A Summary of Recent Results in Fire Blight Control Product Efficacy Trials

Timothy J. Smith, Washington State University, September 14, 2011

Overview: Fire blight is a bacterial disease that may attack apples and pears under certain weather conditions when flowers are present on the trees. For the disease to occur, a series of unusual events must occur in proper order:

- The bacteria *Erwinia amylovora* must be present nearby, usually oozing from an active canker carried over from last season's infections.
- These bacteria must be transported from the oozing canker to the stigma surfaces of open flowers, usually by flies or pollinating insects.
- Warm temperatures must occur, with sufficient warmth to allow the bacteria colony to grow rapidly to large numbers on the stigma.
- The blossom then must be gently wetted, which allows the bacteria to be washed, or to swim from the tip of the stigma where they were growing, to the nectaries, which provide them the necessary open entry into the tree.
- The bacteria that have gained entry into the highly susceptible young fruitlet must then find growing conditions to their benefit, allowing them to grow rapidly and overwhelm the flower tissues, leading to infection. Once the infection of the flower is successful, the bacteria move out of the flower into the other uninfected flowers of the cluster, into the fruit spur, and then beyond into the young wood of the tree. Within 10 to 30 days of initial infection, the damage appears on the tree as a "strike." By this time, the bacteria are moving symptomlessly throughout the host tree, and may cause further damage to distant structures, such as shoot tips or sensitive rootstocks.

There are key points of this infection process that can be managed in the effort to prevent infection, or reduce damage to the host tree or orchard.

***First bullet point*, the presence of blight bacteria**: Sanitation of the neighborhood is the most important step in control. Fire blight is very difficult to control if there are active cankers nearby, providing a constant source of high numbers of blight bacteria. The higher the number of live active cankers, and the closer they are, the higher the difficulty of control. Control of blight depends on the identification and removal of as many of these active cankers as possible. This is not easy, but a careful inspection and sanitation effort should be carried out prior to the normal pruning of the orchard. Blight cuttings can then be removed from the orchard prior to being intermingled with the non-infected pruning wood.

***Second bullet point*, the transport of bacteria to the blossoms:** Efforts to reduce infection by controlling insects that visit blossoms have never been successful.

***Third bullet point*, warm temperatures and bacterial multiplication**: *Erwinia amylovora* bacteria multiply best on the flowers' stigma surfaces, using the same food and moisture resources that the pollen needs for germination and growth. The multiplication rate of the bacteria is dependent on moment by moment temperatures. The average temperature of the day is an outdated rough way to estimate bacterial growth rate. Totaling hourly temperature related to bacterial growth rate values over the time that the flowers are open is more precise. Fire blight infection risk models should serve as a method to determine when an infection is likely in the near future, or if infection has occurred during the current day. (See "CougarBlight 2010" for the recommended blight risk model, or WSU DAS.)

If the infection risk forecast indicates infection conditions are possible in about three or four days, the flowers may be protected during the days leading up to that infection with products *that retard the development of the blight bacteria that may be trying to grow on the blossoms.* Most non-antibiotic products *must* be used this way. The "biological" fire blight control products are often living micro-organisms, and are most effective if they are placed in the newly opened flowers soon after they open, in time to allow them to establish prior to the introduction of blight bacteria. Antibiotic or copper sprays used during this same time can hinder the development and effect of the "biologicals."

***The fourth bullet point*, wetting of flowers:** The actual infection event occurs when the blossoms are wetted by rain, dew, or light irrigation. If the infection risk model you trust indicates that infection conditions have occurred within the past several hours, and, especially if you believe that active cankers may be near your flowering orchard, antibiotics are the only effective treatment to reduce the degree of infection when sprayed at this timing. The antibiotic must be applied within 24 hours before or after the infection event to be most effective. The antibiotics act directly against the blight bacteria in the nectary by stopping their growth and multiplication. It is possible that the yeast product applied in the days prior to the infection event acts against the blight bacteria by changing the pH and sugar content in the nectary, and when the blight bacteria arrive, they don't have the conditions or resources necessary to grow.

