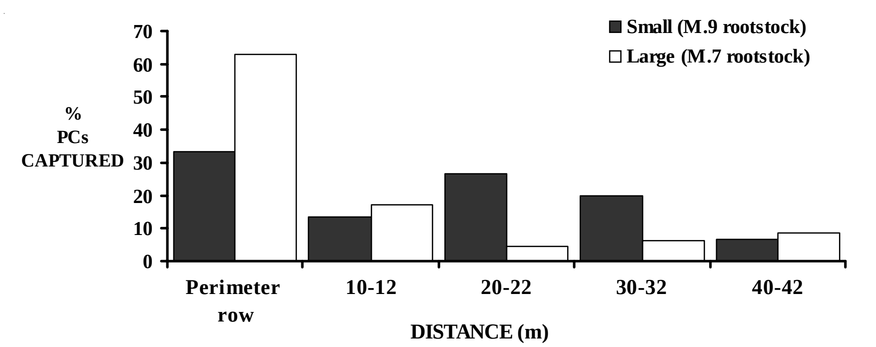

Figure 1. Effects of tree size on penetration of plum curculio into orchard blocks by petal fall.

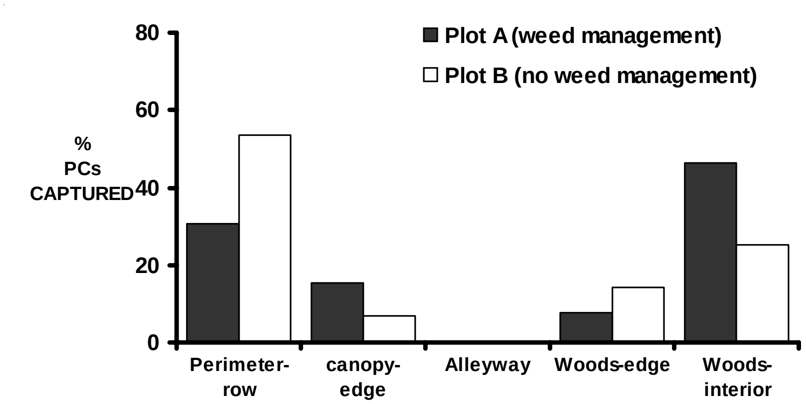

Figure 2. Effects of weed management approach on overwintering plum curculios.

Our second study, conducted in two unsprayed sections of the UMass Cold Spring Orchard, sought to quantify the extent to which PCs are able to overwinter beneath perimeter-row trees, with respect to type of weed control. One of the plots used was subjected to weed management by application of herbicide and mechanical removal of weeds, whereas the second plot was unmanaged (i.e., there was tall grass and other vegetation growing beneath tree canopies). As in 2003, our approach involved placement of 60 emergence traps (1m x 1m) per plot to capture PCs that had overwintered within the area covered by each trap. Traps were arranged in 12 transects of five traps each. We determined that, under Massachusetts conditions, adult PCs not only were capable of overwintering inside orchard blocks in substantial numbers, but also the amount of overwintering beneath perimeter-row trees was higher in the plot that remained weedy than in the plot subjected to weed management (Figure 2).

Our 2004 results, when combined with our 2003 findings, reveal that presence of PCs within orchard blocks can be explained by both successful overwintering as well as by penetration of adults into interior trees, in particular if trees are small in size. These findings suggest that more injury by PC can be expected in interior-row in those orchard blocks having small trees.

Acknowledgements

We thank Joseph Sincuk, Marina Blanco, and Paul Appleton for technical assistance. This work was funded by Hatch Grant: Toward Bio-based Management of Key Apple Pests, MAS00838 0186529, R. J. Prokopy, 10/1/2000 to 9/30/2005.

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Demonstration Vineyard for Seedless Table Grapes for Cool Climates

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This project is designed to evaluate the suitability of seedless table grape varieties for production in a USDA Zone 5 climate. This will require multiple years of observation and assessment particularly with regard to winter hardiness. The project will also seek to develop information for growers on best management practices for successfully growing table grapes in our climate. Once the vines are fully established, demonstration of canopy management, cluster thinning, cane girdling, and other treatments can commence. These trails will be guided by work done in other cold-climate grape production areas, such as Michigan and New York.

