



Organic Farming of Cranberries in the Pacific Northwest 2017

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What we know in 2017

- “ Organically farming cranberries is really, really hard in Washington.
- “ Common insect pests such as Black-headed fireworm can be successfully controlled with organic products.
- “ Organically approved fungicides are widely available and appear to perform well.
- “ Weeds are the greatest challenge and are the primary obstacle to achieving long-term sustainability.

Why so difficult?

- “ Many of our bogs have been in place for a very long time.
 - . As a result they have adapted to being farmed a certain way.
 - . So has the farmer. Difficult to do things different, think different.
 - . Weeds have been in their locations a long time (horsetail).
 - . Insects have been there a long time.
 - . Fungi pathogens been there a long time.

New Planting with Organic

- “ Bogs have not been established with growing organic in mind.
- “ **Using weed block prior to sanding a new bog.**
 - . Seals in the existing deeply rooted weeds that can not be dug out like horsetail.
- “ **Treat the bog conventionally for the first 2 seasons during establishment.**
 - . Fertilize aggressively to achieve rapid establishment of the vines. Thicker vines the less room for weeds to establish.
 - . Use herbicides that can kill the newly seeded weeds.

” Site Selection

”Choose a site that is well drained and has little to no riparian weeds such as: horsetail, canary grass, willows, tussock.

”Of course this isn’t always possible. This is an advantage that Bandon has. Many of their bogs are elevated and in uplands. In Washington most bogs are located in natural wetlands. Ideally suited to our most problematic weed species.

You Now Have Committed to Organically Manage Your Bog. Now What?

“What is different?

“No easy high nitrogen fertilizers like ammonia sulfate and urea.

“Narrow range of insecticides. Based on our data only Entrust[®] and Pyganic[®] are worth using for Fireworm.

“No effective selective herbicides. All are broad spectrum burndown, but can be made somewhat selective by rate and spray volume.

The Good News

“Fungicides are widely available and costs are similar to conventional products.

“Entrust and Pyganic provide excellent fireworm control and can be chemigated.

“Companies see organic as a growing industry and have been putting more money into developing products for growers to use.

The Bad News

“Yield will begin to decline as weed competition increases.

“Vines on peat soils will be more prone to over growth.

“The insecticides for Fireworm cost 2-4x more per application per acre.

“The herbicides available often will burn or injure your cranberries as well as the weeds. Thankfully the vines do recover.

“Expect to weed wackõ ..a lot.

“You now have to look at weedy bogs.

“But you will get used to that.

Fertilizing

- “ Many fertilizers are available.
- “ Many liquid products are good for applying micronutrients.
- “ There are several products that can be applied using conventional equipment.
 - . Nutri-Rich 4-3-2, 8-2-4
 - . Blue Ocean organics 12-12-2.5
 - . ProNatural 13-0-0 (wilbur-ellis)

Fireworm control

“Applications should be done in the evening whenever possible, especially during bloom.

“Never apply during bee activity (mid-day).

“Timing is critical. Wait until peak emergence. Do not spray when you find the first worm.

Weed Control

- "Difficult to do with only post-emergence herbicides.
- "Products are all burndown.
- "Many of the products will burn cranberries as well as your weeds.
- "Plan on using a lot of weed eaters.

Research

With early interest in organic cranberries we began in 2005 looking at new products that became available or ideas that growers had suggested to us, starting with Manuka oil for weed control.

Organic Weed Control

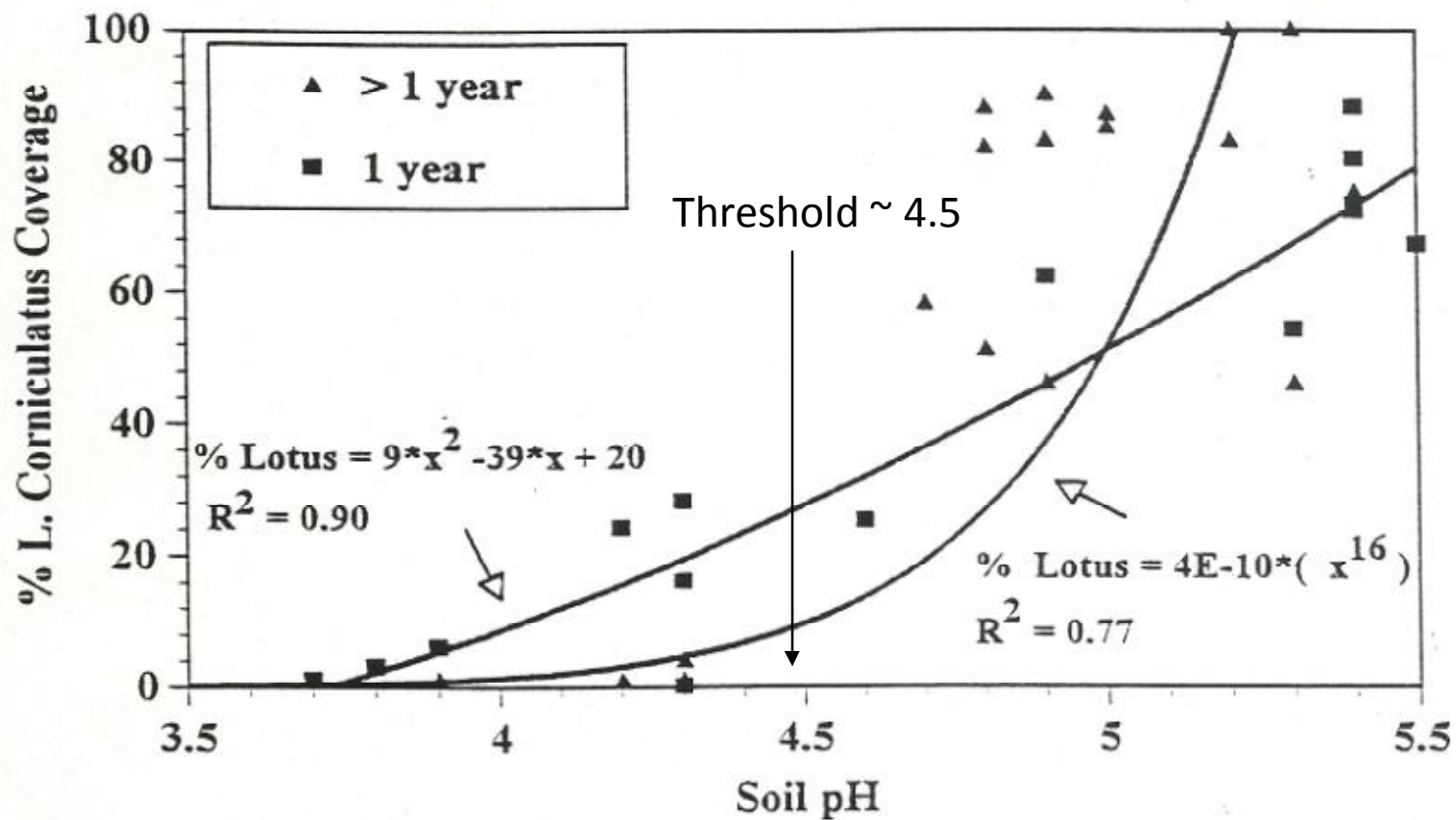
- ” Manuka oil @ 8,16, 32 and 64 oz/ac on lotus with 2 surfactants
 - . Higher rates were OK, but Lotus will grow out of treatment effects relatively quickly. Frequent re-treatment needed.
 - . Surfactant emulsion problem, make sure that you have an emulsion before spraying.
 - . Stuff is expensive. \$600+/32 oz.
 - . Might work on young weeds.

