Changes in Pest and Pollinator Management for Alfalfa Grown for Seed from 2005 to 2017

Emma K. Tribble
Steve Elliott Matt Baur, Ph.D

September 2023

Introduction

Pest Management Strategic Plans (PMSPs) detail pest management practices for a specific crop, identifying all the significant pests of that crop and pest management practices commonly used throughout the growing season. They highlight industry-identified educational, regulatory and research priorities to be addressed and provide strong justification for additional research funding and research and extension efforts.

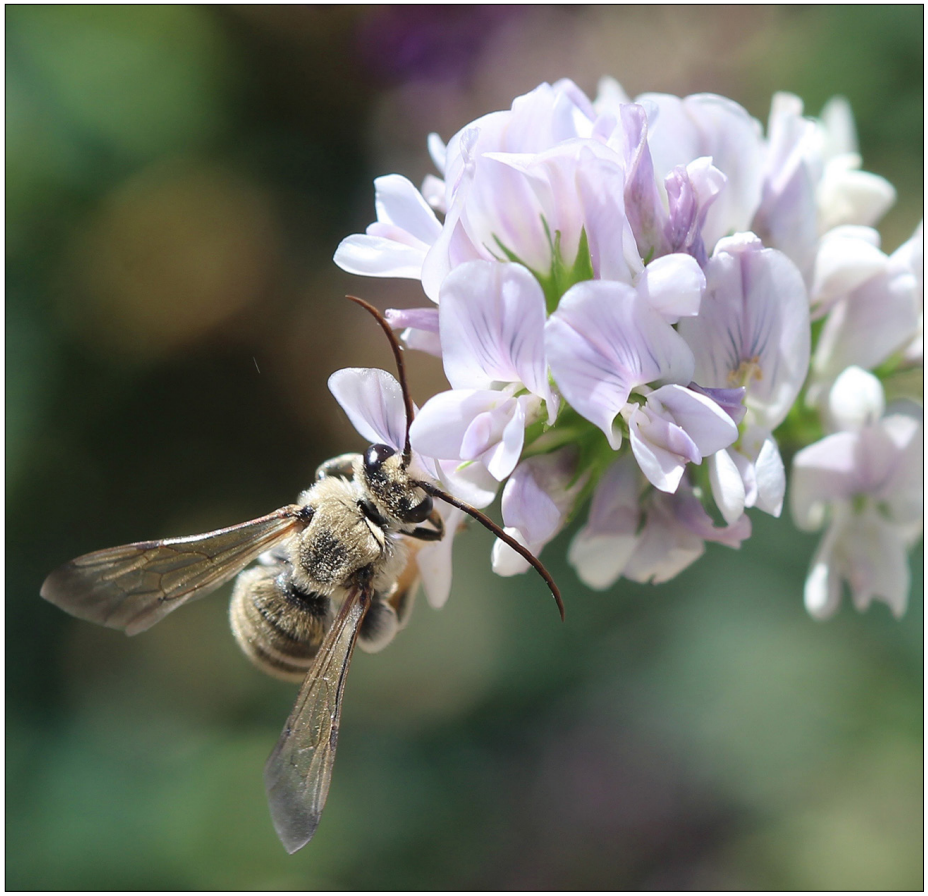

Photo courtesy of Washington State University.

An alkali bee gathers pollen from an alfalfa bloom.

To produce a Pest Management Strategic Plan for alfalfa and clover seed production for the Western United States, researchers, educators, growers, crop consultants, academics, members of government organizations and other stakeholders in the industry came together in 2004. The U.S. Environmental Protection Agency was re-evaluating many of the pesticides for alfalfa and clover seed at that time and the members of the work group felt they should identify key priorities in the industry before the pest management landscape changed with the removal or voluntary cancellation of pesticide registrations. The PMSP from this work group was published in 2005.

Western IPM Center

A publication of the Western Integrated Pest Management Center

USDA

With the guidance of the 2005 Pest Management Strategic Plan, researchers and other stakeholders began to address the critical needs of the alfalfa seed industry. By 2017, much progress had been made and new challenges had arisen. A new work group gathered to create an updated PMSP to capture these changes, specifically focusing on alfalfa seed due to significant differences in clover seed and alfalfa seed pest management. This work group also surveyed 42 growers at the annual conference of the Western Alfalfa Seed Growers Association in 2017 to gather data on growers' use of pesticides and other control methods.

Both the 2005 and 2017 Pest Management Strategic Plans include sections on pollinator management, though the 2017 PMSP focuses more on this critical part of alfalfa seed production. Alfalfa cannot go to seed without cross-pollination, and buying and managing bees accounts for 20 to 40 percent of growers' production expenses. Growers must protect their bees from threats ranging from bee predators and diseases to pesticide residues and other harmful human activity.