***The fifth bullet point*, infection occurs and the strikes appear:** Nothing good happens after this point. Once blight appears, the degree of damage depends on the age and cultivar of the orchard host, and the relative number of blight strikes per tree or acre. In a young apple orchard, or a pear orchard younger than 15 – 20 years, immediate cutting of blight strikes usually leads to a reduction of total bearing surface removal. However, the blight often continues to occur during the season, and the blight manager often believes that the blight cutting is ineffective. It is best to put extra management resources into prevention, rather than reaction to this disease.

Products used for prevention of blossom infection: Over the past decade, the author has tested numerous products and mixtures to assess their effect on fire blight infection. The results are summarized below. The data was developed using standardized evaluation methods that assure high levels of infection in the untreated check, and the "percent control" comparison should not be used as a direct indication of field results under natural infection conditions. To overcome the variability of natural infections, the test trees were all inoculated with high numbers of blight bacteria at full bloom to assure an even dose of bacteria per flower. In practice, products that control the infection of inoculated flowers at about 65% and above, if properly applied, will perform very well in the orchard under natural conditions. Most of the products have specific application requirements, and if correct rate and timing are not followed, are not likely to perform as in the trials. You may notice that results from the same product vary from year to year. This is likely due to variations in weather and degree of successful inoculation, rather than variation in dependability of the tested product. Generally, the various antibiotics have performed better than the other substances, and have been much easier to apply, as most other products require multiple applications prior to the infection period. However, there have been recent results with products that compete with the antibiotics for level of control.

NOTE: Many of these products may not be registered for use on your crop. Results are provided here only to report research results, and are not intended as recommendations or endorsements. Read the label carefully before using any product to be certain that the product is registered on your crop. *Note also that **the bacteria used to inoculate these plots were selected for comparative research purposes, and are susceptible to streptomycin.** Many wild blight bacteria in the western USA are resistant to this substance. **Streptomycin will not be as effective in most orchards** as in these trials.

Antibiotics:

Year	Product	Rate	Timing	Percent Control*
2011	Streptomycin 17%*	1 lb/A, 200 ppm	100% bloom @ inoculation	87.6
2011	Oxytet. (FireLine)	1 lb/A, 200 ppm	100% bloom @ inoculation	80.7
2011	Kasumin 8L	pint/A, 100 ppm	100% bloom @ inoculation	74.4
2010	Streptomycin 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	80.0
2010	Kasumin 2L (1x)	2 qt./A, 100 ppm	100% bloom @ inoculation	79.5
2010	Oxytet. (FireLine)	1 lb/A, 200 ppm	100% bloom @ inoculation	77.7
2009	Streptomycin 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	93.4
2009	Kasumin 2L	200 ppm	100% bloom @ inoculation	79.5
2009	Oxytet. 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	70.5
2008	Gentamycin 10% (three treatments)	2.5, 3, & 3.5 lb/100/A	100% bloom @ inoculation	90.2, 87.0 & 86.8
2008	Oxytet. 17% (two treatments)	1 lb/A, 200 ppm	100% bloom @ inoculation	91.8 & 96.0
2008	Streptomycin 17% (two treatments)	1 lb/A, 200 ppm	100% bloom @ inoculation	90.1 & 87.0
2006	Oxytet. 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	91.7
2006	Streptomycin 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	91.4
2006	Kasumin 2L	200 ppm	100% bloom @ inoculation	89.1
2005	Oxytet. FireLine	1 lb/A, 200 ppm	100% bloom @ inoculation	93.0
2005	Oxytet. Mycoshield	1 lb/A, 200 ppm	100% bloom @ inoculation	92.0
2005	Streptomycin 17%	1 lb/A, 200 ppm	100% bloom @ inoculation	89.6
2004	Oxytet. FireLine	1 lb/A, 200 ppm	100% bloom @ inoculation	92.5
2004	Oxytet. Mycoshield	1 lb/A, 200 ppm	100% bloom @ inoculation	86.4
2004	Gentamycin 10%	3 lb/A	100% bloom @ inoculation + 1 day after	88.3
2003	Oxytet. Mycoshield	1 lb/A, 200 ppm	100% bloom @ inoculation	67.4

