

HAZELNUT (*Corylus avellana* 'Ennis' and 'Royal')
Eastern Filbert Blight; *Anisogramma anomala*

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A Forecasting model for fungicide application for control of eastern filbert blight, 2002 - 2003.

A model was developed, based on length of branch wetness due to rain, to help decide when to deploy fungicides. Healthy 2-year-old 'Ennis' hazelnut trees were planted on 16 Jan 02 adjacent to and south of a commercial block of diseased 'Ennis' trees planted near Newburg, OR. Treatments were arranged in a randomized complete block design with 5 trees in each of 4 replications (total of 20 trees per treatment). Treatments were applied on two sides of the tree to run-off with a backpack sprayer equipped with a hand wand. Approximately 1 gal of a spray suspension was applied per 20 trees. Bravo Weather Stik was applied at 32 fl oz/100 gal water on 25 Mar 02 (budbreak) and again on 8 Apr 02 and 22 Apr 02 depending on the treatment. Applications of Orbit EC at 2.5 fl oz/100 gal water or Elite 45 DF at 2 oz/100 gal water or Procure 50 WS at 4 oz/100 gal water were dependent on detecting greater than 20 hours of branch wetness starting 2 weeks after budbreak until the first week of May. Applications of Orbit, Procure and Elite were made on 11 and 29 Apr 02. An additional protocol for using just Orbit after detecting 20 hours wetness anytime after budbreak but before the 1st week in May resulted in applications on 8 and 29 Apr 02. Branch wetness due to rain was monitored using an Adcon A730 weather station equipped with standard leaf wetness sensors and customized hazelnut branch wetness sensors. The customized branch wetness sensors consisted of two wires in parallel coils wound around a 0.5 inch diameter hazelnut branch. The amount of current running from one coil to the other is directly related to the amount of moisture on the branch surface. Branch wetness due to dew periods were not considered. Roundup at 3 gal/100 gal water was used between trees to control weeds on 10 Jun 02. Trees were fertilized with a 16-16-16 at a rate of 1 lb/3 trees on 18 Jun 02. Trees were painted with at 50% solution of white latex paint on 18 Jun 02 on the southwest side of the trunk to prevent summer sunburn. The number of diseased trees, cankers per tree and total canker length was determined on 21 Jul 03.

Similar trials were conducted adjacent to and north of a heavily diseased 'Ennis' orchard located north of Keiser, OR. Healthy 2-year-old 'Royal' trees were planted on 1 Feb 02. Another set of 'Ennis' trees was planted 4 Feb 02. Treatments were arranged in a randomized complete block design with 5 trees in each of 4 replications (total of 20 trees per treatment) in each block of trees. Bravo applications to 'Royal' trees occurred on 21 Mar 02, 4 Apr 02 and 19 Apr 02. Bravo applications to 'Ennis' trees occurred on 25 Mar 02, 8 Apr 02 and 22 Apr 02. Orbit or Elite were not applied since a wet period of 20 hours or greater was not detected. Roundup at 3 gal/100 gal water was used between trees to control weeds on 11 Jun 02 and 8 Aug 02. Trees were painted with at 50% solution of white latex paint on the southwest side of the trunk on 18 Jun 02 to prevent summer sunburn. Trees were fertilized with a 16-16-16 at a rate of 1 lb/3 trees on 16 Apr 02. The number of diseased trees, cankers per tree and total canker length was determined on 29 Jul 03 for Ennis trees and 30 Jul 03 for Royal trees.

