OREGON DEPARTMENT OF AGRICULTURE

Insect Pest Prevention & Management Program
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Grasshopper and Mormon Cricket Outbreaks in Oregon

Frequently Asked Questions

For more information on this topic, please visit: https://oda.direct/IPPMGrasshoppersCrickets

GRASSHOPPERS ARE NATIVE TO OREGON. WHAT IS THE PROBLEM NOW?

In the summer of 2021 Oregon suffered its worst outbreaks of grasshoppers and Mormon Crickets in fifty years, with a record 10 million acres of rangeland in 18 counties suffering economically damaging levels of infestation. Grasshopper outbreaks often follow or coincide with drought years when low rainfall and warm spring weather create ideal conditions for egg hatches and survival of small grasshopper nymphs, allowing rapid development and reducing the impact of predators and diseases that normally limit grasshopper numbers. Grasshopper outbreaks are damaging to rangelands where excessive insect numbers result in lost forage and vegetation cover essential for livestock and wildlife. The loss of vegetation leads to environmental damage and erosion and may result in starving grasshoppers invading surrounding agricultural areas, resulting in costly crop loss.

WHY CONSIDER OUTBREAKS OF PEST GRASSHOPPERS AND MORMON CRICKETS TOGETHER?

Grasshoppers, crickets, and katydids are relatives. Together these insect families and others form the insect Order Orthoptera. Major agricultural pests in Oregon within the Orthoptera are several species of "short-horned grasshoppers" (the Family Acrididae) and the Mormon Cricket (a member of the Family Tettigoniidae). Pest grasshoppers and Mormon Crickets cause similar damage to rangeland and respond to similar suppression treatments.

WHICH GRASSHOPPER SPECIES ARE PESTS IN OREGON?

More than 100 species of Acridid grasshoppers have been recorded from localities in Oregon. Of these, no more than ten species in Oregon during the past five decades have been known to reach outbreak status and threaten crops and/or valuable range resources. The widespread grasshopper outbreaks of the mid-1980s were comprised primarily of "Spur-throated" grasshoppers in the subfamily Melanoplinae: Migratory Grasshopper (*Melanoplus sanguinipes*), Red-legged Grasshopper (*M. femurrubrum*), Two-striped Grasshopper (*M. bivittatus*), Packard's Grasshopper (*M. packardii*), and Striped Sand Grasshopper (*M. foedus*). Localized outbreaks in the 1990s and early 2000s were mainly Clear-winged Grasshopper (*Camnula pellucida*).

Outbreaks in 2019-2021 have included the economically damaging species Big-headed Grasshopper (*Aulocara elliotti*) and Valley Grasshopper (*Oedaleonotus enigma*) in addition to species of *Melanoplus* and *Camnula pellucida*.

Grasshopper and Mormon Cricket photos

WHAT IS A MORMON CRICKET?

The Mormon Cricket (*Anabrus simplex*) is actually a member of the "long-horned grasshopper" family, and not closely related to the singing field crickets and tree crickets. Mormon crickets and other large flightless shield-backed ground katydids in Oregon East of the Cascades periodically reach outbreak populations, during which they move out of intermountain habitats and into crop and rangeland. Outbreaks historically last for 5 to 21 years. Mormon crickets feed opportunistically on weeds, shrubs, or other insects. Mormon crickets migrate in bands, eating vegetation as they go, contributing to range damage, erosion, and hazards to roadways.

WERE ALL OF THESE PEST INSECTS AT OUTBREAK POPULATION LEVELS IN THE SAME AREAS IN 2021?

No. Each of the pest species has its own unique biology: egg-laying soil preferences, hatching time, developmental rate of nymphs, preferred forage plants and habitat.

The Clear-winged Grasshopper (*Camnula pellucida*) is a wide-spread severe pest species in Oregon. *C. pellucida* lays its eggs in egg-beds with suitable soil moisture in summer. Clear-winged grasshoppers were at outbreak population levels in multiple areas in Klamath, Harney and Malheur Counties in 2020 and 2021.

