Management of Insecticide Resistance in Alfalfa Weevil

for the Intermountain West: Montana, Utah, and Wyoming


Joseph Berger, Bugwood.org

Resistance to pyrethroid insecticides has been identified in alfalfa weevil populations in Montana and Wyoming, with suspected insecticide resistance situations in Utah. Indication of resistance is determined when economically damaging levels of the pest survive after labeled rates of an insecticide are properly applied. The worst-case scenario of resistance is that producers suffer huge losses to alfalfa hay quantity and quality due to weevil feeding combined with the cost of an ineffective insecticide application.

The best strategy for delaying and combating resistance is integrated pest management, which relies on a solid pest monitoring program. Monitoring weevil populations before and after insecticide treatment is the only way producers can identify possible resistance in fields. The current management recommendations for delaying resistance or combating known resistance in alfalfa weevil populations are to rotate insecticide modes of action, apply insecticide applications at the highest labeled rate, and take early harvest when possible.

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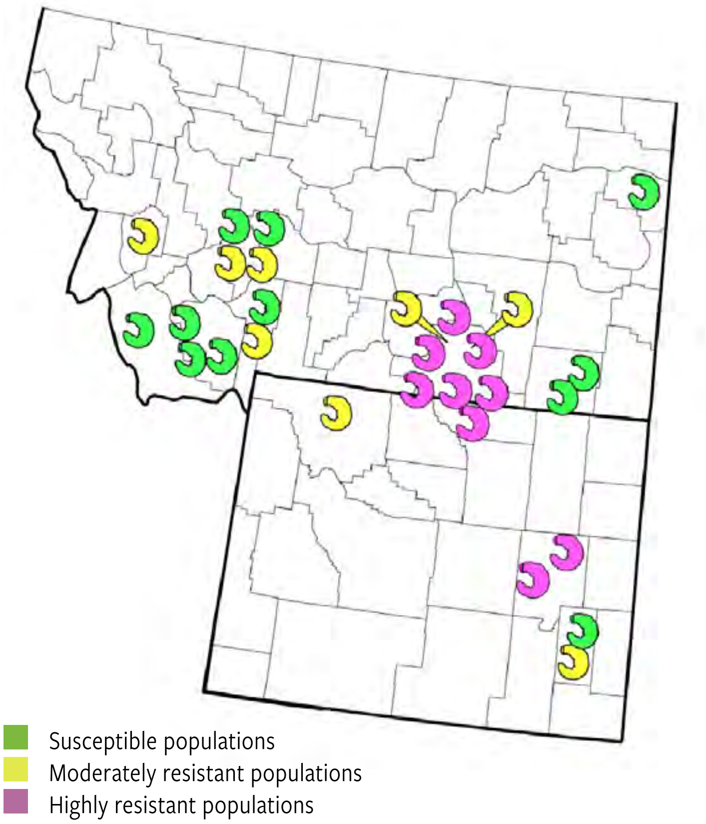

Figure 1. Three levels of insecticide resistance identified in alfalfa weevil populations in Montana and Wyoming.

WHAT IS RESISTANCE AND WHERE IS IT?

Resistance is genetically inherited and develops by the selective pressure of a consistently used control method, in this case with insecticides. Repeated applications of insecticides with the same mode of action continually selects for resistance to that type of insecticide in an alfalfa weevil population.

The map displays sampling efforts in Montana and Wyoming, and the laboratory results indicating resistance levels tested against three modes of action of insecticides. Resistance to pyrethroid insecticides have been identified in alfalfa weevil populations in Montana and Wyoming (Figure 1). Researchers suspect that there are also cases of insecticide resistance in Utah.

Susceptible populations are controlled with insecticides at application rates less than the minimum recommendation rate. Moderately resistant populations are susceptible to insecticides between the minimum application rate and 10 times the minimum application rate. Highly resistant populations are susceptible to insecticide application rates that exceed 10 times the minimum rate.

The moderately and highly resistant populations can be resistant to application rates that exceed legal limits. Montana State University's research has shown that there are populations where 30 times the minimum rate of commonly used Type II pyrethroids has minimal to no control on some alfalfa weevil populations. Once a highly resistant population has developed, there is almost no amount of that insecticide that can be applied to provide effective control.

INSECTICIDE RESISTANCE MANAGEMENT

Insecticide resistance is a very complex issue that exists in isolated areas or at a landscape scale because of the mobility of alfalfa weevil adults and other influencing factors. Resistance can be found in a valley or areas of concentrated alfalfa production; even fields that are not sprayed, like organic fields, become resistant because of the surrounding landscape.