Significant interest among consumers in seedless-table-grape consumption, coupled with the availability of many new cultivars with increased winter hardiness, has prompted the need for this type of evaluation. Many tree-fruit growers have expressed interest in learning more about viticulture, which makes the inclusion of this project at the UMass Cold Springs Orchard Research & Education Center especially appropriate. Growers are encouraged to visit any time

Table 1. Table grape vineyard layout* and winter injury evaluations. Planting includes 12 cultivars, 12 vines of each. There are three vine replications between line posts spaced 6 feet in the row and 12 feet between rows, with three rows.[z]

Field & Woods (left side) — *Cold Springs Rd.* (right side)

Concord (2.58)[y]	**Kyoho**	**Reliance - L[x]**
Jupiter (2.75)	**Himrod**	**Lakemont - S**
Venus (0.33)	**Canadice**	**Mars - M**
Neptune (2.75)	**Marquis**	**Vanessa - M**
Marquis (0.83)	**Venus**	**Neptune - S/T**
Kyoho (0.00)	**Mars**	**Mars - M**
Concord (2.58)	**Reliance**	**Lakemont - S**
Neptune (2.75)	**Vanessa**	**Vanessa - M**
Reliance (2.33)	**Lakemont**	**Kyoho - T**
Vanessa (2.25)	**Jupiter**	**Venus - S**
Jupiter (2.75)	**Lakemont**	**Canadice - S**
Venus (0.33)	**Kyoho**	**Marquis - M/S**
Himrod (1.67)	**Himrod**	**Concord - M/S**
Canadice (2.22)	**Neptune**	**Himrod - M**
Lakemont (2.67)	**Concord**	**Jupiter - L**
Mars (2.92)	**Marquis**	**Relaiance - L**

[z] Detailed descriptions of these cultivars can be found at: http://www.msue.msu.edu/msue/imp/modfr/26429701.html or http://www.nysaes.cornell.edu/hort/faculty/reisch/bulletin/table/
[y] Summer evaluation 0=dead, 1=almost dead, 2=damaged but alive, 3=no damage
[x] Winter evaluation L=light, M=moderate, S=severe, T=toast.

of year to look at the vines and fruit. Growers throughout New England have expressed a high degree of interest in this vineyard and Orchard-store customers have been very receptive to the crop.

In the spring of 2002, 12 vines each of 12 different seedless cultivars were planted at the UMass Cold Spring Orchard Research & Education Center (Block Y1). See Table 1 for list of cultivars. Grow tubes were place on the vines for the first 3 months to accelerate growth and protect young vines from herbicide applications or deer browsing. Cold winter temperatures set back some vines, but most were trained to a 4-arm Kniffen system during the summer of 2003. The trellis was installed this year. No fruit was allowed to set in 2003 so roots and trunks could more fully develop. Routine fertilizer and pesticide applications were made according to recommendations from the *NY/PA Pest Management Guidelines for Grapes*. Again severe winter temperatures set many vines back, requiring some to be replaced. Winter-injury ratings were made in the winter and following summer and are represented in Table 1. Among the cultivars that withstood the extreme cold the best were Mars, Jupiter, Lakemont, and Concord. The cultivars most damaged by winter injury were Kyoho, Venus, Marquis, and Interlaken. Canadice, Himrod, Neptune, Vanessa, and Reliance had moderate levels of injury.

Fruit were allowed to set on some vines in 2004. Fruit was harvested weekly from mid September to mid October and sold at the Orchard Store. The most fruit was harvested from Mars (approx 120 lbs). Approximately 60 lbs of Vanessa fruit were harvested and very well received. Concord also produced enough fruit to harvest for sale. Other cultivars, such as Neptune, Lakemont, Canadice, and Himrod only produced small quantities of fruit in 2004. More fruit is expected in 2005, even though severe winter temperatures were suffered again in the winter.