Outbreak populations of multiple species including Big-headed Grasshopper (*Aulocara elliotti*), Valley Grasshopper (*Oedaleonotus enigma*), Migratory Grasshopper (*Melanoplus sanguinipes*), and Two-striped Grasshopper (*Melanoplus bivittatus*), occurred throughout south-eastern Oregon in 2021.

Mormon cricket (*Anabrus simplex*) populations have been at outbreak levels in Gilliam County since 2017.

WHY IS EARLY SURVEY AND TREATMENT SO IMPORTANT IN SUPPRESSING GRASSHOPPER OUTBREAKS?

Grasshopper **nymphs** hatch from their eggs in spring as tiny wingless versions of grasshopper adults. Small nymphs are easier to control because they cannot move as far.

Grasshoppers must shed their exoskeletons to grow: the nymphal stages between shedding their skins are called **instars**. For most species, young nymphs grow rapidly, and an instar lasts only 3 to 5 days. Most grasshopper species go through 5 instars before maturing and developing wings.

For treatments to have effect on grasshopper populations, diflubenzuron must be applied while grasshoppers are in their early instars. Diflubenzuron disrupts the normal growth process of insects by inhibiting the production of chitin, which forms an insect's exoskeleton. Adult insects are not killed by diflubenzuron.

WHEN DO GRASSHOPPERS BECOME ACTIVE IN SPRINGTIME?

Most grasshoppers lay eggs in the fall that are protected underground over the winter.

Egg hatch in springtime is staggered across Eastern Oregon, and is affected by soil temperature and moisture, elevation, and grasshopper species composition. Egg hatch starts in early April in the lower elevations and can stretch out to mid-July at the Malheur Wildlife Refuge.

Grasshopper eggs underground over the winter are resistant to freezing but can be attacked by fungus and disease organisms in warm winters.

HOW DOES SPRING WEATHER AFFECT GRASSHOPPER POPULATIONS?

Warm spring weather with enough rain to support lush growth of host plants provide favorable conditions for grasshopper outbreaks. Egg-hatch is earlier, and growth of nymphs is faster at higher temperatures.

Dry conditions in the springtime favor grasshopper populations because fewer young nymphs die of natural causes.

HOW DOES SUMMER DROUGHT IMPACT GRASSHOPPER OUTBREAKS?

Summer drought encourages grasshoppers to move in search of forage. Grasshoppers on rangeland may move into pastures and irrigated crop land when population density becomes higher and host plants are consumed.

Some grasshopper species, like Clear-winged grasshopper (*Camnula pellucida*), may exhibit daily movements between feeding areas and egg-laying habitats.

Some species of grasshoppers make longer-distance flights of hundreds of individuals when population density in favorable habitats becomes high.

Mormon Crickets (*Anabrus simplex*) march in bands of migrating insects, eating vegetation as they go. Mormon Crickets can create hazards crossing roadways in numbers.

A warm, dry fall allows grasshoppers to continue feeding and to lay more eggs.

WHERE CAN I FIND MORE INFORMATION ABOUT PEST GRASSHOPPERS?

USDA Agricultural Research Service
Grasshoppers: their biology, identification and management

Suppression Treatments

HOW DO YOU TREAT A PROPERTY FOR GRASSHOPPERS OR MORMON CRICKETS?

Approved treatments for all pest grasshoppers and Mormon crickets are with the growth insecticide **diflubenzuron**. Diflubenzuron disrupts the normal growth process of insects by inhibiting the production of chitin, which forms an insect's exoskeleton. Grasshopper nymphs are not able to shed their exoskeletons normally as they molt to the next instar and die within 2 to 7 days.

WHAT MAKES DIFLUBENZURON THE PESTICIDE OF CHOICE FOR GRASSHOPPER SUPPRESSION TREATMENTS?