Organic Weed Control

” Soil pH/ elemental Sulfur

- . Long-term studies in 1992-1994 with multiple application of elemental sulfur (~200 #/ac/ application) to reduce soil pH below where Lotus thrives.
- . See following figure.

Elemental sulfur for Lotus control



Level of weed coverage as a function of soil pH modification with sulfur treatments

Concerns with using soil sulfur

- “ Hydrogen sulfide generate if wet condition
 - . Toxic to cranberry roots
 - . Best timing to avoid H₂S
 - “ Low rates (100-200 lbs) elemental sulfur (organic label)
 - “ Frequent applications (4-6weeks) until ph drops
 - “ Wait until beds are well drained, avoid wet spots
- “ May take 1-2 years for weed control,
- “ both granular and spray S work
 - . Make sure the granular is readily dissolvable
 - . Spray S is fast acting and work well
- “ Likely to work best on upland weeds

Lotus Control with Sulfur 2015

“As with the earlier sulfur experiments conducted during the 90s we wanted to focus on lotus. This weed seems to do especially well on well-drained sandy bogs.

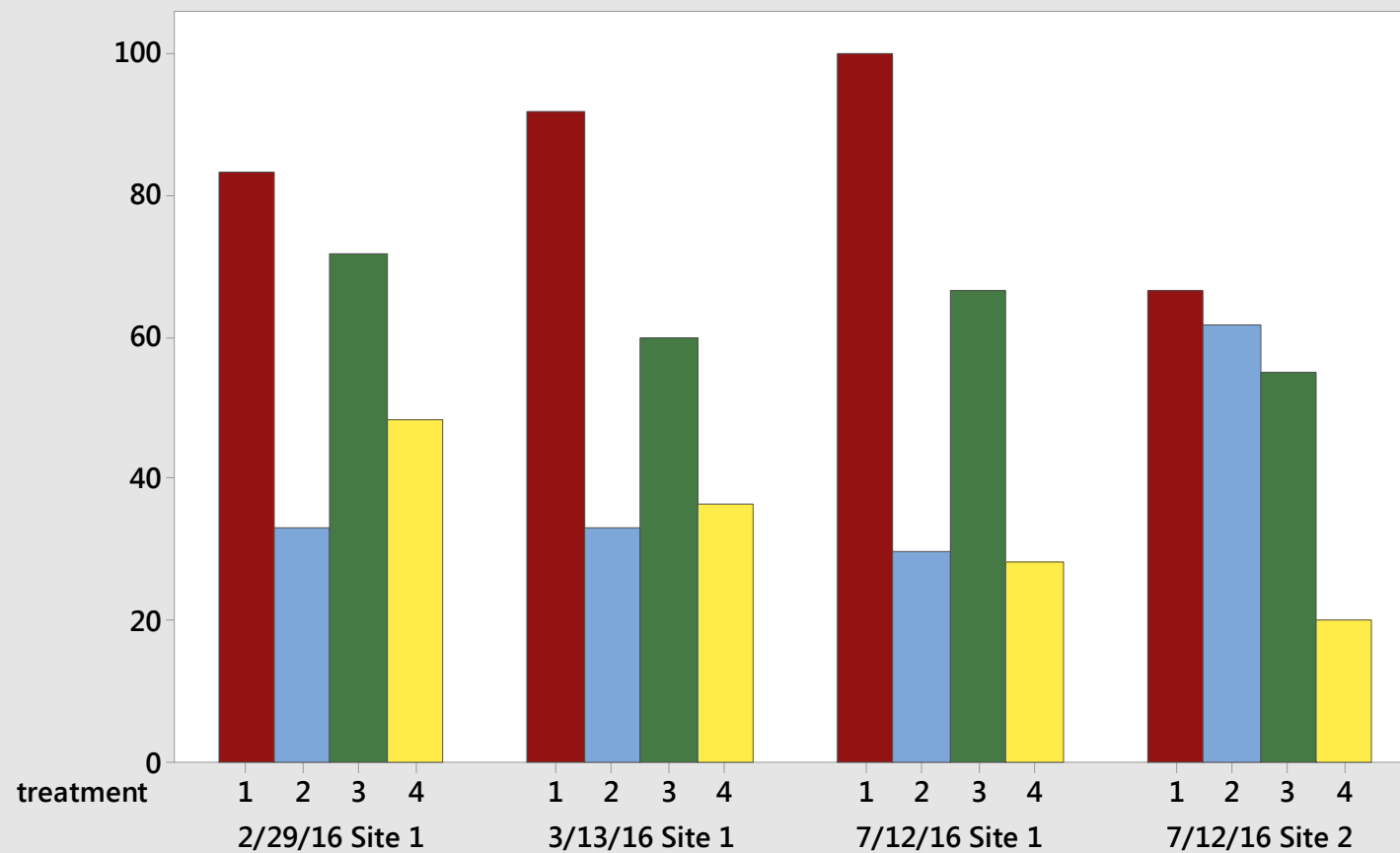
“We performed 2-3 applications from March through August to determine damage from high rates and timing.

“Treatments were made March, June, July; April, June, Aug; or April and June. All plots had a total of 750 lbs/acre per year.

