

## **Integrated Pest Management of Weevils 2019.**

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**Abstract:** In specific areas of Washington State alfalfa forage and alfalfa seed growers have raised concerns regarding the efficacy of specific organophosphate and pyrethroid insecticides that are applied for control of alfalfa weevil *Hypera postica* (Coleoptera: Curculionidae). In response we completed 2 in-field insecticide efficacy trials and a series of controlled laboratory bioassays with our Potter precision spray tower. In the field trials we observed greater weevil grub mortality following insecticide exposure at our University-based Roza site near Prosser, WA then we did at a grower cooperator site near Goldendale, WA. The Goldendale site had a history of multiple insecticide sprays over the past several years. The Prosser site had no history of insecticide applications. Weevil grub mortality was greater at the Roza site for the insecticides chlorantraniliprol, spinosad, cyantraniliprole, chlorpyrifos, indoxacarb, and lambda-cyhalothrin. Most notably, chlorpyrifos and lambda-cyhalothrin nearly eradicated weevil grubs on our Roza trial but only provided 75 and 70% control, respectively in Goldendale, indicating that the weevils in Goldendale are developing tolerance to these two insecticides.

Concurrently, we completed controlled laboratory insecticide bioassays on 6 weevil grub populations. Three populations were bioassayed from alfalfa forage fields near Goldendale, WA. Two populations were bioassayed from alfalfa forage fields near Touchet, WA and the population from our Roza field near Prosser was bioassayed too. There was a definite trend with lambda-cyhalothrin in that the weevil grubs from 3 Goldendale populations were more tolerant to exposure to lambda-cyhalothrin than the other 2 Touchet and Roza populations. At the maximum field rate concentration, we tested less than 50% of the weevils were killed from Goldendale. Mortality of weevils from the Roza field was 80% and mortality was 100% in weevils from both Touchet fields. With chlorpyrifos there was not a trend towards the Goldendale weevil populations being very different in their response to exposure to chlorpyrifos from the populations near Touchet.

**Introduction:** In specific areas of Washington State alfalfa forage and alfalfa seed growers have raised concerns regarding the efficacy of specific organophosphate and pyrethroid insecticides that are applied for control of alfalfa weevil *Hypera postica* (Coleoptera: Curculionidae). Most notably alfalfa forage growers near Goldendale Washington had reported field failures with the formulated pre-mix insecticide Cobalt™ in 2018. Cobalt is an insecticide marketed by Corteva™ Agrisciences and is a mixture of the organophosphate insecticide chlorpyrifos (aka Lorsban Advanced™) and the synthetic pyrethroid lambda-cyhalothrin (aka Warrior™). Field failures were not unique to a single grower. In response we submitted a small grant request to the

National Alfalfa and Forage Alliance check-off program for research funding. This request for funding was in-turn leveraged with another request for funding from the Washington State Commission on Pesticide Registration.

### **Materials and Methods: Field Efficacy Trials**

In late spring we completed 2 insecticide efficacy field. One insecticide trial was completed near Goldendale, WA and the other was completed near on the Roza unit of WSU IAREC near Prosser, WA. Candidate chemistries included in both field trials are detailed in Table 1.

Table 1. Insecticide treatments applied to plots near Goldendale, WA on June 5, 2019 and near Prosser, WA On June 6, 2019.

<u>Treatment</u>	<u>Active Ingredient</u>	<u>Rate/acre</u>
Lorsban Advanced	Chlorpyrifos	32 fluid oz
Steward EC	Indoxacarb	11.3 fluid oz
Warrior II w/ Zeon	Lambda-Cyhalothrin	1.92 fluid oz
Entrust SC	Spinosad	4.0 fluid oz
Coragen	Chlorantaniliprole	7.5 fluid oz
Exirel	Cyantraniliprole	20.5 fluid oz
Untreated Control	n/a	n/a

Each insecticide treatment was applied to 4 replicates that were 12' by 20' for a total of 240ft<sup>2</sup> per replicate. Insecticides were applied by CO<sub>2</sub> powered backpack sprayer in dilution at approximately 20 gallons per acre. The plots near Prosser, WA were sampled by sweepnet on June 5, June 6, and June 10, specifically 1, 2, and 6 days after treatment. The plots near Goldendale, WA were sampled on June 7, June 13, and June 20, specifically 1, 8, and 14 days after treatment. Each sample consisted of five 180° sweeps. Insect abundance was counted directly from these sweep net samples in the field. The alfalfa field on the Roza near Prosser, WA was in a field that is used for small plot insecticide efficacy work. It is surrounded by over 80 acres of alfalfa forage that is never sprayed with insecticides. We consider the *Lygus* from this site as our susceptible population due to no history of being sprayed with insecticides. The Goldendale site was a site that had been treated at least once and sometimes twice with Cobalt on each of the past several years. We did not include Cobalt as a treatment in the trial. Rather, we included Cobalt's two active ingredients, chlorpyrifos in Lorsban Advanced and lambda-cyhalothrin in Warrior II with Zeon.