Despite the poor tolerance among some cultivars in this trial to the cold winter temperatures, further evaluation is needed, since mature established vines may be better able to tolerate the cold temperatures than immature ones. Therefore, we have not abandoned any cultivars yet and are replanting vines that were severely damaged in order to more accurately assess them. In 2005, routine fertilizer and pesticide applications will again be made according to recommendations from the *NY/PA Pest Management Guidelines for Grapes*. Fruit will be harvested and more records kept on ripeness dates, ˆBrix of fruit, cluster weights, etc. Until all vines are in full production, it will be hard to collect truly reliable data, but some relevant data will be collected this year. Additionally, some adjustments to the training system may be made, converting some cultivars from the 4-arm Kniffen system, to a high cordon system for easier cane management and better fruiting conditions.

Acknowledgement

This project was funded partially by the Massachusetts Fruit Growers' Association.

* * * * *

New Wine Grape Project at the UMass Cold Spring Orchard Research & Education Center

Daniel Cooley, William Coli, Sonia Schloemann, Justine Vanden Heuvel, Duane Greene, Wesley Autio, Jon Clements, Anne Averil., Craig Hollingsworth, Frank Caruso, Hilary Sandler, and Jochen Weiss
University of Massachusetts

The business of growing fruit in Massachusetts and New England is changing. Recognizing that alternative fruit crops and direct marketing will play an increasingly important role for many Massachusetts tree fruit growers, the Fruit Team with funding from the Massachusetts Agricultural Experiment Station has started a new project to look at options for growing wine grapes in regions away from the Southeast coast.

Several excellent vineyards grow grapes and produce wines along the southern coast of New England, and this project compliments a Northeast Regional Sustainable Agriculture Project that is working with these growers on pest management issues. This project, headed by Bill Coli and Sonia Schloemann, has been in progress for over a year.

In addition, Duane Greene is working on a project to produce cider apple varieties. We have a goal over the next three years of developing our capacity to do controlled, experimental fermentations at UMass Cold Spring Orchard. Growing the fruit is one challenge, making it into a quality product, wine or cider, is another.

This year, we are planting approximately two acres at UMass Cold Spring Orchard (Block G1) with two varieties of hybrid grapes, Frontenac and Chardonnel. These are relatively hardy grapes that will hopefully stand our winter cold and at the same time ripen quality fruit. This is actually the second planting of grapes at the orchard. Sonia Schloemann planted a test of table grape varieties two years ago. Next year, we will be planting a variety trial of several wine grape cultivars.

This is an exciting new area of research for the Fruit Team and UMass Cold Spring Orchard. We are looking forward to the day, hopefully not too distant, when we will have bottles of wine with a University of Massachusetts Amherst label.

* * * * *

Beach Plum Seedling Evaluation Trial

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Beach plum, *Prunus maritima*, is a fruiting shrub native to coastal dunes of the Northeastern United States. The fruit has been collected from the wild for making preserves and jelly since colonial times. Commercial production of preserves and jelly remains dependent on wild plantings, but supplies are unreliable. This has generated interest in commercial production, which has prompted small-scale production trials to evaluate germplasm and to define horticultural practices for commercial production. UMass Extension in Barnstable County and Cornell University teamed up to secure funding to support these objectives. Seeds were collected from wild stands up and down the east coast (Figure 1, Table 1).

The UMass Cold Spring Orchard Research & Education Centerwas provided with approximately 150 seedling plants (five each from 25 genotypes from 14 collection sites plus smaller numbers of additional genotypes) from the seeds collected at the above sites in 2003 (Table 1). The objective was to plant these seedlings and to determine if and how well *Prunus maritima* may grow and fruit in non-traditional sites. Results from earlier trails in this project have indicated that increased fruitfulness can be obtained with fertilization and irrigation, something not found in native sites.

In May 2003, seedlings were planted in a randomized block at a 4-foot in-row and 15-foot between row spacing (Block G2). Whips were protected with grow tubes for the first 3 months to protect them from herbicide applications and deer browsing. Fertilizer and pesticide applications were made according to normal practices for plums already growing at the UMass Cold Spring Orchard. No fruit set in the summer of 2004. Figure 2 shows the growth habit of a 3-year-old plant growing in this trial.