Treatment	%cover Site 1 July 2016	%cover Site 2 July 2016
No Sulfur	100a	66.7a
Sulfur 3x March, June, July	30a	61.7a
Sulfur 3x April, June, August	66.7a	55a
Sulfur 2x April, June	28.3a	20.3a

*All applications were to add up to 750lb/a

% Lotus cover season following initial treatments



Treatment 1:
No sulfur

Treatment 2:
250lb/a March,
June, July

Treatment 3:
250lb/a April,
June, August

Treatment 4:
375lb/a April,
June

Summary . three years of vinegar experiment

- " Timing – late April**
- " Rate – 4 to 5% acetic acid**
- " Volume – 7500 gpa**
- " Washoff- 2500 gpa**
- " Inconsistent effects occurred on highly saturated and poorly drained peat or muck soils.**
- " Most consistent efficacy occurred on sandy well drained soils.**

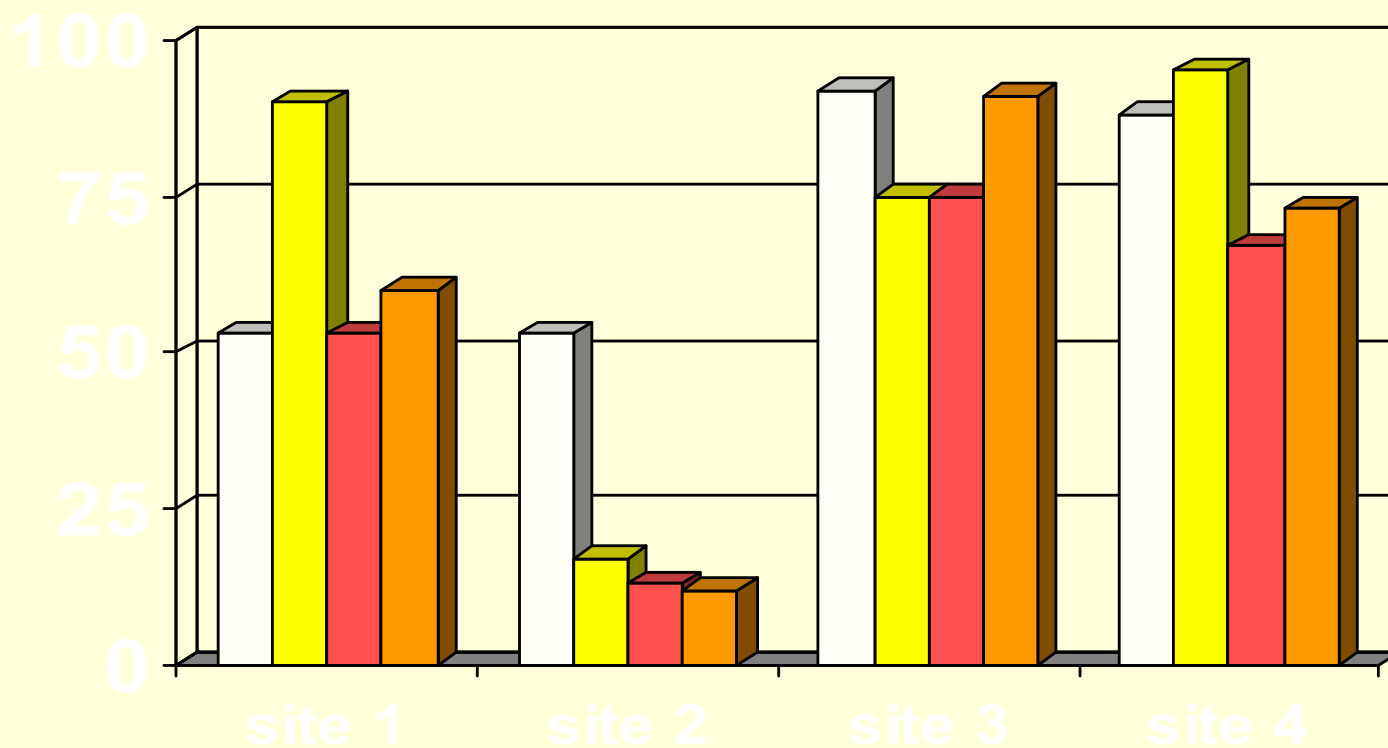
False lily-of-the-valley control and
cranberry vine damage

Best treatments of several experiments

Date of treatment	% Acetic acid	Application volume (gpa)	Washoff Volume (gpa x10 ³)	Lily (% control)	Vine damage rating*
3/25/04	3	8000	2500	97	2
3/23/05	4	5000	2500	89	2.1
4/20/05	4	6000	2500	97	3.3