When used according to label directions, diflubenzuron is low-risk for people, pets, and livestock including honeybees. Unlike many other alternatives, diflubenzuron requires only a single application per season.

HOW IS THE TREATMENT APPLIED?

Aerial application is quick and efficient for treating rangeland. As an example, when using Dimilin®2L (active ingredient is diflubenzuron) we use a 50% coverage of 1 fl. oz. Dimilin®2L mixed with 20 fl. oz. water and 10 fl. oz. oil (crop oil concentrate or an alternative) per acre, for a total of 31 fl. oz. per *applied* acre. One (1) fl. oz. per acre is below the full rate listed on the label. The protected acreage is twice as much as the applied acreage because only 50% of the area is treated.

WHAT IS A RAAT?

RAAT stands for "reduced agent/area treatment." With this treatment insecticide is applied only every other pass, leaving treated swaths alternating with untreated land (the "reduced area" part). "Reduced agent" means that pesticides are applied at lower than label rates.
Read more about this treatment strategy here:
https://www.uwyo.edu/entomology/grasshoppers/raat/index.html
https://www.uwyo.edu/entomology/grasshoppers/raat/raats-results.html

HOW DOES A RAAT TAKE ADVANTAGE OF GRASSHOPPER BEHAVIOR TO REDUCE PESTICIDE IMPACT ON NON-TARGET INSECTS?

Grasshoppers are active and mobile insects. Grasshoppers present in the untreated swaths will move into the treated swaths and encounter the pesticide, while populations of beneficial insects like biological control agents are able to find refuge in the untreated swaths.

HOW DO I REQUEST TREATMENT FOR MY PROPERTY?

To be surveyed for grasshoppers, request must be made through the online grasshopper reporting form (https://oda.direct/GMCReport.) This form will be used to coordinate survey efforts this season and to process reimbursement for suppression efforts. Both private and public land managers will use this form to request grasshopper survey in the 2022 season.

WHEN WILL TREATMENTS OCCUR?

Nymph surveys begin when grasshoppers hatch (early April) and will continue until approximately July 4. Nymph surveys are conducted to assess grasshopper population levels for the current years' treatment.

Suppression treatments are conducted from May to August depending on area and species present. Mormon Crickets are earlier and some of the low elevation areas will be able to be treated in May.

Approximately two weeks after the suppression treatment another survey will take place to evaluate the effectiveness of treatment.

Surveys for adult grasshoppers will take place from July 5 to August 31. Adult grasshopper surveys are to create a grasshopper risk map for the following year.

WHY DOES ODA NEED TO SURVEY MY PROPERTY BEFORE TREATMENT?

ODA grasshopper nymph surveys measure the grasshopper population density.

"Grasshopper numbers are the key to economic damage levels. Fifteen to 20 grasshoppers per square yard, spread over a 40-acre field of alfalfa, will eat one ton of hay per day. Over the season, 10 to 20 grasshoppers per square yard in bluegrass pasture consume as much forage as one cow per acre. Seven grasshoppers per square yard over 10 acres of rangeland can eat the equivalent of one cow feeding throughout the season."

Reference: Grasshoppers in Washington, Extension Bulletin 1392. Daniel Suomi, Gary Thomasson, and Dave Keim. Revised January 1990. Cooperative Extension, College of Agriculture & Home Economics, Washington State University, Pullman.

The method our surveyors use to estimate grasshopper density depends on their ability to consistently estimate a square foot area 10-12 feet ahead of them in the field. As the surveyor approaches the visualized area, he/she estimates the number of grasshoppers jumping out of the square foot area (but not into it). Walking into the area flushes out any remaining nymphs or adults. This procedure is repeated 18 times throughout the sampling area by walking in a wide circle with a radius of 20 to 25 yards.