Shoot terminal growth data will be collected in 2005. Trunk caliper diameters may also be recorded,

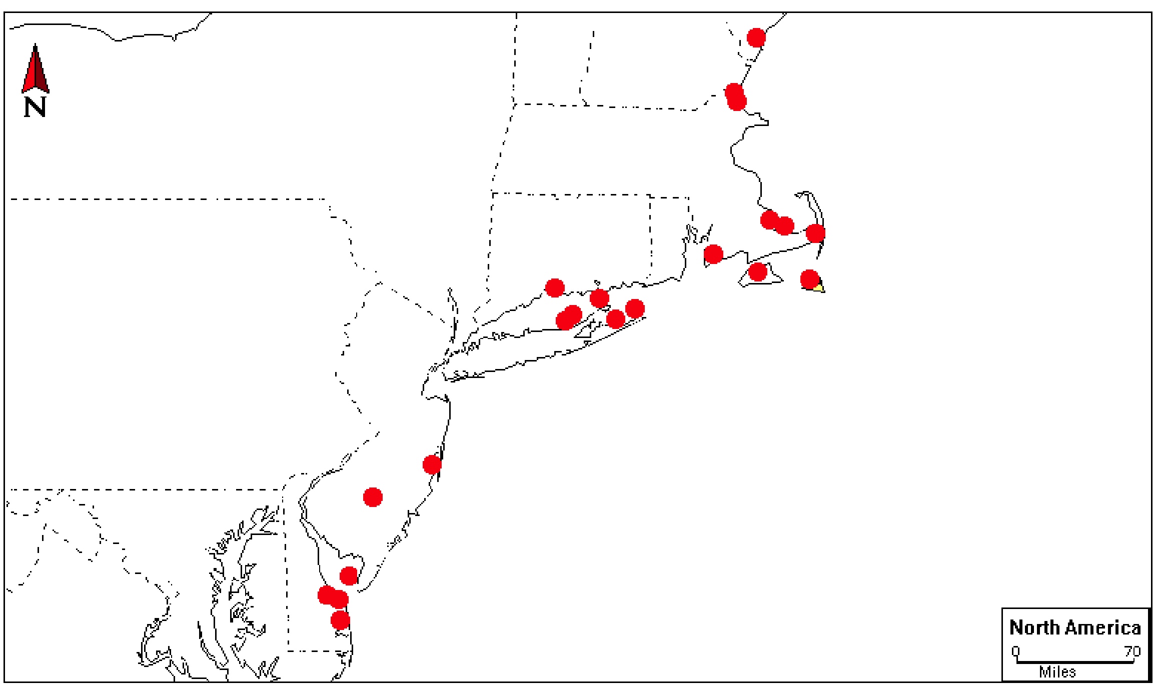

Figure 1. Collection sites for seeds of *Prunus maritima in 2002.*

Table 1. Beach plum seed collection sites.

Site	City	State	Latitude	Longitude
marsh path	Ogunquit	ME	43°15'57.5"	70°35'23.1"
Plum Island[z]	Newburyport	MA	42°46'24.0"	70°48'23.4"
Crane Beach[z]	Ipswich	MA	42°41'	70"46'
East Sandwich Beach[z]	East Sandwich	MA	41°45'13.3"	70°26'52.5"
Sandy Neck Beach[z]	Barnstable	MA	41°43'57.6"	70°21'33.3"
Gillis property[z]	Chatham	MA	41°40'	69°55'
Westport Point[z]	Westport	MA	41°30'39.2"	71°04'45.0"
North Neck	Martha's Vineyard	MA	41°23'	70°30'
Chaffinch Island	Guilford	CT	41°18'	71°41'
York and Madaket	Nantucket	MA	41°17'	70°
Orient Beach State Park	Orient Point	NY	41°07'47.0"	72°15'55.7"
Montauk Point State Park[z]	Montauk	NY	41°04'33.7"	71°51'57.5"
Goldsmith Inlet	Southold	NY	41°03'25.4"	72°28'13.8"
Mattituck Inlet[z]	Mattituck	NY	41°00'48.2"	72°33'33.6"
Hither Hills State Park[z]	Montauk	NY	41°00'	72°02'
Island Beach State Park[z]	Seaside Park	NJ	39°51'	74°05'
Wharton State Forest[z]	Atsion	NJ	39°44'21.3"	74°43'32.2"
Higbee Beach[z]	Cape May	NJ	38°57'43.1"	74°57'46.9"
Beach Plum Island[z]	Broadkill Beach	DE	38°48'12.3"	75°11'11.5"
Cape Henlopen State Park	Lewes	DE	38°47'	75°05'
Deleware Seashore S. Park	Dewey Beach	DE	38°36'15.9"	75°03'43.0"