2006 Treatments – 3,4 & 5 % acetic acid @ 7500 gpa; 5% @ 5000 gpa, all with 2500 gpa washoff (late March/early April).

% lily control - 2006



□ **5% 7500 gpa**

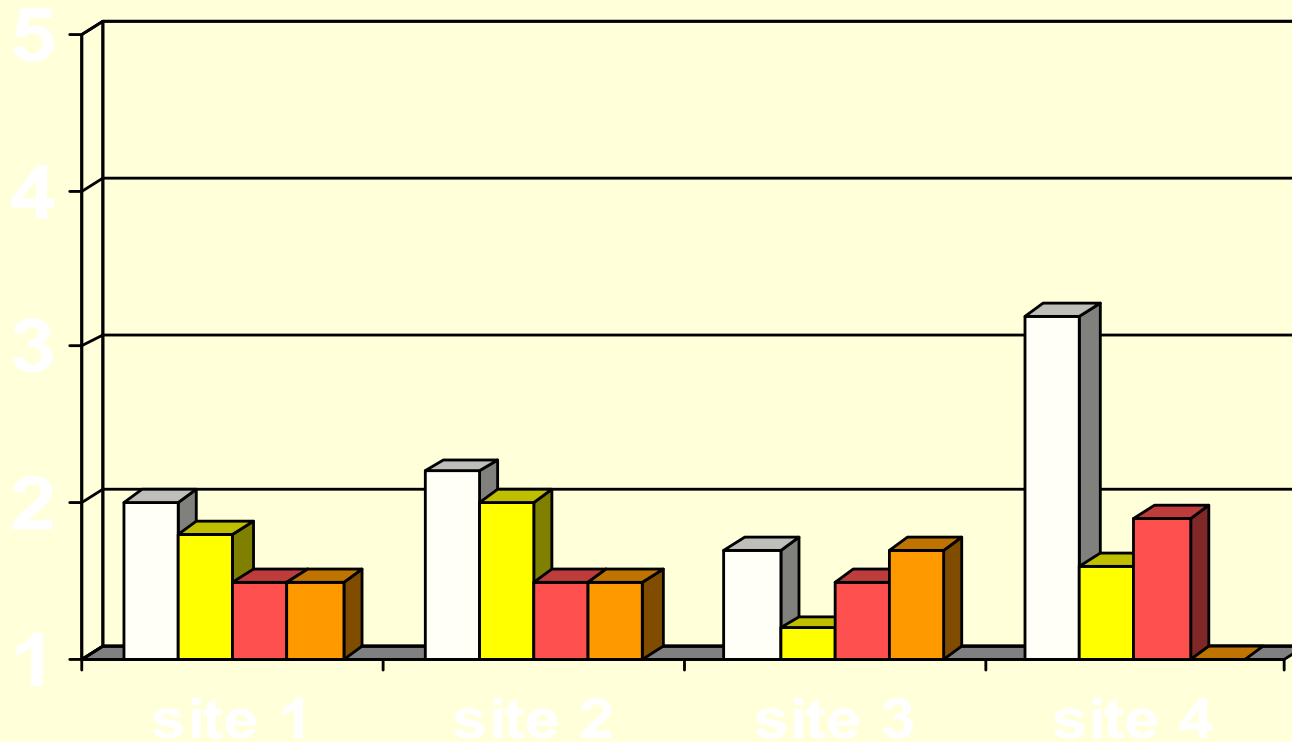
■ **4% 7500 gpa**

■ **3 % 7500 gpa**

■ **5% 5000 gpa**

Cranberry phytotoxicity rating

1- none, 5= dead



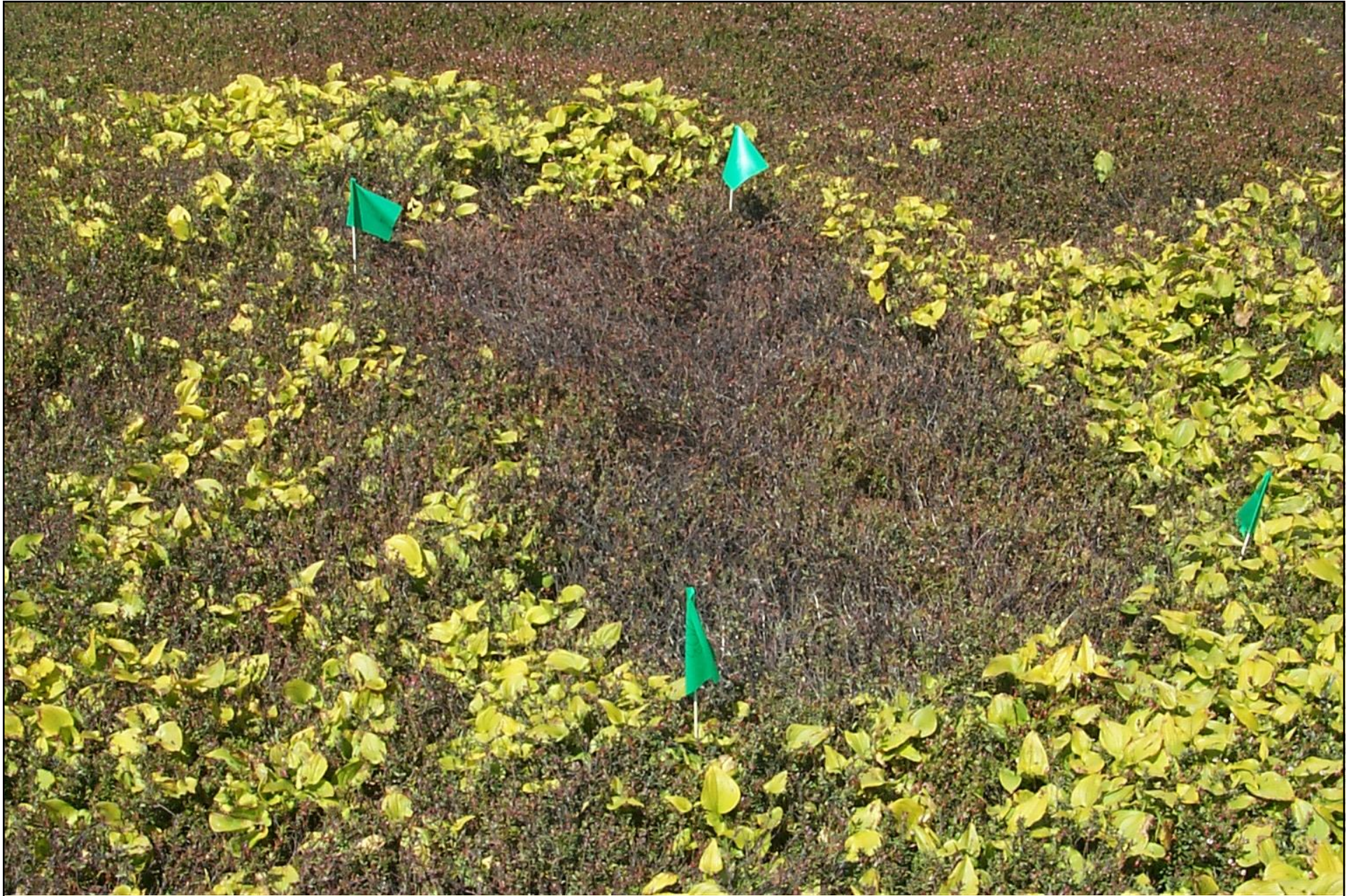
Acetic acid concentration

5% 7500 gpa

4% 7500 gpa

3 % 7500 gpa

5% 5000 gpa



Summary . three years of vinegar experiment on false lily of the valley

- ” Timing – late April**
- ” Rate – 4 to 5% acetic acid**
- ” Volume – 7500 gpa**
- ” Washoff- 2500 gpa**
- ” Inconsistent effects occurred are on
highly saturated & poorly drained peat or
muck soils.**
- ” Most consistent efficacy occurred on
sandy well drained soils.**

Vinegar control of other weeds

"Weeds that have been treated with vinegar (10% acetic acid):

"False lily of the valley

"Tussock

"Moss

"Silverleaf

"Buttercup

"Velvet grass

"Lotus

"Control is extremely variable. The most consistently susceptible weeds are false lily of the valley, moss, tussocks.

Vinegar contõ

“Timing, size of plant, duration of application greatly effect weed control.

“When treating plants basal applications (soaking the roots), works best.

“When treating large tussocks remove the nozzle if using a backpack sprayer.

“The addition of salt water (made with 1-2 cups/gallon rock salt) can enhance efficacy.

Moss Control

"On going research trials have demonstrated that vinegar has successfully suppressed moss, however regrowth always occurs and the spray volume necessary for effective application >1000gpa makes application difficult. Concentration depends on total volume applied. 3-10%. Higher concentrations for less volume.

"I have observed on many farms both conventional and organic that flooding the moss for at least a few days effectively burns it down. Moss turns black and breaks down. Will still regrow. If you have a low lying farm block your culverts in the winter occasionally to let the rain and high water table flood without pumping. Later in winter pump when necessary, only need to submerge the moss completely not the vines. Works well when timed with fireworm flood in early April if vines haven't begun new growth.

Other herbicide options

“Following our marginal success with Vinegar we began looking at other chemical options: GreenMatch (Limonene oil), compared to the 10% acetic acid (200 grain vinegar at 50%), Manuka oil in 2014.

