The 2000 Fire Blight Epidemic in Southwest Michigan Apple Orchards

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Southwest Michigan apple orchards suffered severe fire blight damage following unusually warm, humid and wet weather in May 2000. Fire blight is a highly contagious disease of apples and pears caused by a bacterium *Erwinia amylovora*. Heavy rains, often with hail, throughout the apple-growing region intensified the threat to the area's apple-growing industry. The fire blight epidemic in southwestern Michigan was as severe as anyone can remember. Many acres of high-density apple orchards have been destroyed with the death of almost all the orchard trees. From 350,000 to 450,000 apple trees were or will be killed and 1,550 to 2,300 acres of apple orchards will be lost. The development cost of these orchards was over $9 million. Apple yields will be reduced by 35% over the region. Some growers will suffer 100% losses in some plantings. The southwest region produces an average of 4.5 to 7 million bushels (1 bushel =42 lb or 19.1 kg) and the expected crop loss is 2.7 million bushels, about $10 million. It will take at least 5 years for yields to recover with a cumulative loss of yield valued at nearly $36 million. The region's economic loss will total almost $42 million.

Attempting to remain competitive, orchardists in southwest Michigan replaced outdated mature orchards with new high-density systems. Many of the new premium varieties that were planted such as Gala and Fuji as well as several strains of Jonathan and Rome and others were all susceptible to fire blight as were the dwarfing rootstocks on which they were grafted. Now fire blight has destroyed the investment and effort of the past decade.

The apple industry in southwest Michigan will likely never be the same. The region comprises 29% of the state's apple acreage (Table 1). The perfect fire blight conditions of 2000 occurred previously in 1991. At that time the industry was less vulnerable with less susceptible varieties. It will be very difficult for apple growers to learn to manage fire blight, given the current lack of premium fire blight resistant varieties. In addition, strains of the fire blight bacterium resistant to streptomycin are widespread in Van Buren County and were detected in orchards in neighboring Berrien County this year. Streptomycin has been the single bullet for fire blight control and it will be several years before chemicals in the registration pipeline will be available to replace it. Orchards can get through average fire blight years with existing controls, only to sustain devastating losses in 5 to 10 years when perfect fire blight conditions occur.

Incorporating fire blight resistance into current blight-susceptible varieties through genetic engineering shows considerable promise for the future. However, the public's negative view of genetically altered crops will need to be overcome before orchardists can use this new technology. The new blight-resistant rootstocks from conventional breeding will help growers most years, but only resistant varieties combined with resistant rootstocks will allow growers to avoid losses when perfect conditions occur for fire blight in years such as 2000.

This epidemic will change the way we grow apples in southwest Michigan.

THE DISEASE

Fire blight is caused by a bacterium harmless to humans. It is a highly contagious and deadly disease of apples and pears. Fire blight attacks blossoms, leaves, shoots, branches, fruits and roots. During bloom the disease often enters the tree through flowers. Once established in the tree, fire blight quickly moves through the current season's growth into older wood. Death of infected shoots is so rapid that the blackened leaves do not fall off the tree. Young non-bearing and newly bearing trees can be killed easily by the infection while mature bearing trees may survive even if all the new growth is killed. Heavy rainstorms can spread the

blight-causing bacterium and result in what is known as "trauma" blight. One infected tree adds bacteria to local rainfall in frequent summer storms, further spreading the disease. For additional information see the fire blight articles at the University of West Virginia Web site (http://www.caf.wvu.edu/kearneysville/disease_month/fireblight.html).

Antibiotic sprays applied during bloom are used to control fire blight. A computer program called MaryBlyt is used to track disease development and time the applications of antibiotics. Streptomycin, the most commonly used antibiotic for fire blight control, gives good control if used immediately before infection or within about 12 hours (24 hours maximum) after an infection. Oxytetracycline is used to control fire blight where streptomycin resistance exists. To be effective, oxytetracycline must be applied before an infection.

A mix of fresh market and processing apple varieties is grown in southwest Michigan. The key apple varieties in the region, Gala, Idared, Jonathan and Jonagold, are very susceptible to fire blight. Also grown are Golden Delicious and Romes which are less susceptible, and Delicious which is almost resistant. In order to preserve the economic viability of the southwest Michigan apple industry, many new plantings of these susceptible varieties were established in the region during the last decade.

Apple cultivars are grafted on rootstocks that improve the size and quality of the fruit and the overall fruitfulness of the trees. Common dwarfing rootstocks such as Malling 26 (M.26) and Malling 9 (M.9) are very fire blight susceptible; they may even increase the susceptibility of the scion varieties. Rootstocks can become infected by direct infection of rootstock suckers at the base of the tree or when bacteria travel symptomlessly through the trunk into the roots. Infected susceptible rootstocks are quickly killed, resulting in the death of the whole tree. Such systemic movement from a minor infection can result in tree death, even of resistant Delicious trees.

