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

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A Forecasting model (GrammaCast) for fungicide application for control of eastern filbert blight, 2003 - 2004.

A model called GrammaCast was developed, based on length of branch wetness due to rain, to help decide when to deploy fungicides. Healthy appearing 2-year-old 'Ennis' hazelnut trees were planted on 16 Jan 03 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 14 Mar 03 (budbreak) and again on 28 Mar 03 and 11 Apr 03 depending on the treatment. Applications of Orbit EC at 2.5 fl oz/100 gal water or Procure 50 WS at 4 oz/100 gal water or Flint 50 WDG at 1 ox/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 Flint were made on 4 and 24 Apr 03. 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 20 Mar 03, 8 and 24 Apr 03. 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 was not considered. Roundup at 3 gal/100 gal water was used between trees to control weeds on 9 May 03. Trees were fertilized with a 16-16-16 at a rate of 2 lb/6 trees on 20 May 03. Trees were painted with at 50% solution of white latex paint on 27 Oct 03 on the southwest side of the trunk to prevent winter and summer sunburn. The number of diseased trees, cankers per tree and total canker length was determined on 5-6 Aug 04.

Similar trials were conducted adjacent to and north of a heavily diseased 'Ennis' orchard located north of Keiser, OR. Healthy appearing 2-year-old 'Ennis' trees were planted on 8-9 Jan 03. 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 occurred on 16 Mar 03, 28 Mar 03 and 11 Apr 03. Applications of Orbit, Procure and Flint were made on 4 and 24 Apr 03. Roundup at 3 gal/100 gal water was used between trees to control weeds on 9 May 03. Trees were fertilized with a 16-16-16 at a rate of 2 lb/6 trees on 20 may 03. Trees were painted with at 50% solution of white latex paint on the southwest side of the trunk on 27 Oct 03 to prevent winter and summer sunburn. The number of diseased trees, cankers per tree and total canker length was determined on 27-28 Jul 04.

Two PVC trough spore traps were placed at the Newburg site on 6 Mar 03. (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 14, 20 and 28 Mar 03, 11 and 24 Apr 03 and 9 May 03 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 M^2 of trap surface. Rainfall during the spore trapping periods were as follows: 3.82 in from 6 Mar 03 to 14 Mar 03, 1.08 in from 14 Mar 03 to 20 Mar 03, 2.73 in from 20 Mar 03 to 28 Mar 03, 2.49 in from 28 Mar 03 to 11 Apr 03, 4.09 in from 11 Apr 03 to 24 Apr 03, and 1.24 in from 24 Apr 03 to 9 May 03. Two spore traps were located at Mission Bottom starting 6 Mar 03 with rainwater collected on 16, 20 and 28 Mar 03, 11 and 24 Apr 03 and 9 May 03. Rainfall during those periods was 3.45, 0.39, 2.06, 1.47, 3.21 and 1.17 inches.

Newburg

During early shoot growth there were 7 wet periods, initiated by rain, that were 20 hours or longer (Figure 2). These wet periods occurred on 15, 19 and 20 Mar 03 and 2, 5 and 23 Apr 03 and 3 May 03. The DMI fungicides were applied within 2-4 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 (Fig 3), however, counts just after bud break were high enough to expect infections. There were no significant differences in canker number or length comparing fungicide treated trees with nontreated trees (Table 1). Although, none of the trees showed any phytotoxicity during the growing season, trees treated with Orbit showed typical growth regulation activity in the form of smaller, darker green leaves. Trees had a difficult time surviving site conditions during the 2 season waiting period as many died during the 03-04 dormant period and summer of 2004. Of the trees that did not die, 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. Low spore counts could also have been a factor.

Fig 1. EFB Fungicide Timing Model, GrammaCast.

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 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	Ave Number of Cankers/Tree[1,3]	Total Canker Length[1,3] (cm)
Nontreated.....……..	None…….	0	0.0	0.0
Bravo Weather Stik 32 fl oz	14 Mar (BB) only	1	0.3	1.6
Bravo Weather Stik 32 fl oz then Orbit EC 2.5 fl oz after a wetness period of >20 hours	14 Mar……. 4 and 24 Apr …..	1 2	0.3	3.0
Bravo Weather Stik 32 fl oz then Procure 50 WS 4 oz after a wetness period of >20 hours	14 Mar……. 4 and 24 Apr …..	1 2	0.3	1.0
Bravo Weather Stik 32 fl oz then Flint 50 WDG 1 oz after a wetness period of >20 hours	14 Mar……. 4 and 24 Apr …..	1 2	0.0	0.0
Orbit EC 2.5 fl oz after a wetness period of >20 hours	4 and 24 Apr …..	2	0.0	0.0
Bravo Weather Stik 32 fl oz every 2 weeks……..	14 and 28 Mar, and 11 Apr……..	3	0.3	5.1
Orbit EC 2.5 fl oz after a wetness period of >20 hours	20 Mar, 8 and 24 Apr ……..	3	0.0	0.0

Mission Bottom

During early shoot growth there were 4 wet periods, initiated by rain, that were 20 hours or longer (Figure 3). These wet periods occurred on 19 and 21 Mar 03 and 2 and 23 Apr 03. The DMI fungicides were applied within 2-3 days of these events depending on the treatment protocol. Spore counts showed an especially active period between 16 to 20 Mar (Fig 5). Spore counts also seemed low from 28 Mar to 11 Apr. All fungicide treated trees had significantly fewer EFB cankers than nontreated trees, except for trees treated only once at bud break with Bravo (Table 2). Treating trees with 3 applications of Bravo resulted in significantly fewer cankers per tree than treating trees with only one application. Trees treated according the forecasting program had the lowest number of cankers per tree. Using Orbit in the GrammaCast program resulted in significantly fewer cankers than treating trees with 3 applications of Bravo. Using Procure or Flint in the program resulted in no significant difference in canker number when compared with a program of 3 regular applications of Bravo. Although, none of the trees showed any phytotoxicity during the growing season, trees treated with Orbit showed typical growth regulation activity in the form of smaller, darker green leaves.

Table 2 – Mission Bottom - 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	100	a	6.3	a	143.4	a
Bravo Weather Stik 32 fl oz	16 Mar (BB) only	1	85	abc	4.5	ab	58.7	ab
Bravo Weather Stik 32 fl oz then Orbit EC 2.5 fl oz after a wetness period of >20 hours	16 Mar…… 4 and 24 Apr	1 2	45	d	0.6	f	7.5	d
Bravo Weather Stik 32 fl oz then Procure 50 WS 4 oz after a wetness period of >20 hours	16 Mar…… 4 and 24 Apr	1 2	60	cd	1.3	ef	15.5	d
Bravo Weather Stik 32 fl oz then Flint 50 WDG 1 oz after a wetness period of >20 hours	16 Mar…… 4 and 24 Apr	1 2	75	bcd	1.3	def	19.0	cd
Orbit EC 2.5 fl oz after a wetness period of >20 hours	4 and 24 Apr	2	90	ab	2.5	bcd	28.8	bc
Bravo Weather Stik 32 fl oz every 2 weeks……..	16 and 28 Mar, and 11 Apr…..	3	85	abc	1.7	cde	31.1	bc
Orbit EC 2.5 fl oz after a wetness period of >20 hours	20 Mar and 24 Apr ……	2	85	abc	2.8	bc	40.1	bc

[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.

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