“GreenMatch® is no longer available data may be relatable to using Avenger® (same active ingredient d-limonene oil).

“Manuka oil is very cost prohibitive and is a weak herbicide

“Suppress Herbicide (working on in 2017)

Weed burndown (1= none, 5= toast)

Treatment	Sourgrass 5 DAT	Moss 5 DAT
No spray	1 b	1 b
GreenMatch 15%	5 a	5 a
Vinegar 10% acetic acid	5 a	5 a
Manuka Oil 8 oz/a	1 b	1 b

Vine burndown (1= none, 5= toast)

Treatment	2 WAT
No spray	1 c
GreenMatch 15%	3.7 a
Vinegar 10% acetic acid	2 b
Manuka Oil 8 oz/a	1.3 bc

Burndown rating applied on Pilgrims vines at bud swell early April at 100 gpa

Treatment	Sourgrass 2 WAT	Lotus 2 WAT (not in every plot)	Cranberry vine damage 2 WAT	Cranberry % blooming uprights 2 MAT	Pilgrims Yield (g)/ft2 September 2014
Not treated	1 b	1	1 a	81.7 a	91.63 a
GreenMatch 5%	4 a	3	1 a	4 b	13.2 b
GreenMatch 10%	5 a	4	1 a	1 b	4.95 c
Vinegar 5%	5 a	2	1 a	81.7 a	91.33 a
Vinegar 10%	5 a		1 a	80 a	106.3 a

Suppress Herbicide 2017

"Made from Caprylic Acid (47%) and Capric Acid (32%).

"Shows excellent burndown control of winter present weeds and grasses such as Velvet grass and moss.

"Rates above 3% do tend to burn vines so be careful. 3% may also burn vines so be careful.



Other Options For Weed Control

“Using a propane torch to burn weeds. Tussocks respond well to burning the crown, but it must be cut low to be effective.

“Weed wack a lot. Possibly build a weed mower. (Currently working on one that will mount a mower deck under my vicin).

“Use of rock salt on crowns of tussocks, may also reduce vigorous vine growth.

Organic Fungicide Research

“Several methods have been found useful: Flooding the bog for prolonged periods in February (2-3 weeks), sound irrigation management (allowing canopy to dry during the day), chemical

“We have tested several products over the years for both twig blight and fruit rot control.

“Serenade, Oxidate, Double Nickel LC, Trilogy, Regalia

2015 3 Week Bog Flood



Covered approximately 4.5 acres for 2-3 weeks.

This was a three week flood with the vines completely submerged for approximately 2 weeks with areas having a full 3 weeks submerged. From Feb 1-Feb 21.





"Flooding the bog resulted in many of the green winter present weeds such as buttercup greatly diminishing in vigor and wilting. All these grew back.

"Strange algae formed on the vines that remained submerged the most (difficult to keep the water that deep for 3 weeks).

"Yield that fall was similar to the previous year.

"This area had approx 20% of the vines with heavy infestation of twig blight. Following the flood twig blight symptoms were absent. **TWIG BLIGHT WAS ERRADICATED.**

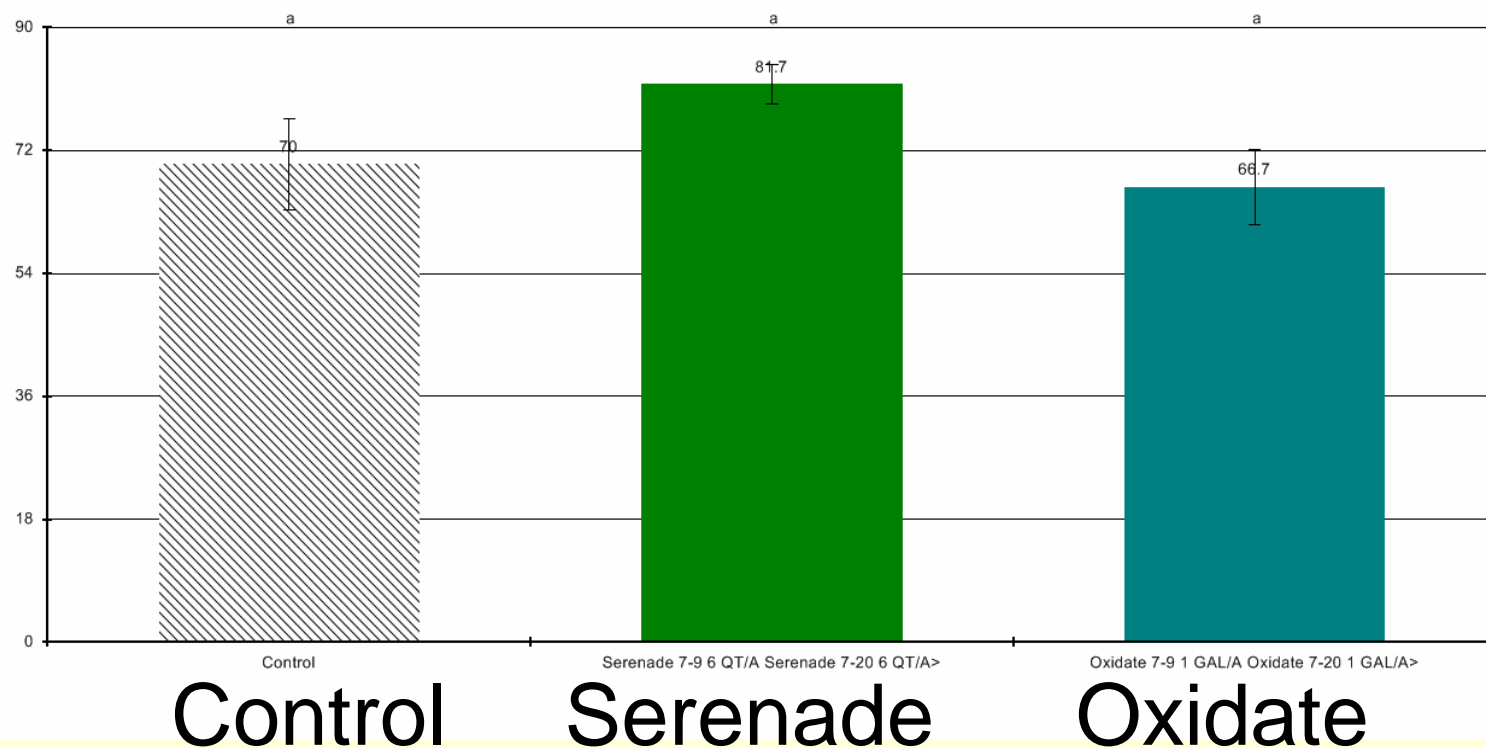
"Twig blight was still present in adjoining bogs that were not flooded.