Two PVC trough spore traps were placed at the Newburg site on 6 Mar 02. (Each spore trap consisted of a 2.3 meter long 1/2 inch PVC pipe split in half lengthwise, supported by 2 metal posts, and angled at 20 degrees to drain into a covered 16 liter collection bucket. Each bucket contained 200 ml of 50% copper sulfate v/v as a spore preservative and germination inhibitor.) Rainwater from the traps was collected on 25 Mar 02, 8, 11, 22 and 29 Apr 02 and 14 May 02 by swirling the contents and pouring into a volumetric cylinder to measure the total volume of rainwater collected. Approximately 500 ml of the rainwater was collected for laboratory analysis and the copper sulfate solution was replenished after each collection. The rainwater was filtered first through a 20 um sieve then through a cellulose nitrate filter with 0.8 um pore size. This filter paper was placed on a microscope slide, stained with 0.05% (v/v) trypan blue in lactoglycerine. The number of ascospores on filters was then determined using a light microscope at 400X and used to calculate the number of ascospores collected per M² of trap surface. Rainfall during the spore trapping periods were as follows: 3.57 in from 6 Mar 02 to 25 Mar 02, 0.29 in from 25 Mar 02 to 8 Apr 02, 1.12 in from 8 Apr 02 to 11 Apr 02, 1.07 in from 11 Apr 02 to 22 Apr 02, 0.16 in from 22 Apr 02 to 29 Apr 02, and 0.11 in from 29 Apr 02 to 14 May 02. Four spore traps were located at Mission Bottom (2 in the Royal block and two in the Ennis block) starting 6 Mar 02 with rainwater collected on 21 Mar 02, 4 and 19 Apr 02 and 14 May 02 for the Royal block and 25 Mar 02, 8 and 22 Apr 02 and 14 May 02 for the Ennis block. Rainfall during those periods was 5.25, 0.15, 1.28, and 0.55 in for both blocks.

Newburg – Rainfall was also below normal during the spring of 2002. During early shoot growth there were 3 wet periods, initiated by rain, that were 20 hours or longer (Figure 2). These wet periods occurred on 5, 9 and 26 Apr 02. The DMI fungicides were applied within 2-3 days of these events depending on the treatment protocol. Spore counts tended to be lower at this site than in plots located in other areas in other years but not enough to be concerned about (Fig 3). There were no significant differences in canker number or length comparing fungicide treated trees with nontreated trees (Table 1). None of the trees showed any phytotoxicity during the growing season, however, trees treated with Orbit showed typical growth regulation activity in the form of smaller, darker green leaves. Overall, the number of cankers per tree was uncharacteristically low for this trial. Given the spore counts, favorable weather and susceptible trees (trees from the same lot were heavily infected when planted in a different location) it is highly likely that this plot was accidentally oversprayed from the adjacent commercial orchard.

Fig 1. EFB Fungicide Timing Model.

Step 1) Apply protectant fungicide (such as Bravo) at Budbreak.

Step 2) Wait two weeks.

Step 3) Apply systemic fungicide with after infection activity (such as Orbit or Elite) within 3 days of a rain event that wets branches for longer than XX (20) hours. If a long wet period is not detected until after the first week in May then no more fungicide is needed.

Step 4) Wait 14 days then repeat step 3.

Stop after the first week of May.

Note: Model is based on research, high costs of fungicide and grower reluctance to make more than three applications per season. If more applications of fungicide are possible then continue forecasting through mid-May.

Table 1 – Newburg - Ennis

Treatment and Rate /100 gal water	Application Timing	Number of Applications	Disease Incidence ^{1,2} (%)	Ave Number of Cankers/Tree ^{1,3}	Total Canker Length ^{1,3} (cm)
Nontreated.....	None.....	0	20	1.0	12.7
Bravo Weather Stik 32 fl oz	25 Mar (BB) only	1	0	0.0	0.0
Bravo Weather Stik 32 fl oz then Orbit EC 2.5 fl oz after a wetness period of >20 hours	25 Mar..... 11 and 29 Apr	1 2	0	0.0	0.0
Bravo Weather Stik 32 fl oz then Elite 45 DF 2 oz after a wetness period of >20 hours	25 Mar..... 11 and 29 Apr	1 2	10	0.5	4.4
Bravo Weather Stik 32 fl oz then Procure 50 WS 4 oz after a wetness period of >20 hours	25 Mar..... 11 and 29 Apr	1 2	10	0.5	3.2
Orbit EC 2.5 fl oz after a wetness period of >20 hours	11 and 29 Apr	2	10	0.5	6.4
Elite 45 DF 2 oz after a wetness period of >20 hours	11 and 29 Apr	2	5	0.3	2.5
Bravo Weather Stik 32 fl oz every 2 weeks.....	25 Mar, 8 and 22 Apr.....	3	0	0.0	0.0
Orbit EC 2.5 fl oz after a wetness period of >20 hours	8 and 29 Apr	2	0	0.0	0.0

¹ Means without any letters did not differ significantly.