### **Laboratory Bioassays:**

To quantify the dose response of alfalfa weevil populations in Washington State weevil larva were collected at 6 locations in Washington State and transported back to the Environmental and Agricultural Entomology Laboratory at WSU Prosser. These weevils were then subjected to dose response bioassay via our Potter precision spray tower. Larva populations were collected from sites including our Roza alfalfa field as detailed above, 3 alfalfa forage fields in Goldendale and 2 alfalfa forage fields near Touchet. The 4 insecticides tested included the registered products Warrior (lambda-cyhalothrin), Lorsban Advanced (chlorpyrifos), Steward (indoxarb), and the experimental unregistered insecticide Exirel (cyantraniliprole). Serial dilutions were completed for each insecticide with the maximum field rate in a dilution equivalent to 20 gallons per acre.

Subsequent dilutions were made at 75%, 50%, 25%, 10%, 5%, and 0% of the maximum field rate again diluted in the equivalent of 20 gallons of water per acre. Each treatment was applied to 4 replicates of 5 weevil grubs in a Petri dish with a filter paper bottom in 2 ml of solution in our Potter precision spray tower. The weevil larva were evaluated at 24 and 48 hr after treatment for mortality and survivorship. Subsequently our data evaluations were completed on the weevil mortality after 48 hr of exposure. Weevil larva were considered dead when they failed to respond to being touched with a fine camel hair brush.

### Project Objectives and Corresponding Results

Objective 1. *Test selected field collected populations of alfalfa weevil from a representative sample of alfalfa seed fields and compare their dose response curves to insecticide naïve populations from alfalfa forage fields on the WSU IAREC campus.*

Result: There was a definite trend with Warrior (lambda-cyhalothrin) in that the weevil larva from Goldendale appeared to be more tolerant to exposure to Warrior than the other 3 populations tested (Figure 2.). At the maximum field rate concentration, we tested less than 50% of the weevils were killed. Mortality at the Roza field was 80% and mortality was 100% at both Touchet fields. With Lorsban Advanced (chlorpyrifos) there was not a trend towards the Goldendale weevil populations being very different in their response to exposure to chlorpyrifos from the populations near Touchet.

Objective 2. *Conduct insecticide efficacy trials for weevil control in a commercial forage alfalfa field near Goldendale, WA and in a WSU-managed field near Prosser, WA.*

Result: The weevil population from Goldendale with a history of exposure to insecticides appears to be more tolerant to insecticides than our susceptible population from the Roza site.

Objective 3. *Disseminate educational outreach materials to alfalfa seed and forage alfalfa growers and other stakeholders.*

We are accomplishing this by submitting this report. This information will also be presented at the Washington State Hay Growers Association meeting in December in Kennewick, WA and at the Western Alfalfa Seed Growers meeting in Las Vegas, NV in January.

### Results and Discussion: Insecticide Efficacy Trials

The results of our insecticide efficacy trials are displayed graphically below in figures 1 and 2.

Figure 1. Alfalfa Weevil Grubs per Five 180° Sweeps ± Standard Error on WSU Roza Alfalfa Field

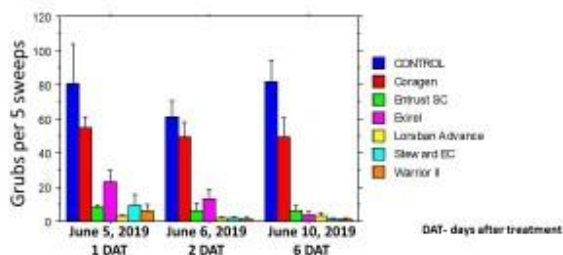
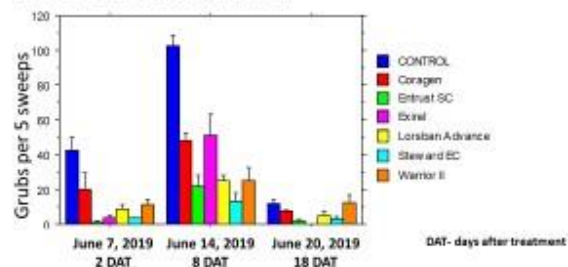


Figure 2. Alfalfa Weevil Grubs per Five 180° Sweeps ± Standard Error on Goldendale Alfalfa Field