Chemical Control of Twig Blight

“In 2012 we tested Serenade and Oxidate for twig blight control. 3 applications applied weekly beginning in early July. This was done in an area with 100% twig blight infestation. All vines with in the plot area exhibited complete twig blight infestation the april prior to treatment.

Twig Blight % blighted uprights spring following application 2013



Twig Blight contõ

“Several plots were treated in 2014 and in 2015. However our 2014 plots were within the 3 week flooded bog, which exhibited no significant twig blight following the flood. Our 2015 plot was oversprayed by the grower chemigating Double Nickel LC at approx 0.5 gal/acre twice. Twig blight was largely nonexistent the following year.

“This farm had endemic twig blight for as long as the neighboring growers could remember, but 2 apps of Double Nickel LC the previous July appeared to bring it under control.

Twig Blight Conclusions

“Prolonged bog flooding works as a solution to cure endemic twig blight. No symptoms the spring following the February flood.

“Serenade and Oxidate appear to have no activity on twig blight.

“Double Nickel LC appears to control it exceedingly well with two well timed applications.

Fruit Rot With OMRI Products 2015

Treatment	Total weight (g) per ft ²	% rot at harvest	% rot 6wks storage
Untreated	207.28	29	12.7
Proline 5 oz + Abound 15.4 oz	301	21.8	17.4
Regalia 4 qt/a	320.3	17.8	11
Double Nickel LC 6 qt/a	306.5	25.6	12.3

*All treatments applied at 1200 gpa.

Black-Headed Fireworm Control

"We have worked with several organically approved products:

"**Entrust SC** -works very well, our gold standard at 10 oz/a

"**Pyganic 1.4 and 5** -works well, especially as a fast knockdown. Ideal to rotate with Entrust.

"**Dipel** -Little to no effect. May enhance efficacy of entrust allowing lower rates.

"**Agree BT** -Performs marginally better than dipel. May enhance efficacy of entrust.

"**Grandevo**-Despite promising data from Wisconsin we have found no control.

"**Venerate**-No control

"**Azera**-Shows promise, but expensive and marginal.

"**Neemix 4.5** -Shows promise, but expensive and marginal.

Experiment BHFW 2nd generation 2014

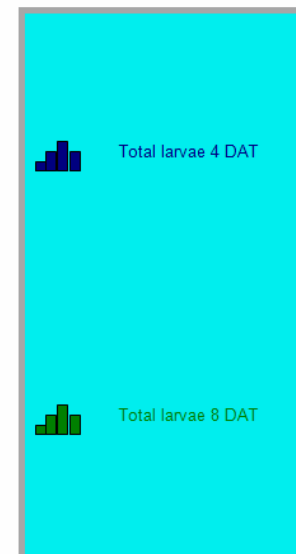
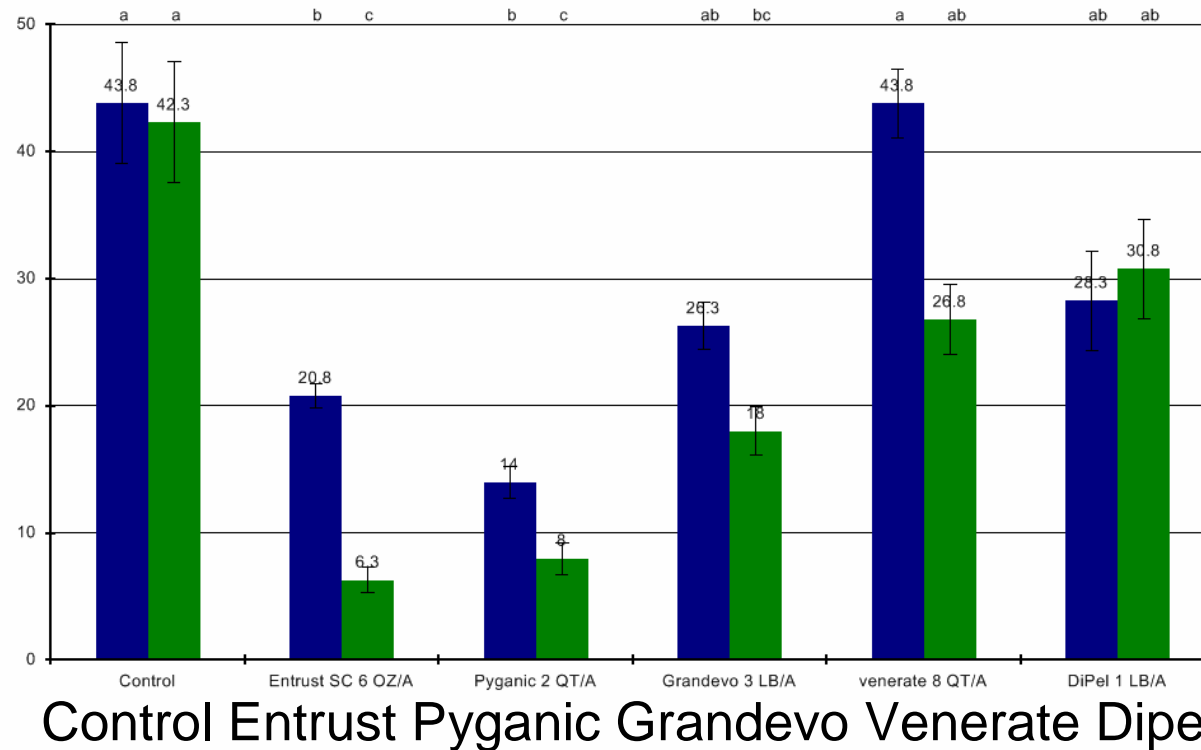
Treatment	% dead 4 DAT	Total larvae 8 DAT
Not Treated	0 b	42.3 a
Entrust SC 6 oz/a	55.2 a	6.3 c
Pyganic 1.4 EC 2 qt/a	55.7 a	8 c
Grandevo 3 lb/a	13 b	18 bc
Venerate 8 qt/a	5 b	26.8 ab
Dipel 1 lb/a	7.2 b	30.8 ab