THE INDUSTRY

This fire blight epidemic in southwest Michigan affects primarily Berrien and Van Buren counties, the two largest fruit-growing counties in the region (Table 2). Other counties such as Allegan, Branch, Cass, Hillsdale, Kalamazoo and St. Joseph also have severely affected apple plantings. Today in 2000 there are probably only 6000 commercial acres of apples in both Berrien and Van Buren counties, 1300 in Allegan, and 2000 in the rest of the affected counties.

Southwest Michigan apple growers have suffered from poor prices for the last several years and many older growers have reduced inputs into their apple orchards by reducing pruning and fertilizing. The resulting trees have less new growth and are unlikely to suffer greatly from fire blight infection. While these trees are still vulnerable to infection it is less likely to cause tree death or dramatic yield losses. With reduced maintenance, yields and fruit quality on these trees decline. Growers who cannot afford to maintain their orchards will not do the dormant pruning necessary to remove overwintering cankers that serve as the primary inoculum for fire blight in the spring. Reducing inputs is not a viable long-term strategy and these orchards soon fail.

The next step after reducing inputs is orchard abandonment. There are probably over a thousand acres of abandoned orchards in Berrien and Van Buren counties. These orchards have been abandoned or sold by their owners. In many cases the new owners are not fruit growers but urban emigrants who desire rural land. They are unable to maintain the orchards and unwilling to remove the trees because of the high cost of removing fully grown, 30- to 50-year-old standard apple trees. These orchards serve as a reservoir for fire blight as well as other pests and diseases of apples and increase the costs and difficulty of maintaining adequate disease management programs in neighboring commercial orchards.

During the last decade, progressive southwest Michigan apple growers have shifted from conventional plantings with 55 to 499 trees per acre to high density plantings with more than 500 trees/acre. These new high value plantings used increasingly popular M.26, M.9 and Mark dwarfing rootstocks. There were approximately 1,500 acres of fire blight susceptible dwarfing rootstocks in southwest Michigan in 1997 and new plantings on these rootstocks were being added at 100 or more acres per year. In 2000, there was a total of about 2000 acres of high density plantings. There are 500 to 700 acres which are 5 years old or less (the most vulnerable age) that could be killed outright by fire blight. In addition, many older high density plantings with highly susceptible varieties also could be lost.

Total apple planting in southwest Michigan averages about 400 acres per year, resulting in 2000 acres of trees 5 years old or less. Most apples planted in recent years have been newer varieties such as Gala, Fuji and Braeburn. These varieties receive a premium price for fresh market fruit. The economics of the apple industry in the last several years have reduced profit margins to the point that large older trees are not profitable to maintain. To preserve the economic viability of their orchards, many

TABLE 1

Size and structure of the southwest Michigan apple industry (1997 Southwest Michigan Fruit Census).

			Michigan apple %	
No. of farms	**Acreage**	**No. of trees**	**No. of farms**	**Acreage**
447	17,000	2,500,000	35%	29%

TABLE 2

Apple tree and acreage loss estimates by southwest Michigan county (based on '97 fruit acreage).

	County					
	Berrien	**Van Buren**	**Cass**	**Allegan**	**Kalamazoo**	**Total**
Total acreage	7,100	7,100	1,100	1,300	500	17,100
Affected acreage	4,000	3,000	300	300	50	7,650
Acreage loss	950	450	75	50	25	1,550
Trees lost	234,000	104,000	19,500	13,000	6,500	377,000
•Assuming an average loss/acre of 180 Bu/A (37.5% of the 480 Bu/A average).						
Lost bushels	1,278,000	1,278,000	198,000	234,000	90,000	3,078,000
Lost crop	$4,830,840	$4,830,840	$748,440	$884,520	$340,200	$11,634,840
•Assuming a loss of 50% (240 Bu/A) on affected acres and 100% (480 Bu) on lost acres.						
Lost bushels	1,188,000	828,000	90,000	84,000	18,000	2,208,000
Lost crop	$4,490,640	$3,129,840	$340,200	$317,520	$68,040	$8,346,240

progressive growers in the region have been replacing older plantings of standard and semi-dwarf trees with high density orchards with dwarfing rootstocks. Yields of high quality fresh market fruit from these plantings quickly climb in the early years to high levels that should be sustainable.