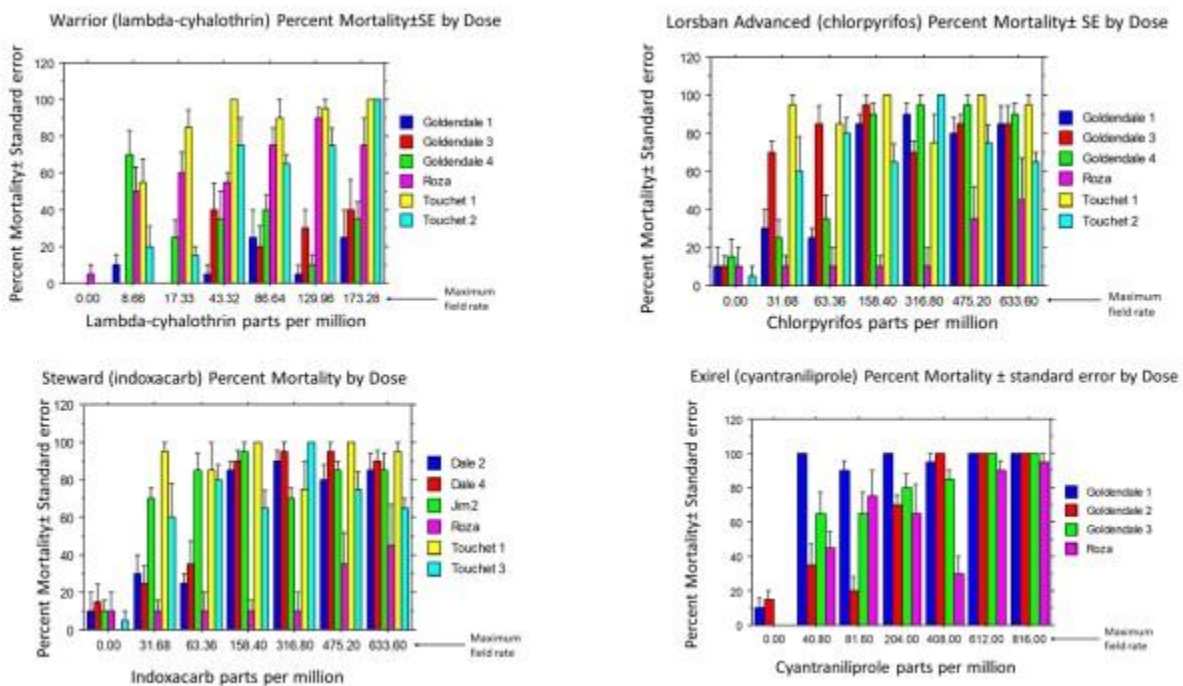
From these data we calculated percent control provided by each insecticide compared to the non-treated control at 6 days after treatment at the Roza site and 8 days after treatment at the Goldendale site (Table 1).

As a rule it appears that our results were close to what we predicted. The weevil population from Goldendale with a history of exposure to insecticides appears to be more tolerant to insecticides than our susceptible population from the Roza site.

Coragen is an insecticide that targets mainly caterpillars. Hence we see relatively low mortality in weevils at both sites. Entrust targets caterpillars, thrips, and vinegar flies. Entrust is organically certified by the USDA and WSDA. Exirel is not registered for use on alfalfa. Exirel controls a wide range of insect pests including weevils on crops it is registered on. We were testing it for efficacy. Lorsban Advance has been a mainstay insecticide for weevil control for decades. On the Roza Lorsban Advanced nearly eradicated the weevil population. In Goldendale control was only 75%. Steward is a recommended insecticide. It was the superior insecticide in these trials, specifically in Goldendale. Entrust is an organically certified insecticide Entrust provided acceptable control of weevils and could be used in rotation with other insecticides. The control provided by Warrior II with Zeon at the Goldendale site is concerning. We do think that tolerance is becoming a problem with the weevil populations in Goldendale. This is reinforced in our lab bioassays which will be described below.

### Laboratory Bioassays:

Figure 2. Percent mortality of alfalfa weevil larva from 6 populations 48 hrs after exposure to Warrior, Lorsban Advanced, Steward and to 4 populations following exposure to Exirel.



There was a definite trend with Warrior (lambda-cyhalothrin) in that the weevil larva from Goldendale appeared to be more tolerant to exposure to Warrior than the other 3 populations tested (Figure 2.). At the maximum field rate concentration, we tested less than 50% of the weevils were killed. Mortality at the Roza field was 80% and mortality was 100% at both Touchet fields. With Lorsban Advanced (chlorpyrifos) there was not a trend towards the Goldendale weevil populations being very different in their response to exposure to chlorpyrifos from the populations near Touchet. What stands out is the response exhibited by the Roza

population. The Roza is in proximity to wine grape vineyards and tree fruit orchards that could be spraying Lorsban Advanced in delayed dormant season applications. A similar response was also exhibited by the Roza weevil population compared to all the other populations in their response to exposure to Steward. At present we have no explanation for why the Roza population has greater tolerance to both Lorsban Advanced and Steward compared to all the other populations. We were unable to collect enough weevil larva from the fields in Touchet to complete bioassays on the weevil populations to the non registered experimental insecticide Exirel. However, all the weevil populations from Goldendale and the Roza weevil population appear to be susceptible to the insecticide Exirel.

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**Key Words:** alfalfa weevil, insecticide resistance, pyrethroid insecticides