[z]Sources used in the UMass Cold Spring Orchard planting.

but growth habit varies from a multiple branching bush type to a small central leader type, so a consistent measure of annual growth is needed. Bloom dates will be recorded for those genotypes flowering in 2005, and if fruit sets and develops, fruit characteristics will also be recorded. Any harvested fruit will be either sold at the UMass Cold Spring Orchard Store fresh or preserved and sold as jelly.

Figure 2. Three-year-old beach plum at UMass Cold Spring Orchard Research & Education Center showing growth habit.

Acknowledgement

Plant material was provided by Northeast SARE.

* * * * *

APPENDIX

UMass Cold Spring Orchard Research & Education Center
Blocks, December, 2004

Size, species included, and date planted of blocks at the UMass Cold Spring Orchard Research & Education Center.

Block	Acres	Crop	Year planted
A1	0.76	apple	1963
A2	0.14	apple	–
A3	0.94	apple	1999-2000
A4	1.25	apple	1963
A5	1.01	apple	1995
A6	0.26	apple	2002-03
A7	0.24	open	–
A8	1.09	apple	2001
A9a	0.93	apple	1988-89
A9b	0.8	apple	1972;1986
A10	1.05	apple	1975-76
A11	0.21	apple	2002
A12	0.88	apple	1986
A14	0.56	open	–
A15	0.44	cherry	2001
B1	0.47	apple	–
B2	0.64	apple	2000
B3	0.45	apple	2002
B4	0.52	apple	2003
B5	0.62	open	–
C	1.55	apple	1997-98
D	1.39	apple	–
E1	2.3	apple	1989–present
E2	0.21	apple	1995
E3	1.11	apple	1996-97
E4	0.62	pear	1964; 2002
G1	2.17	open	–
G2	0.56	plum	2000
H1	0.84	peach, nectarine	1993, 1994
H2	0.37	peach, plum	1999
H3	0.27	apple	–
H4	0.52	peach	2002-03
H5	1.23	apple	1991
H6	0.57	apple	1999
H7	0.79	apple	1996; 1998; 1999
H8	0.5	apple	1991
H9	0.37	open	–
K1	0.8	peach	1990
K2	1.64	apple	1988
K3	1.69	apple	1981
M1	0.46	apple	1990
M2	0.93	peach	20,002,001
M3	2.18	apple	1988
X1	0.99	apple	–
X2	0.65	apple	–
X3	0.42	apple	–
Y1	0.34	grape	2002
Y2	0.53	apple	1988
Y3	0.54	open	–
Y4	0.42	blueberry	–

Yearly Weather Summary

Specware 6.02 UMASSCSO Year Summary From 01/01/2004 To 12/31/2004

Month	Temperature High	Day	Low	Day	Mean	Degree Days*	Chill Hours	Wet Hours	Wet Days	Rain Fall	Rain Days
01	43.7	04	-11.7	15	15.5	0.0	-	-	0	0.83	5
02	53.1	29	-4.3	16	27.3	0.1	-	0.0	0	1.65	10
03	71.1	26	13.3	23	36.4	15.2	-	10.0	1	3.62	15
04	85.9	19	23.7	06	47.2	104.9	-	196.5	18	6.18	12
05	87.4	12	34.6	05	58.9	305.8	-	205.5	25	3.41	20
06	91.0	09	41.5	12	65.0	451.9	-	117.0	15	1.81	14
07	88.1	22	55.1	07	69.8	613.0	-	158.8	24	2.61	14
08	91.0	28	48.8	08	69.4	594.9	-	120.3	24	2.70	10
09	86.6	04	42.3	20	63.2	401.1	-	95.0	13	9.20	9
10	77.4	08	30.6	06	50.1	107.9	-	116.3	16	2.26	8
11	66.3	07	17.3	10	40.7	22.2	-	-	0	3.12	12
12	58.0	23	-4.3	21	29.3	2.6	-	-	0	4.17	12
Total					47.8	2619.7	-	1019.3	136	41.56	141