Since 2005, much research has been done to preserve alfalfa pollinators and to protect alfalfa seed crops from pests. The number of pesticides available for growers has expanded, even as older broad-spectrum pesticides have been removed from registration. Growers have responded to research to better care for their pollinators while also managing insect pests. Although insect and pollinator management are the main concerns for growers, some advances have also been made in managing weeds. Diseases and nematodes are of lesser importance in alfalfa seed production.

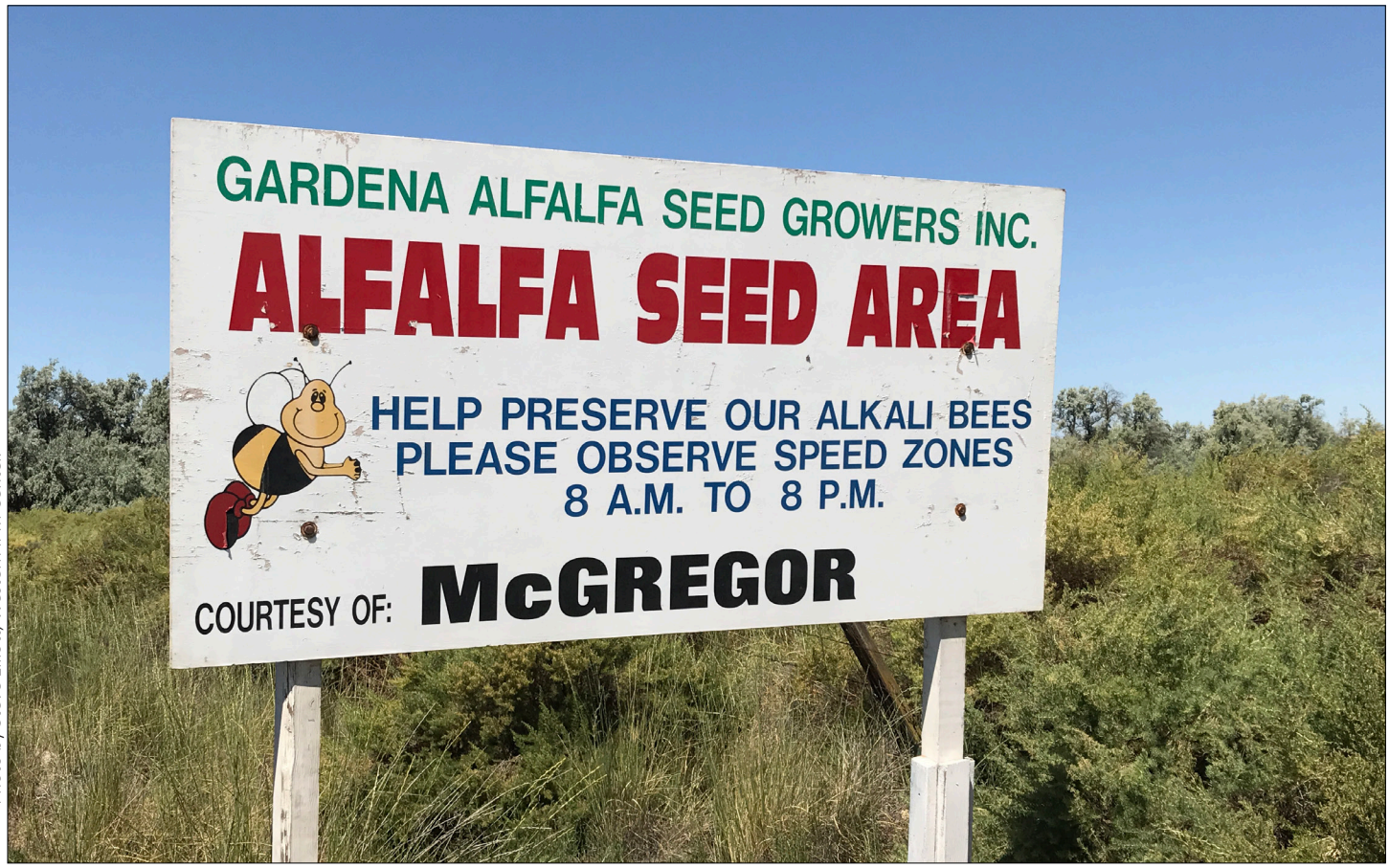

Photo by Steve Elliott, Western IPM Center.

Alfalfa seed production areas can have their own speed limts to protect ground-nesting alkali bees.

Alfalfa Seed Production

Growers produce alfalfa seed in the semi-arid regions of Washington, Idaho, Utah, California, Nevada, Montana, Oregon, Colorado, Wyoming and Arizona. California and Washington grew the most alfalfa seed in 2014, the last year production statistics were available to the 2017 work group. Not all states have data on alfalfa seed production, but California, Idaho, Montana, Nevada, Wyoming and Washington produced a total of 55 million pounds of alfalfa seed combined in 2014. Many Western states have declared alfalfa seed a non-food crop, meaning that pesticides registered for alfalfa seed do not need to have a federal limit set on the level of pesticide residue on the crop at harvest. However, no part of a crop that has had pesticides like these applied can be used for human or animal food or feed.