Once the total number of grasshoppers for all 18 square feet is calculated, that number is divided by 2 to obtain an estimate of the number of grasshoppers per square yard (9 square feet = 1 square yard).

The most accurate density estimates are made when the temperature is 60 to 950 F, the wind is less than 15 mph, and the vegetation is not wet.

WHAT IS THE "ECONOMIC THRESHOLD" FOR TREATMENT?

The economic threshold for treatment is the density of the grasshopper infestation at which the cost of damage from grasshopper feeding will be greater than the cost of treatment. The density that would almost certainly warrant treatment consideration in all regions of the West is 24 grasshoppers per square yard. Control is rarely justified at densities below 8 grasshoppers per square yard.

WILL THERE BE A FOLLOW-UP INSPECTION TO EVALUATE EFFECTIVENESS OF TREATMENTS?

Yes. Approximately two weeks after diflubenzuron application, ODA will conduct a second survey for grasshoppers to assess the effectiveness of the treatment. Inform ODA of treatment date as soon as possible to schedule a follow up on treatment efficacy.

Our goal is grasshopper population suppression, not eradication.

WILL MY PROPERTY REQUIRE MORE THAN ONE TREATMENT?

Probably not. A single RAAT treatment using an aerial application of diflubenzuron can achieve up to 85% control of grasshopper pests.

DO I NEED TO BE PRESENT DURING SURVEYS?

No, you can schedule a grasshopper survey by contacting ODA. Please make sure that your property is accessible to the surveyor. All applicable outside gates and entryways should be unlocked. ODA will contact you with the results of the survey and treatment information.

HOW DO I CONTACT A LICENSED AERIAL PESTICIDE APPLICATOR?

The ODA Pesticide Licensing database can be used to search for licensed applicators (for example, licensed aerial applicators). http://oda.direct/PestLicenseStatus

HOW DO I CONTACT ODA TO LET THEM KNOW MY TREATMENT HAS BEEN COMPLETED?

Contact ODA by phone or email as soon as possible after treatment to schedule a follow-up efficacy survey.

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HOW CAN I PARTICIPATE IN THE ONE-TIME COST SHARING PROGRAM FUNDED BY OREGON SB5561?

Find instructions on how to submit a report or request for survey online prior to submitting your application. https://oda.direct/IPPMGrasshoppersCrickets

Diflubenzuron Safety

WHAT IS THE PESTICIDE THAT THE ODA RECOMMENDS TO TREAT MY LAND?

The insecticide **diflubenzuron** is one of a class of insecticides that work by inhibiting normal insect development. As an example, the formulation Dimilin®2L is a liquid that can be applied at low volume aerially (there are other similar insecticides available). The formulation is a restricted use pesticide and must be applied by a certified pesticide applicator.

WILL IT HARM HUMANS, LIVESTOCK OR PETS, OR OTHER ANIMALS?

USDA-APHIS evaluated the potential human and animal health risks of diflubenzuron and determined that, when applied according to label directions, toxicity to vertebrates is low. This pesticide generally is of low toxicity to humans, other mammals, and birds. Diflubenzuron disrupts the normal growth process of insects by inhibiting the production of chitin, which forms an insect's exoskeleton.

- Diflubenzuron has low toxicity to pollinators, including honeybees.
- Diflubenzuron is a restricted use pesticide due to its toxicity to aquatic invertebrates. The USDA-APHIS also encourages applications below label rates to reduce risk to aquatic habitats.
- THE USDA evaluation of diflubenzuron: “Final Human Health and Ecological Risk Assessment for Diflubenzuron Rangeland Grasshopper and Mormon Cricket Suppression Applications” https://www.aphis.usda.gov/plant_health/ea/downloads/2019/diflubenzuron-hhera-final.pdf

DO ANIMALS/LIVESTOCK NEED TO BE MOVED BEFORE TREATMENT? AND IF SO, WHEN IS IT SAFE FOR GRAZING TO RESUME?