***All samples were collected as number of larvae per 5 sweeps.**

***All treatments applied at 30 gpa spray volume.**

Experiment BHFW 2nd generation 2014

Organic sprays for fireworm efficacy in organic farms



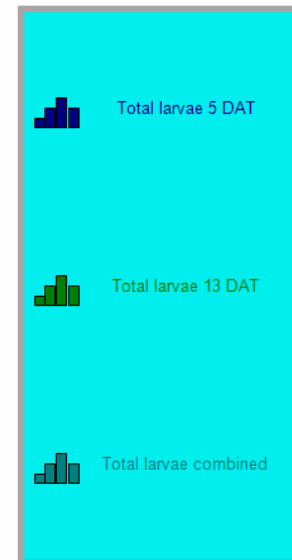
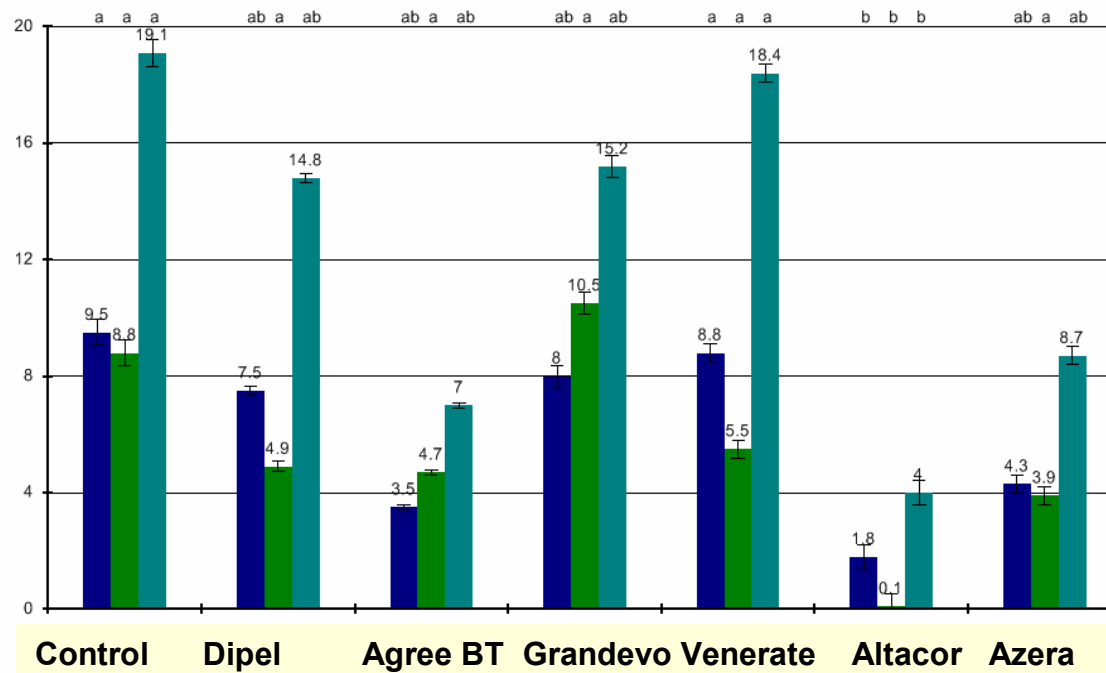
BHFW early season control 2015

Treatment applied 4/15 and 4/23/15	Total Larvae 5 DAT (after 1st treatment)	Total Larvae 14 DAT (after 1st treatment)	Total Combined Larve
Untreated	9.5 a	8.8 a	19.1 a
Dipel BT 2 lb/a	7.5 ab	4.9 a	14.8 ab
Agree BT 2 lb/a	3.5 ab	4.7 a	7.0 ab
Grandevo 3 lb/a	8 ab	10.5 a	15.2 ab
Venerate 8 qt/a	8.8 a	5.5 a	18.4 a
Altacor 4 oz/a	1.8 b	0.1 b	4 b
Azera 2 pt/a (applied 4/16)	4.3 ab	3.9 a	8.7 ab

*Treatments applied at 100 gpa spray volume.

BHFW early season control 2015

Early season BHFW control with soft chemistries



2 PT/A

BHFW Azera and Agree BT at Chemigation rates 1000 gpa

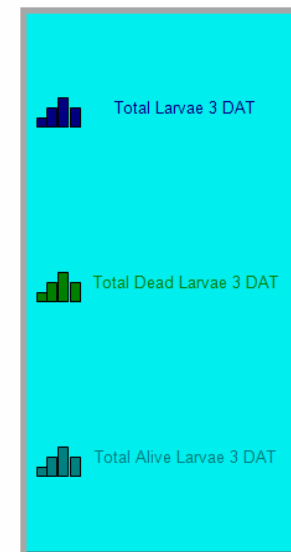
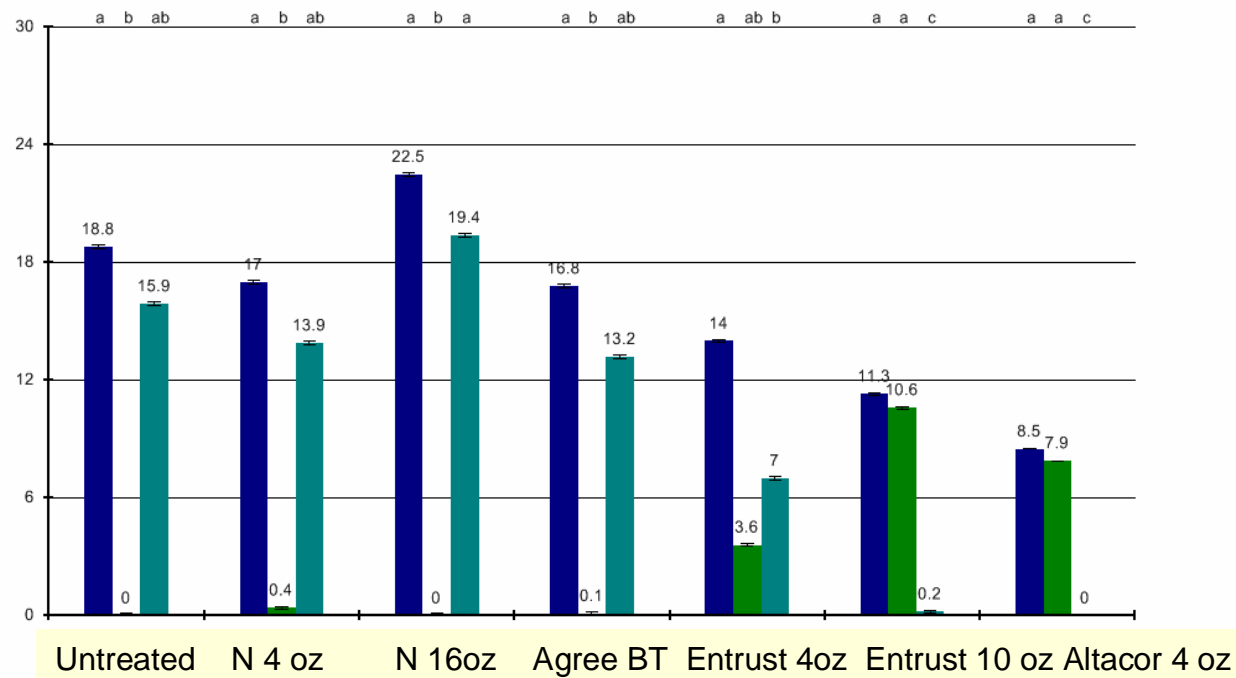
Treatment	Total Larvae 4 DAT	Total Dead Larvae 4 DAT
Untreated	9.5 a	0 a
Agree BT 2 lb/a	8.8 a	1.5 a
Azera 2 pt/a	2.5 b	0.1 a