Insecticide resistance is accelerated by the continual use of insecticides that have the same mode of action (MoA). A mode of action is the pathway or process by which an insecticide affects the insect and is identified with a numbering system on the front of the label (Figure 2). For more information and a searchable database to identify insecticide active ingredients and their respective MoA, please refer to the IRAC Mode of Action mobile phone app at irac-online.org/latest-resources.

The best approach to delaying insecticide resistance or combating known resistance is utilizing integrated pest

Figure 2. Example of insecticide label — the red arrow indicates the Mode of Action, Group 3.

management, which is the use of all suitable pest control methods to keep pest populations below the economic injury level. This includes selective use and rotation of chemical control methods. Unfortunately, with the removal of chlorpyrifos-based insecticides, there are only two main modes of action (pyrethroids 3A and indoxacarb 22A) labeled for alfalfa weevil control that are considered consistently effective. Refer to Table 2 for a list of insecticides labeled for alfalfa weevil.

Be aware that there are subclasses within modes of action. For example, the MoA 3A can be divided into non-ester, Type I, and Type II pyrethroids. Type I pyrethroids are an older chemistry than Type II; Type II pyrethroids include many of the most common insecticides labeled for alfalfa weevil management.

Just changing the brand name or active ingredient of insecticides does not necessarily rotate the mode of action. For example, Mustang Maxx® and Respect EC® are different brand names of insecticide but are the same MoA (Group 3A) and contain the same active ingredient, zeta-cypermethrin. Warrior® II and Mustang Maxx® are another example: these insecticides are the same MoA (Group 3A) but have different active ingredients.

Current management recommendations for delaying resistance or combating known resistance are to rotate insecticide MoA annually, apply effective insecticide applications at the highest labeled rate, and take early harvest when possible. A management scenario for alfalfa weevil populations that have not developed insecticide resistance could be first year indoxacarb, second year early harvest, third year pyrethroid.

All insecticide applications should be administered only when economic thresholds are exceeded. If thresholds are not met, harvest without an insecticide application is encouraged. Producers must rotate in the more expensive insecticides, or those with less familiar labels, like indoxacarb, if they hope to avoid building resistance to the less costly older insecticides like pyrethroids.

Once resistance has developed, management options are extremely limited. In the case of pyrethroid resistance, the only control options are indoxacarb and early harvest. In this situation, control must rely on early harvest as much as possible so as to not overuse indoxacarb. If indoxacarb is overused, resistance can and will develop to that chemistry, leaving no chemical options available for future treatments.


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Alfalfa weevil (*Hypera postica*) larvae.

Combating known insecticide resistances requires not using that MoA for several years to allow surviving susceptible alfalfa weevil descendants to increase in the population. The current hypothesis is that a minimum of 5 years or more is needed before use of the insecticide could be attempted again.

Tank mixing, with herbicides or other insecticides, is not recommended. Timings of herbicide applications typically do not coincide with weevil control timings; therefore, it is a waste of effort and money to mix an insecticide in the tank for weevil control. Tank mixing with other insecticides is not recommended because of the limited chemical options that are available. According to the Insecticide Resistance Action Committee, tank mixing will most likely maintain or accelerate resistance in the local population.

In addition to chemical control options, early harvest of the first cutting can be effective in some situations. Early harvest for alfalfa forages means cutting between bud break to 10% bloom. The majority of alfalfa weevil larvae mortality occurs because of food loss and not from physical crushing. Hot, dry conditions allow for a rapid dry-down of the crop, efficient harvest and baling, and removal of the hay that creates the greatest food depletion and larvae mortality. Conversely, wet, cool conditions keep the windrows moist enough and long enough that the weevil larvae that survived the swather's conditioner can crawl down to the alfalfa regrowth and damage it while completing their development.

The effectiveness of early harvest is a timing issue, which is not always in the producer's control. If the early harvest or harvest without an insecticide application approach is taken, watch the regrowth of second cutting for activity of alfalfa weevil larvae, which can impact second cutting's yield as well. If 2 or more larvae per crown or densities of 4 to 8 larvae per square foot are found, then a fast-acting insecticide with contact activity should be selected for post-harvest treatment.

MONITORING

Monitoring is the key to a successful integrated pest management program and is important to maintaining susceptible alfalfa weevil populations. At a minimum, alfalfa weevil monitoring should happen at 10 inches of growth and again at bud stage to determine population levels and if control measures are warranted. The two methods used to monitor alfalfa weevil populations are sweep netting and the bucket method.

Sweep Net Sampling

Use a 15-inch diameter heavy-duty net to sweep across the top of alfalfa when it is at least 10 inches tall. One full sweep is a 180° arc that travels from one side of the sweeper's body to the other. Use a series of consecutive sweeps (10 sweeps per site) from multiple areas of the field. Calculate the average number of larvae per sweep by dividing the total larvae collected by the total number of sweeps.

Table 1. Use stem count samples to determine when action is necessary.