The cultivation practices necessary to facilitate alfalfa seed production differ from those needed for alfalfa produced for forage. Growers' contracts with seed companies determine what varieties they plant, and seed certification standards generally require that an alfalfa seed field cannot be grown within 165 feet of a different alfalfa variety due to cross-pollination concerns. Compared to alfalfa grown for forage, alfalfa grown for seed is planted in wider rows with fewer plants per row. Planting alfalfa in the fall promotes a higher yield in the establishment year, but growers in colder states like Wyoming and Montana plant primarily in the spring to avoid freezing winter temperatures.

Most alfalfa grown for seed is irrigated, allowing growers to reduce water inputs later in the season to encourage flowering and seed set. Before harvest, growers dry the crop in the field, usually with a desiccant. Leftover straw in the field after harvest is either shredded or burned.

After two to four years of production, growers remove the alfalfa stand with herbicides or cultivation. Rotational crops compatible with alfalfa seed include small grains, corn, sugarbeets, onions, potatoes, safflower and cotton. However, some of the herbicides used on alfalfa seed have plant-back restrictions for specific rotational crops that range from 12 months to more than three years.

Alfalfa Pollinators

The main pollinator used for alfalfa seed production is the alfalfa leafcutting bee. Regionally, the alkali bee and the honey bee are also important pollinators.

Alfalfa leafcutting bees are imported from Canada as prepupae and are incubated to match the timing of alfalfa bloom. The females create a series of leaf-lined nests inside long cavities of grower-provided bee boards. Growers store the nests, full of larvae by the end of the season, in cold storage until they incubate them for the next blooming season. The size of an alfalfa leafcutting bee population decreases by more than 50% from one generation to the next in the Western U.S. growing areas (James & Pitts-Singer 2013). Factors that decrease viable larvae include natural enemies, a fungal disease called chalkbrood, and "pollen balls", a phenomenon where eggs fail to hatch or larvae die very young. Growers must supplement their stock of bees with new bees from Canada each year.

Alkali bees are native, ground-dwelling pollinators used exclusively in Washington. Growers salt the surface of their alkali-bee

Photos courtesy of Washington State University.

An imported leafcutting bee (left) and a native ground-dwelling alkali bee (right).

beds in the spring to prevent weed growth and retain ideal levels of soil moisture. Many growers also irrigate their beds with buried PVC pipe. Alkali bees naturally emerge and begin foraging when the soil is warm. Research between 2005 and 2017 showed that growers can better sync alkali bee emergence with peak alfalfa bloom by manipulating the soil temperature with clear plastic sheeting, white chalk, or white plastic sheeting (Vinchesi et al. 2013). Because alkali bees travel long distances, growers of other crops near alfalfa seed fields must use insecticides with lower toxicity during alfalfa bloom, and roads near alkali bee beds have lower speed limits to prevent cars from hitting bees.

Honey bees have been used for pollination in California and Arizona, but growers in these states have been increasingly using alfalfa leafcutting bees due to the inefficiency of honey bees for alfalfa pollination. Honey bees dislike how alfalfa flowers bop bees on the head with their stamens when pollinated, so they learn how to avoid the pollination process by taking nectar from the sides of the flower (Scott 2018). In the Pacific Northwest, honey beekeepers often place their hives near alfalfa fields during summer or between pollinating other crops. These honey bees then compete with the growers' own bees for nectar and are considered pests by the alfalfa seed growers (Doug Walsh, personal communication, March 16, 2023).

Stakeholders have been working to raise awareness of the importance of pollinating bees in alfalfa seed production. Multiple publications have been released since 2005 to address this issue. In addition to this, the alkali bee appeared in various news sources in the early 2010s due to the controversial rerouting of a highway in Washington through the bees' flight path.

Researchers at Washington State University

determined that alkali bees fly at the same height as car and truck grills, meaning that the fast highway traffic would kill the bees. The researchers placed barriers around the road to encourage a higher flight path for the bees, but the bees did not fly above the height of the cars for the full width of the highway. The Washington State Department of Transportation funded this research to explore solutions that did the least harm to the bees (Vinchesi et al. 2018). When the highway was built, the Washington State Department of Transportation moved some sections of the highway away from these sensitive areas, but unfortunately other sections were still built through and around alkali bee beds (Doug Walsh, personal communication, September 22, 2023).