Diflubenzuron is labeled for grasshopper control in rangeland and in pastures and is also labeled for applications to other crops that may be harvested for forage or hay, such as alfalfa and cereal grains. Livestock need not be removed from rangeland but should be moved from pasture areas prior to application to avoid direct contact. Label directions must be followed if harvesting treated areas for forage; for example, allow at least one (1) day after treatment before cutting grass, one (1) day for alfalfa, and three (3) days for cereals such as triticale and wheat, etc.

IS DIFLUBENZURON SAFE FOR PLANT CROPS?

Diflubenzuron is "lipophilic", that is, it sticks to the waxy cuticle of plants, so that grasshoppers consume the pesticide as they eat. The pesticide is not taken up into plant tissues.

IS DIFLUBENZURON SAFE FOR HONEYBEES?

- Diflubenzuron is non-toxic to honeybee workers. In force-feeding experiments on bee brood, brood development is affected at higher rates of exposure.
- Diflubenzuron is mixed with water and crop oil (or an alternative) as an additive to help disperse the spray. Crop oils have no effect on honeybee development.
- Avoid spray contact with beehives. Beekeepers should dump and replace water in bee water buckets after diflubenzuron treatment. Treatments should be timed, if possible, to avoid contact with bees during bloom time, by spraying in the late afternoon or evening when bees are less active.
- Dimilin®2L and Bee Safely (UPL)
  https://www.oregon.gov/oda/programs/IPPM/SurveyTreatment/Documents/Dimilin%20and%20Bee%20Safety.pdf
- Dimilin®2L BMPs for Honeybee Safety on Almonds (UPL)
  https://www.oregon.gov/oda/programs/IPPM/SurveyTreatment/Documents/Dimilin%20BMPs%20for%20Honey%20Bee%20Safety%20on%20Almonds.pdf
- Dimilin®2L and honeybees
  https://www.researchgate.net/publication/230197315_The_toxicity_of_diflubenzuron_to_honey_bee_Apis_mellifera_L_colonies_in_apple_orchards
  https://link.springer.com/article/10.1007/s10646-005-0024-6

IS DIFLUBENZURON SAFE FOR NATIVE BEES?

In laboratory toxicity studies, diflubenzuron has no acute toxicity on worker bumblebees when ingested with pollen. However, there are effects on brood production of ground-nesting bees like bumblebees.

- Hazards and uptake of chitin synthesis inhibitors in bumblebees *Bombus terrestris*.
  https://onlinelibrary.wiley.com/doi/abs/10.1002/ps.1238

The RAAT strategy helps to conserve populations of potentially sensitive beneficial insects like native bees, by alternating untreated swaths with treated swaths. Populations of beneficial insects are able to find refuge in the untreated swaths, and so are able to re-establish in treated areas more rapidly.

I READ THAT DIFLUROBENZURON SPRAYS CAN BE USED TO CONTROL PEST CATERPILLARS AS WELL. WILL GRASSHOPPER SUPPRESSION TREATMENTS KILL MONARCH BUTTERFLIES?

Diflurobenzuron is non-toxic to adult insects including butterflies and bees.
Identifying and delineating native and planted milkweed stands that are the larval foodplants of Monarch butterfly caterpillars is a crucial step. The Xerces Society recommends, for aerial sprays of liquid insecticides, a minimum of 3-mile buffers from the edges of milkweed stands to protect caterpillars and ovipositing adults.
For maps and models of milkweeds in western states, visit the
Western Monarch Milkweed Mapper: monarchmilkweedmapper.org

Early survey and treatment may allow grasshopper suppression to take place before Monarchs are reproducing in the summer. Work with your surveyor for an appropriate treatment plan.