Average # larvae per stem	Stem height	Action
Less than 1	>10 in.	Sample again in 7 days
Less than 2	>10 in.	Sample again in 3–5 days
Greater than 2	10–14 in.	Control warranted
Greater than 2.5	15–18 in.	Control warranted
Greater than 3	>18 in.	Control warranted

As a rule of thumb, populations that equal 15 to 20 larvae per sweep should be continually monitored and considered for control measures. Considerations should include the potential yield loss, price of hay, cost of insecticide application, duration to harvest, ability to time insecticide application, and other factors. Check with your local extension office for specific scouting and threshold recommendations best suited to your production system and area.

Sweeping is particularly effective for late-stage larvae because younger larvae are not as easily dislodged from the whorl of the leaves. As a result, fields that are swept early in larval development will inaccurately indicate low weevil populations.

Bucket Method

Gently cut randomly selected stems at ground level from alfalfa that is at least 10 inches tall. Invert stems into a 5-gallon bucket and shake stems vigorously into the bucket to dislodge larvae. Collect stems from multiple sites (at least 10 stems per location) within the field while recording the number of stems and larvae from each site. Determine the larvae per stem ratio by dividing the total number of larvae collected by the number of stems sampled. Refer to Table 1 for management recommendations.

Follow-up monitoring should be conducted a week to 10 days after every insecticide application and after first harvest to determine the efficacy of control measures and identify potential insecticide resistance. If high levels of alfalfa weevil populations survive insecticide applications and application error can be ruled out, then insecticide resistance is possible. If 2 or more larvae per crown or 4 to 8 larvae per square foot are detected in the stubble regrowth, then an insecticide application is recommended to protect second cutting yield.

For more information on alfalfa weevil monitoring, life cycles, and general management, please see Additional Resources, page 6.

Table 2. Common foliar insecticides labeled for alfalfa weevil larvae as of 2022. Insecticides are listed alphabetically by active ingredient with a non-exhaustive list of products containing them that are labeled for usage on forage alfalfa. Product labels and registration can change, so make sure to read them before purchase or application.

Active ingredient and some example products labeled for forage alfalfa	Mode of action #	Pre-harvest interval	Field re-entry interval
Alpha-cypermethrin (Fastact, Fastac EC)	3A, Type II	3 days	12 hours
Beta-cyfluthrin (Baythroid XL, Sultrus)	3A, Type II	7 days	12 hours
Carbaryl (Carbaryl 4L, Sevin 4F, Sevin XLR Plus) *Note: Carbaryl can cause young leaves to bleach and has low efficacy on aphids.*	1A	7 days (*Do not use this product in water with pH values above 8.0 unless a buffer is added.*)	12 hours
Cyfluthrin (Tombstone, Tombstone Helios)	3A, Type II	7 days	12 hours
Dimethoate (Cheminova Dimethoate 4E, Dimate 4E, Dimethoate 2.67, Dimethoate 4EC, Dimethoate 400, Dimethoate 400 EC, Dimethoate LV-4)	1B	10 days	48 hours
Indoxacarb (Steward 1.5 SC)	22A	7 days	12 hours
Gamma-cyhalothrin (Declare, Proaxis, Proaxis-Insecticide)	3A, Type II	1 days	24 hours
Malathion (Cheminova Malathion 57%, Fyfanon ULV-AG*, Malathion 5, Malathion 8 Aquamul, Malathion 57 EC, Malathion ULV Concentrate)	1B	0 days	12 hours
Methomyl (Lannate LV, Lannate SP, Nudrin LV, Nudrin SP) *Signal words on label: DANGER–POISON. Toxic to fish and wildlife.*	1A	7 days	48 hours
Permethrin (Ambush, Artic 3.2 EC, Perm-Up 2.3EC, Perm-Up 25DF, PermaStar AG, Permethrin, Permethrin 3.2 EC, Permethrin 3.2 AG, Permethrin 3.2EC)	3A, Type I	14 days (> 4foz and ≤ 8foz)	12 hours
Phosmet (Imidan 2.5-EC, Imidan 70-W)	1B	7 days	5 days (120 hours)
Zeta-cypermethrin (Mustang, Mustang Max)	3A, Type II	3 days	12 hours
Organic Option			
Spinosad (Entrust SC) *OMRI listed suppression*	5	3 days	4 hours

ADDITIONAL RESOURCES

High Plains Integrated Pest Management Website, https://wiki.bugwood.org/HPIPM:Main_Page

University of Wyoming Publication B-983 Alfalfa Weevil Biology and Management

Utah State University Fact Sheet Alfalfa Weevil

Utah State University YouTube Video – How to Sweep Sample for Pests

Insecticide Resistance Action Committee (IRAC) website, https://irac-online.org/

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