² Analysis of variance is based on arcsin (square root (x)) transformation. Values presented are detransformed means.

³ Analysis of variance is based on log₁₀ (x+1) transformation. Values presented are detransformed means.

Mission Bottom – Conditions at this location were dry and no wet periods longer than 20 hours were detected during early shoot growth (Figure 4). Analysis of the weather records indicate that the rain sensor may not have been functioning correctly during early April. A wet period of 18-20 hours, possibly initiated by rain, occurred on 9 Apr 02. Spore counts showed an especially active period between 4 and 8 Apr (Fig 5 and 6). Trap information showed low spore counts in the Royal block before and high counts after 4 Apr (Fig 5). Trap information from the Ennis block showed high spore counts before and low counts after 8 Apr (Fig 6). There was only a small rain event on 5 Apr where bark wetness sensors were wet for 10 hours. A painted leaf wetness sensor, however, was wet for 28 hours. There was no rain recorded for the previous 11 days prior to that rain event.

Due to the dry weather no DMI fungicides were applied to either set of trees. Data from all trees left unsprayed was used to estimate levels of EFB (20 data points per rep instead of only 5). Likewise, data from all trees treated only once with Bravo were used to estimate levels of EFB for that treatment (15 data points instead of only 5). The number of cankers that developed on Royal trees treated once with Bravo at bud break was not significantly different from the number of cankers on nontreated trees (Table 2). Royal trees treated with 3 applications of Bravo on a protection schedule had significantly fewer cankers than nontreated trees. The number of cankers that developed on Ennis trees treated once with Bravo at bud break or treated with three regular applications was significantly different from the number of cankers on nontreated trees (Table 3). None of the trees showed any phytotoxicity during the growing season.

Table 2 – Mission Bottom – Royal trees

Treatment and Rate /100 gal water	Application Timing	Number of Applications	Disease Incidence ^{1,2} (%)	Ave Number of Cankers/Tree ^{1,3}	Total Canker Length ^{1,3} (cm)
Nontreated.....	None.....	0	100 a	16.0 a	185.9 a
Bravo Weather Stik 32 fl oz	21 Mar (BB) only	1	92 a	14.0 a	174.2 a
Bravo Weather Stik 32 fl oz every 2 weeks.....	21 Mar, 4 and 19 Apr..	3	75 b	7.0 b	110.5 b

¹ Means followed by the same letter do not differ significantly based on Fisher's protected LSD (P=0.05). Means without any letters did not differ significantly.

² Analysis of variance is based on arcsin (square root (x)) transformation. Values presented are detransformed means.

³ Analysis of variance is based on log₁₀ (x+1) transformation. Values presented are detransformed means.

Table 3 – Mission Bottom – Ennis trees

Treatment and Rate /100 gal water	Application Timing	Number of Applications	Disease Incidence ^{1,2} (%)	Ave Number of Cankers/Tree ^{1,3}	Total Canker Length ^{1,3} (cm)
Nontreated.....	None.....	0	80	15.6 a	165.5 a
Bravo Weather Stik 32 fl oz	25 Mar (BB) only...	1	50	5.6 b	67.9 b
Bravo Weather Stik 32 fl oz every 2 weeks.....	25 Mar, 8 and 22 Apr..	3	57	5.8 b	82.7 b

¹ Means followed by the same letter do not differ significantly based on Fisher's protected LSD (P=0.05). Means without any letters did not differ significantly.

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³ Analysis of variance is based on log₁₀ (x+1) transformation. Values presented are detransformed means.

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