1st Generation BHFw Control 2016

Treatment	Total Larvae 3 DAT	Total Dead Larvae 3 DAT	Total Alive Larvae 3 DAT	% Dead 3 DAT
Untreated	18.8 a	0 b	15.9 ab	0 c
Neemix 4 oz/a	17 a	0.4 b	13.9 ab	3.2 bc
Neemix 16 oz/a	22.5 a	0 b	19.4 a	0 c
Agree BT 2 lb/a	16.8 a	0.1 b	13.2 ab	0.8 c
Entrust 4 oz/a	14 a	3.6 ab	7 b	21 b
Entrust 10 oz/a	11.3 a	10.6 a	0.2 c	99.7 a
Altacor	8.5 a	7.9 a	0 c	100 a

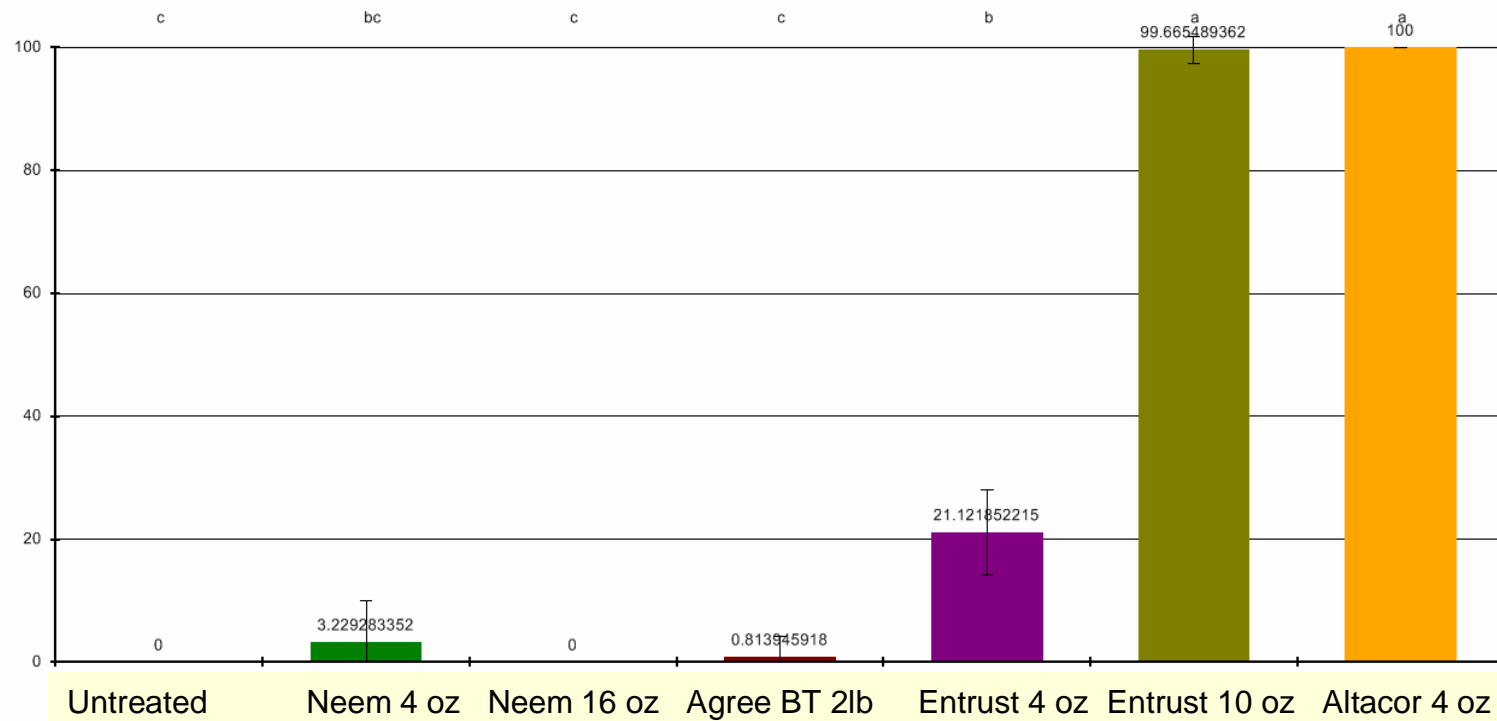
*All treatments applied at 950 gpa

BHFW control 1st generation



% Dead Larvae 3 DAT

BHFW control 1st generation



2nd Generation BHFW 2016

Treatment	Total Larvae 3 DAT	Total Alive Larvae 3 DAT	% Dead 3 DAT
Untreated	10 ab	10.3 a	1.3 b
Vestron + Agree BT	12 ab	12.5 a	11.1 b
Agree BT 1 lb/a	12 ab	12.8 a	26.4 b
Neemix 16 fl oz/a	12.5 a	11 a	11.7 b
Entrust 10 fl oz/a	2 b	0 b	12.9 b
Dipel Pro 2 lb/a	7.5 ab	6.3 ab	23.7 b
Entrust 5 oz + Dipel Pro 2 lb/a	7.8 ab	1 b	84 a

***All treatments applied at 30 gpa**

Tipworm Control

Treatment	Total TP larvae and pupae 6 DAT (single app)	Total TP larvae and pupae 6 DAT (second app)	% Tips damaged mid July	Estimated yield mid July
Untreated	6.1 a	18 a	76.8 a	58.8 a
Azera 2 pt/a	5.3 ab	10.5 a	73.2 a	56.3 a
Pyganic 2 qt/a	9.4 a	11.5 a	78.4 a	63.8 a

*Treated 2x at 750 gpa.

Insect Control Summary

"Entrust and Pyganic are still the best options for BHFV control. Use full rate of Entrust to achieve control.

"Pyganic may have some activity on tipworm and its our only option currently.

"We are continuing to work on ways to reduce entrust rates and still achieve optimal control by adding BT products such as Agree. As well as screening new products as they become available.

GreenFuture Light Trap



Operates at night using a uv bulb that attracts insects and electrocutes them. It is a self contained unit and is mobile.

We put one out last August and moved to several farms for a week or so at a time. We caught girdler, fireworm, tipworm, and a lot of cutworm moths. Supposed to cover 5 acres and cost approximately \$700.