* Base 50

Apple Scab Infection Periods/Percent Mature Spores

Specware 6.02 UMASSCSO Apple-Scab From 04/13/2004 To 05/31/2004

	Temperature		Wet	Degree	%Spore	Infection Degree		
Date	High	Low	Hrs	Days	Mature	Mills	Wash St	Cornell
04/13*	44.5	36.2	24.0	8	0	Heavy	None	Infected
04/14	56.6	42.3	21.5	28	0	Heavy	Medium	Infected
04/15	55.9	36.2	12.8	40	1	Heavy	Medium	Infected
04/16	61.5	33.8	0.0	54	1	None	None	None
04/17	75.3	34.6	3.0	77	2	None	None	None
04/18	72.5	48.8	0.0	105	3	None	None	None
04/19	85.9	42.3	0.0	135	4	None	None	None
04/20	69.7	47.4	0.0	162	6	None	None	None
04/21	64.2	40.8	0.5	182	7	None	None	None
04/22	78.1	50.3	9.5	211	10	None	None	None
04/23	59.4	41.5	21.3	226	11	Medium	Light	Infected
04/24	62.8	40.0	8.5	245	13	Medium	Light	Infected
04/25	56.6	33.0	4.3	256	17	None	None	None
04/26	52.4	37.7	24.0	271	19	Medium	Light	Infected
04/27	66.3	44.5	7.0	293	22	Medium	Medium	Infected
04/28	52.4	38.5	0.3	305	24	None	None	None
04/29	73.9	38.5	0.0	330	29	None	None	None
04/30	77.4	52.4	0.0	361	34	None	None	None
05/01	78.1	51.0	0.0	393	40	None	None	None
05/02	67.7	57.3	10.8	423	45	Light	Light	Infected
05/03	61.5	43.0	23.8	444	49	Heavy	Heavy	Infected
05/04	53.8	37.7	7.5	457	52	Heavy	Heavy	Infected
05/05	59.4	34.6	8.0	473	55	None	None	None
05/06	69.7	37.7	8.3	496	59	None	None	Infected
05/07	80.2	49.6	2.8	528	65	None	None	None
05/08	62.8	37.7	0.3	546	68	None	None	None
05/09	60.1	41.5	4.0	562	71	None	None	None
05/10**	76.0	40.8	9.0	587	75	None	None	None
05/11	82.9	55.0	8.5	624	81	None	None	Infected
05/12	87.4	57.3	0.0	663	87	None	None	None
05/13	78.8	52.1	0.0	697	91	None	None	None
05/14	76.6	44.4	0.0	726	94	None	None	None
05/15	84.8	59.5	6.3	764	97	None	None	None
05/16	76.1	55.5	8.8	797	98	None	Light	Infected
05/17	78.0	52.0	9.0	828	99	None	None	Infected
05/18	72.6	53.9	9.3	858	99	None	None	Infected
05/19	72.5	52.5	8.8	890	99	Light	Light	Infected
05/20	72.6	49.0	6.0	917	99	None	None	None
05/21	80.7	50.2	4.3	949	99	None	None	None
05/22	64.7	45.5	10.0	970	99	None	None	Infected
05/23	81.4	45.5	9.8	998	99	Medium	Medium	Infected
05/24	68.8	52.2	6.3	1024	99	None	None	None
05/25	68.9	48.4	9.8	1048	99	Light	Light	Infected
05/26	57.1	45.2	9.3	1066	99	None	None	None
05/27	78.1	51.6	10.5	1096	99	Light	Light	Infected
05/28	68.4	53.8	11.3	1122	99	Light	Light	Infected
05/29	62.2	45.2	0.0	1143	99	None	None	None
05/30	71.8	40.8	0.0	1169	99	None	None	None
05/31	73.9	44.5	3.8	1194	99	None	None	None
Overall			342.0			Heavy	Heavy	Infected