The remainder of the apple production in southwest Michigan is processed into sauce, slices and juice by area processors. Jonathan is preferred among all other varieties for the manufacture of frozen slices and Idared and Rome are preferred for apple pie slices and for use in applesauce. These varieties are susceptible to fire blight injury and subsequent tree death. In 2000, large blocks of these varieties suffered with severe fire blight.

Streptomycin-resistant fire blight bacteria were found in Van Buren County in 1990 and resistance had spread countywide by 1999. A few growers use a costly but relatively effective combination of streptomycin plus oxytetracycline, and these growers are more active in following predictions of the MaryBlyt model in an attempt to apply treatments just ahead of an infection. However, most growers use less costly and weaker treatments of oxytetracycline, copper, or Aliette, or continue to use streptomycin despite resistance of the bacteria, or do not treat with any material. Where possible, treatments are applied before infection periods are predicted by MaryBlyt, but in practice are more likely to be applied after an infection. A few Van Buren County growers have avoided new plantings of fire blight-susceptible varieties and susceptible dwarfing rootstocks. However, they have older fire blight-susceptible plantings and are concerned about what varieties to plant in the future.

Many acres of high-density apple plantings have been severely affected by this epidemic. These orchards will be destroyed as economic units by the death of most of the trees. This epidemic will change the way we grow apples in southwest Michigan. Few growers will again risk planting the new premium varieties, hoping instead to maintain profits with older varieties in a market with global oversupply, in this way believing they could control fire blight. A major unanswered question is "What varieties can be grown profitably in the future without undue fire blight risk?"

TABLE 3

Total loss estimate.

	Lost income
Crop loss 2000	$9,679,313
Tree loss 2000	$9,305,338
Crop loss 2001 to 2005	$23,230,350
Total loss	$42,215,002

THE 2000 FIRE BLIGHT EPIDEMIC

Because of the warm growing conditions in the spring, fire blight is an annual disease problem in southwest Michigan. Growers typically apply 2 to 3 sprays of antibiotics during bloom and save the final spray for use after a hailstorm or other trauma. In southwest Michigan the question is not "will you have fire blight" but "how bad will it be."

In 2000, fire blight symptoms began to appear in some Idared and Jonathan orchards several days earlier than predicted by the MaryBlyt model. Backtracking from the date of the first symptoms would indicate that the initial infections took place on May 7 and 8 when predicted bacteria levels reached record high levels. There was no rain or prolonged dew on these dates, but the average daily relative humidity was 79.2% and 80.5%, respectively. Although rare in occurrence, infection can occur during dry periods when daily relative humidity values are above 70%. With minimum nighttime temperatures of 65 and 68˚F, respectively, bacterial populations increased throughout each 24-hour period, resulting in very high populations that overwhelmed subsequent antibiotic treatments. Orchardists who applied antibiotics ahead of this weather achieved the best control. Beginning May 9, MaryBlyt subsequently predicted three infection periods associated with rain and favorable temperatures. Golden Delicious and Rome were in bloom and bloom blight was common on these varieties while all varieties suffered trauma blight from the heavy storms.

As the symptoms of the blossom and trauma infections began to appear, a cold front with widespread hail and thunderstorms moved through the region on May 18. The blossom blight symptoms that began to appear in mid-May appeared mainly in unsprayed blocks of susceptible varieties and also in varieties such as Golden Delicious that do not normally get fire blight and were not sprayed. Fire blight strikes also could be found on varieties that are normally very resistant such as Empire, McIntosh and Delicious. This indicates we had extremely high levels of inoculum and good infection conditions. The rainstorm on May 18 spread the disease throughout the growing region. This large-scale weather event lasted for several days. It spread the disease to many previously uninfected blocks. Growers who applied antibiotics after rains were hard pressed to cover all their acreage within 24 hours. In addition this weather system spread the fire blight strains that are resistant to streptomycin to a large area where they previously were not found. It seems that where streptomycin resistant fire blight is found the use of streptomycin makes the disease worse because it removes competitors of the bacteria that normally slow its spread. This means that the application of streptomycin actually may have increased the severity of the disease in some orchards.

At the beginning of June, another wave of fire blight symptoms began to appear in all susceptible varieties as a result of the trauma for wind, heavy rain and hail. The symptoms from this infection are very severe and widespread. Most apple growers who planted new trees in the last 5 years will lose those plants. Others are concerned about the health of their older orchards. All apple growers will lose a portion of their crop for the next several years.

LOSS ESTIMATES

The southwest Michigan apple industry will be severely affected for at least the next 5 years. Large portions of this year's crop have been lost due to the death of branches and trees that supported the fruit. Many young orchards will need to be replanted. About 5 years will be required for these orchards to return to significant production. In mature orchards, 3 to 5 years will be required to grow new branches and restore production.