More resources with information about Monarch butterflies:

- A recent paper of milkweeds on rangelands
  https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.3816
- "Managing for Monarchs in the West"
  https://xerces.org/publications/guidelines/managing-for-monarchs-in-west

- "Timing Management in Monarch Breeding Habitat" https://xerces.org/sites/default/files/2018-06/18-010_Timing-Management-in-Western-Monarch-Habitat_XercesSoc.pdf
- Western Association for Fish and Wildlife's "WESTERN MONARCH BUTTERFLY CONSERVATION PLAN, 2019–2069" provides a vision for what it will take to recover western monarchs https://wafwa.org/wpdm-package/western-monarch-butterfly-conservation-plan-2019-2069/

WHAT ARE THE EFFECTS OF GRASSHOPPER SUPPRESSION TREATMENTS ON OTHER INSECTS?

Field studies of diflubenzuron application to rangeland have found no significant whole-field effects on populations of non-target arthropods.

- Effects of An Operational Application Of Dimilin® On Non-Target Insects. https://www.cambridge.org/core/journals/canadian-entomologist/article/abs/effects-of-an-operational-application-of-dimilin-on-nontarget-insects/E8FC09B4058FBE4DDDA0370B97C3DF87
- Sprayed barriers of diflubenzuron for control of the migratory locust (*Locusta migratoria capito* (Sauss.) https://www.sciencedirect.com/science/article/abs/pii/0261219496000294?via=ihub

The RAAT strategy helps to conserve populations of potentially sensitive beneficial insects like ground-nesting native bees and biocontrol agents, by alternating untreated swaths with treated swaths. Populations of beneficial insects can find refuge in the untreated swaths, and so are able to re-establish in treated areas more rapidly.

WHAT ABOUT THE EFFECTS ON BIRDS THAT RELY ON GRASSHOPPERS (OR OTHER INSECTS) FOR FOOD, IF ODA SUPPRESSES GRASSHOPPER POPULATIONS?

The alternative to grasshopper suppression (doing nothing) will result in loss of forage and plant cover for everything. In some areas in 2021, grasshoppers ate it all to the dirt. Long term consequences include loss of vegetative diversity, loss of cover, increased soil temperatures, decreased soil moisture, increased run-off and erosion, and decrease in soil nutrients.

The RAAT strategy minimizes negative environmental effects by leaving untreated areas within the managed property and using a reduced rate narrow-spectrum insecticide. Grasshopper suppression treatments are for population management, not eradication.

DOES DIFLUBENZURON AFFECT GROUNDWATER/SOIL LONG-TERM?

No, diflubenzuron does not persist in the environment long-term. In soil the half-life of diflubenzuron is from 2 to 7 days.

ARE THERE OTHER MITIGATING FACTORS, LIKE TREATMENT TIME, THAT REDUCE NON-TARGET EFFECTS OF DIFLUBENZURON TREATMENT FOR GRASSHOPPER SUPPRESSION?

Due to its toxicity to aquatic invertebrates, the Dimilin®2L product label prohibits applications within 25 feet (for ground applications) or within 150 feet (for aerial applications) of bodies of water. Always follow the label directions.

Avoid spray contact with beehives. Beekeepers should dump and replace water in bee water buckets after diflubenzuron treatment. Treatments should be timed, if possible, to avoid contact with bees during bloom time, by spraying in the late afternoon or evening when bees are less active.

Our goal is grasshopper population suppression, not eradication.

WHERE CAN I GET MORE INFORMATION ABOUT DIFLUBENZURON AND DIMILIN®2L?

- THE USDA evaluation of diflubenzuron: "Final Human Health and Ecological Risk Assessment for Diflubenzuron Rangeland Grasshopper and Mormon Cricket Suppression Applications" https://www.aphis.usda.gov/plant_health/ea/downloads/2019/diflubenzuron-hhera-final.pdf
- Dimilin®2L Rangeland/Pastures Solution Sheet (UPL): https://us.uplonline.com/download_links/qSEQuDnyQbZ1nCoynDhw6sLEo2ek1iABKRvEphJS.pdf

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