Antibiotic Mixes:

Year	Product	Rate	Timing	Percent Control*
2011	Actigard Pre-bloom, Sprayed on tree. + Strep, 100% bloom + Act. 1 – 2" shoots *	Actigard 2 oz./A Strep. 200 ppm Actigard 2 oz./A	Actigard 50% bloom Strep. 100% Bloom Act. @ 1 - 2" shoot	98.5
2011	Actigard Pre-bloom, Sprayed on tree. + Strep 100% bloom*	Actigard 2 oz./A Strep. 200 ppm	Actigard 50% bloom Strep. 100% Bloom	95.5
2010	Actigard Pre-bloom, Sprayed on. + Strep 100% bloom	Actigard 1 oz./A, Strep. 200 ppm	Actigard 20 and 50% bloom Strep. 100% Bloom	98.2
2010	Kasumin 2L + oxytetracycline	2 qt./A, 100 ppm 1 lb/A, 200 ppm	100% bloom	82.4
2009	"Blossom Protect" + Buffer A, Then oxytet. 17%	1.34 lb/100gal/A 9.35 lb/100/A 1lb/100/A	BP + buffer @ 20 & 50% bloom, Oxytet. @ 100% bloom	70.4
2006	Oxytet. + Cal/Phos fertilizer	1 lb./A 200 ppm 2 qt./A	100% bloom	72.5

Copper and other fungicides:

Year	**Product**	**Rate**	**Timing**	**Percent Control***
2011	Copper Product GWN-9979	64 fl.oz./A	50% and 100% bloom	81.5
2011	Copper Product GWN-9979	48 fl.oz./A	50% and 100% bloom	81.5
2011	Cueva (copper soap)	1 gallon/100/A	20 & 50% 100% bloom	79.8
2011	Copper Product GWN-9979	96 fl.oz./A	50% and 100% bloom	76.7
2010	Kocide 3000	0.5 lb/100/A	80& 100% bloom	52.3
2010	Copper Product GWN-4620	4 qt./A	80, 100% bloom & 1 day post inoculation	90.0
2009	Copper Product GWN-4620	4 qt./A	80, 100% bloom & 1 day post inoculation	98.4
2009	Copper Product GWN-4620	2 qt./A	80, 100% bloom & 1 day post inoculation	87.6
2009	Copper Product GWN-4620	1 qt./A	80, 100% bloom & 1 day post inoculation	53.3
2009	Kocide 3000	0.5 lb/100/A	80& 100% bloom	61.1
2006	Manzate	3.2 lb./A	80& 100% bloom	41.1
2005	Kocide 3000	0.5 lb/100/A	80& 100% bloom	56.1
2005	Dithane (manzate)	3.2 lb. / A	80& 100% bloom	44.0
2004	Dithane + Champ (Cu hydrox.)	3.2 lb. / A +0.67 pint	Pink + 100% bloom, then 3, 6 and 9 days later	71.0
2004	Champ (copper hydroxide 37.5%)	0.67 pint/A	Pink + 100% bloom, then 3, 6 and 9 days later	27.4

Yeasts (Blossom Protect) and Bacteria (Serenade):