Crop Loss Estimates for 2000

The southwest Michigan apple crop varies from 4.5 to 7 million bushels with a gross grower income of $30 to $40 million each year. Yield losses will probably be in the 20% to 70% range for most apple varieties. Some individual grower losses will be much higher. The total production loss for the region in 2000 is estimated at 2.7 million bushels (113 million lbs). Using 9 cents as an average price per pound, the total crop loss is $10,179,000. About two-thirds of the region's apple crop is processed and processing prices ranged from 4.5 to 9.5 cents/lb in 1999. Fresh market returns vary from 17 to 4 cents per lb, processing/culls included. Returns depend on variety and grade and percent pack out.

- Estimated loss at fresh market price of $.15 x 37,700,000 lbs (1/3 of crop) = $5,655,000
- Estimated loss at processing price of $.07 x 75,400,000 lbs (2/3 of crop) = $5,277,813

- Total estimated loss for 2.7 million bushels = $10,932,813

Accumulated 5-Year Loss of Crop and Income

The 2000 apple crop was expected to be off from previous years due to a heavy crop in 1999 and a severe frost in early April that probably reduced the 2000 apple crop by 20%. The part of the apple tree that was killed will not bear a crop next year. Apples bear their fruit on 2-year-old and older wood, so yields will not rise greatly until 3 years from now. If the tree is not killed, it will probably be back to full production in 5 years. Losses in 2001 would be almost equal to 2000, then yield should begin to rise. For older trees (7 years or more) this increase in yield should end in about 5 years.

If the initial loss were about 1 million bushels, the cumulative loss over 5 years will be about $15 million. For an initial loss of 2.5 million bushels, the loss will be $332 million. An average loss figure for the region would be $25.5 million.

Estimated Tree and Acreage Losses for 2000

Young trees of susceptible varieties are very vulnerable to fire blight. I anticipate that most susceptible trees from 1 to 5 years of age will be killed in this epidemic. Trees from 5 to 7 years old will be severely damaged and many will die. Orchards that lose more than 20% of their trees are no longer economically viable and the orchard will need to be replaced. I do not believe that replanting by interplanting into an existing orchard is economically viable once the orchard is more than 3 years old. The entire orchard or sections of the orchard should be removed. The extra cost of maintaining small interplant trees in an older planting until they reach full size generally is not worthwhile.

I estimate the total loss at 1550 acres (Table 2) with a lost investment value of $9,300,000 (Table 3). I estimate that growers will lose 720 acres of 1 to 3-year-old trees, 240 acres of 4-year-old trees, 251 acres of 5-year-old trees, 165 acres of 6-year-old trees, 120 acres of 7-year-old trees and 46 acres of 8-year-old trees (Table 2).

ADVICE FOR GROWERS

This epidemic will change the way we grow apples in southwest Michigan. Most growers avoided fire blight susceptible varieties on dwarfing rootstocks, while others planted the new premium varieties, believing they could control fire blight. With these new varieties, they hoped to maintain profits in a market with global oversupply. After this season I doubt few growers will chance it again. Other growers planted those new varieties on semi-dwarfing stocks and still had severe damage. Still others planted Golden Delicious, hoping that fire blight would not be a serious problem. We had perfect conditions for fire blight during bloom and we saw damage in nearly all apple blocks.

My advice to growers with severe fire blight at this time (during the growing season) is to do nothing. Most of the damage for the year already has been done. There is no spray or cure for fire blight once it is in the trees. If there are only a few strikes in the orchard, pulling out shoots makes sense when symptoms first appear. However, when there are many strikes in each tree, waiting until the disease stops spreading is a good option. Many southwest Michigan growers have abandoned their crop in severely affected young orchards and sprayed with copper, hoping to slow the spread of the disease. This is little more than a feel-good option. It only reduces the population of bacteria on the trees. Copper has no effect on the bacteria in the trees. If your trees need calcium or potassium, apply it. These minerals help maintain cell walls and membranes. Potassium is very important in water relations and may slow the advance of the disease in older tissues. I am not suggesting that you spray these materials onto trees.

My recommendation is that fire blight-affected branches be pruned out in the winter. Several trips through the orchard should be made to be sure that all fire blight-affected branches are removed. Many growers in southwest Michigan apply copper in the early spring. Next year I recommend that everyone do it. Growers who do not use the Maryblyt model should get a copy and learn to use it. If at all possible, controls for blossom blight should be applied before infections. For more information, see the fire blight articles at the University of West Virginia Web site (http://www.caf.wvu.edu/kearneysville/disease_month/fireblight.html).