*McIntosh green-tip date
**McIntosh full bloom date

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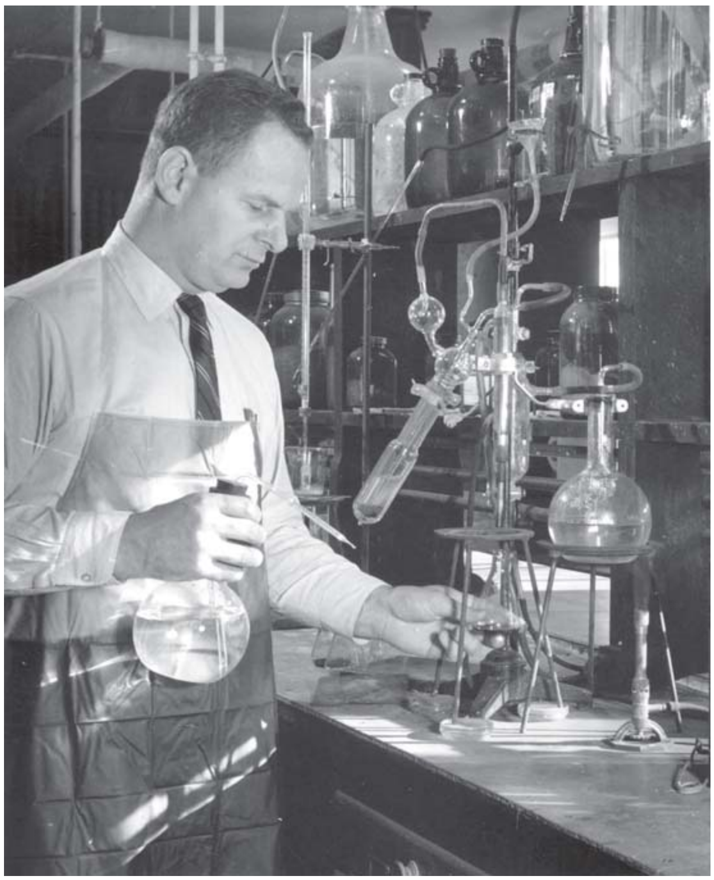
Dedication: Franklin W. Southwick

Dr. Franklin W. Southwick came to the University of Massachusetts in the 1948 as a young member of the faculty of the Department of Pomology. He retired fromthe University in 1983, and during those years he was a huge contributor to the New England tree fruit industry. He brought with him many "new ideas" which he developed into the commercial practices of chemical thinning, stop-drop treatments, and CA storage. His research developed the application principles for all of these practices, and he worked tirelessly with fruit growers to put them into use and transform the apple industry.



When it became known that the University orchard was to become the site for campus expansion, Frank was a catalyst among the leaders of the Massachusetts Fruit Growers' Association who found a site where a new orchard could be established, led a campaign to buy the site and establish the orchard, and give it to the University as a trust. This, of course, is today's UMass Cold Spring Orchard Research & Education Center.

When the Departments of Pomology, Olericulture, and Floriculture merged to form the Department of Horticulture, Frank was chosen to be the head, and when Horticulture merged with Agronomy, again Frank was chosen as head of the new Department of Plant & Soil Sciences. He served in the role of head for 14 years, bringing two groups of diverse faculty together into a smoothly functioning academic unit.

Frank also served for 36 years as Secretary/Treasurer of the Massachusetts Fruit Growers' Association and also was a trustee of its Horticultural Research Fund for 40 years. Even after retiring in 1983, he continued to serve in the latter role until his death. His investment strategies for MFGA funds were legendary for their soundness and success, and under his leadership the Research Fund has grown to become a substantial contributor to research projects by fruit faculty and extension educators.

Because of his importance to the Massachusetts fruit industry and to the University of Massachusetts Cold Spring Orchard Research & Education Center, we dedicate our first annual report to his memory.

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