Year	Product	Rate	Timing	Percent Control*
2011	"Blossom Protect" + Buffer A full rate	1.34 lb/100gal/A 9.35 lb. /100/A	20 & 50% 100% bloom	85.7
2011	"Blossom Protect" + Buffer A ½ rate	1.0 lb/100gal/A 5.0 lb. /100/A	20 & 50% 100% bloom	85.4
2011	Bacillus subtilis QRD146	1.5 lb/100gal./A	30 & 50% 100% bloom	70.0
2011	Serenade MAX	3.0 lb/100gal./A	30 & 50% 100% bloom	63.1
2010	"Blossom Protect" + Buffer A ½ rate	1.34 lb/100gal/A 4.7 lb/100/A	20, 50 & 100% bloom	82.4
2010	"Blossom Protect" + Buffer-A ½ rates	0.68 lb/100gal/A 4.7 l b/100 A	20, 50 & 100% bloom	82.4
2010	"Blossom Protect" + Buffer A	1.34 lb/100gal/A 9.35 lb. /100/A	20, 50 & 100% bloom	81.1
2010	Blossom Protect + alternative buffer	1.34 lb/100gal/A to pH 5	20, 50 & 100% bloom	62.8
2009	"Blossom Protect" + Buffer A	1.34 lb/100gal/A 9.35 lb/100/A	20, 40, 70 & 100% bloom	80.8
2009	"Blossom Protect" + Buffer A	1.34 lb/100gal/A 9.35 lb/100/A	40 & 80% bloom (fewer applications than above)	73.0
2009	"Blossom Protect" full rate No Buffer	1.34 lb/100gal/A	20, 40, 70 & 100% bloom	69.5
2009	"Blossom Protect" NO Acid Buffer Then Oxytet. 17%	1.34 lb/100gal/A 1 lb/100/A	BP @ 20 & 50% bloom Oxytet. @ 100% bloom	69.0
2009	Serenade Max	1 lb/100/A	20, 50 & 100% bloom	66.0
2009	Serenade QRD 146	0.5 lb/100/A	20, 50 & 100% bloom	44.2
2008	"Blossom Protect" (full rate)+ Buffer A	1.34 lb/100gal/A 9.35 lb/100/A	10, 40, 70 & 90% bloom	90.0
2005	Serenade ASO	6 qt. /100 gal/ A	20, 50 & 100% bloom	84
2005	Serenade Max	2 & 3.5 lb/100/A	20, 50 & 100% bloom	63 & 71
2004	Serenade AS	6 qt. /100 gal/ A	90% Bloom, day before inoc.	14
2003	Serenade	6 lb./A	@ 100% bloom, pre-inocul.	26.7
2003	Serenade	6 lb./A	@ 100% bloom, pre-inocul. + 3 days after	42.1

Other:

Year	Product	Rate	Timing	Percent Control*
2011	Actigard Pre-bloom, Sprayed 3 times prior to inoculation	Actigard 1 oz./A each spray	20 & 50% 100% bloom	56.5
2011	Actigard, Sprayed twice after 1st symptoms seen	1.34 oz / A	Sprayed twice, three day interval, after 1st symptoms seen	37.8
2011	Actigard (SAR) soil treatment	1 oz./A	Tight Cluster & 50% Bloom	40.5
2010	Acid Buffer (pH 5)	2 qt./A	20, 50 & 100% bloom	38.5
2010	Buffer A	9.35 lb. /100/A	20, 50 & 100% bloom	37.9
2008	Organic nutrient spray series	Various, N, P, K Calcium, micro	Pre-bloom	32.0
2006	Cal/Phos Fertilizer	Series of various	Pre-bloom	21.9
2006	Physpe (SAR)	Series of various	4 times Pre-bloom	18.0
2006	Physpe (SAR)	Series of various	2 times Pre-bloom	0
2005	Cal/Phos Fertilizer	Series of various	Pre-bloom	5.0

Treatment	Number of Valid Treatments	Highest Percent Control	Lowest Percent Control	Average Percent Control
Strep + ASM*	6	98.4	90.6	95.1
Copper (new)	9	98	76.7	85.8
Streptomycin	9	90	75	85.3
BCYP + Buffer A	12	90	72	82.6
Oxytetracycline	15	93	53	78.9
Kasugamycin	8	89	62	77.5
Gentamycin	6	88	51	74.5
Serenade	12	84	38	63.5
Copper (old)	7	80	26	49.5
Fungicides	6	57	33	48.6
Acid Buffers	4	39	19	30.5
SAR (Claims)	10	46	0	30.2
Nutrient minerals	3	32	5	18.8

Summary of author's current and past fire blight control efficacy trial results. Plots all inoculated. *ASM = Actigard, BCYP = Auriobassidium pulullans, "Blossom Protect."