Scientists researching alfalfa seed pollinator management continuously test registered pesticides for their toxicity to alfalfa-pollinating bees. One such study since 2005 tested the toxicity of novaluron, an insect growth regulator used to control Lygus bugs, on alfalfa leafcutting bees. The study determined that, when female bees forage on recently treated alfalfa or ingest novaluron, a significant number of their offspring die as larva or do not hatch (Hodgson 2011).

There is also a growing awareness that pesticides can have sub-lethal impacts on pollinators such as decreased foraging activity, changed nesting behaviors and lower levels of fertility. Methods have been developed to observe sub-lethal impacts of pesticides on alkali and alfalfa leafcutting bees, including recording videos of pesticide-exposed bees and imaging brood cells using x-rays. One study used video recordings to observe the sub-lethal effects of an adjuvant and a fungicide on alfalfa leafcutting bees and discovered that these sprays lowered the bees' abilities to find their individual nests in a bee board. The researchers hypothesized that bees in a field environment may completely abandon their nests due to their disorientation (Artz & Pitts-Singer 2015). Of the growers surveyed by the 2017 PMSP work group, 15 percent used this fungicide, a mixture of pyraclostrobin and boscalid, in their fields.

Other research from 2005 to 2017 included fungicide studies to manage chalkbrood, but research has not yet found a solution to this deadly disease of alfalfa leafcutting bees. Disinfecting the bee boards appears to have no relation to the incidence of chalkbrood

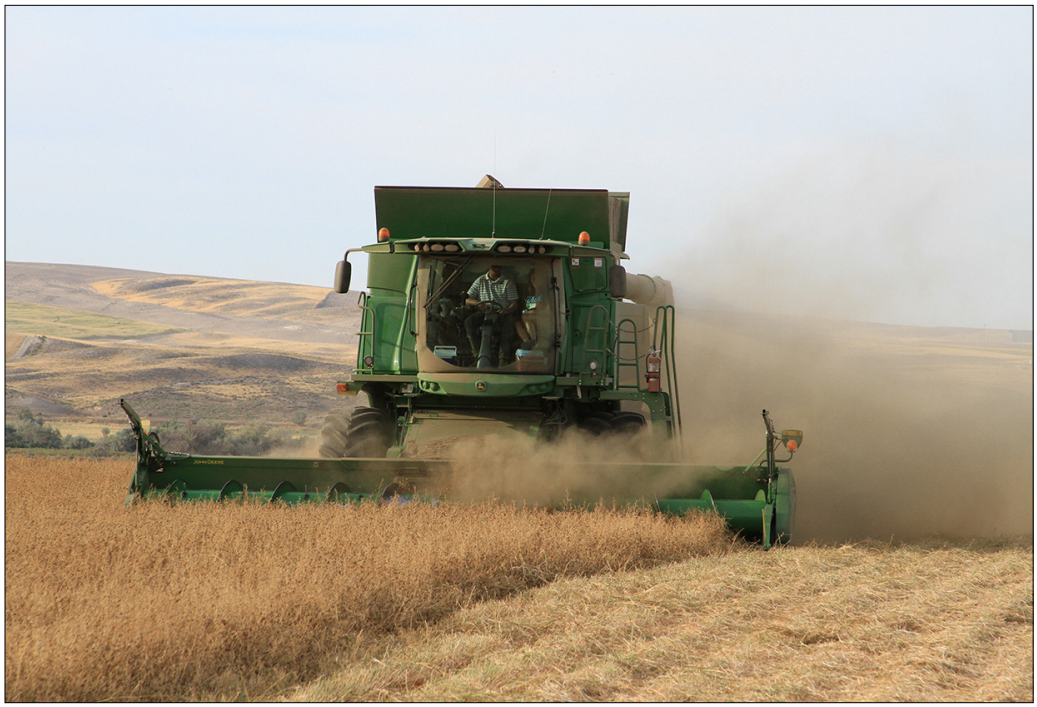

Photo courtesy of Washington State University.

Alfalfa being harvested for seed in Washington state.

in an alfalfa leafcutting bee generation (James & Pitts-Singer 2013). Treating the bee nests themselves with fungicides has had inconsistent results. A study on iprodione revealed that it could reduce chalkbrood by 50% in some trials but have no effect in others, making researchers think that the disease may come from an additional unidentified source instead of being spread solely on bee nesting materials (James 2011).

Insects

Lygus bugs typically cause the most damage to alfalfa grown for seed. The peak egg hatch for Lygus nymphs occurs at the peak bloom for alfalfa, making it complicated to control Lygus while also protecting pollinators.

Growers usually apply a pre-bloom "cleanup spray" of an organophosphate or pyrethroid insecticide before pollinators enter the field. They then apply pesticides in the evening during bloom to avoid pollinator activity. In 2005, growers used short-residual pyrethroids or organophosphates, primarily naled, for this purpose. The field is treated once more post-bloom after the pollinators have stopped foraging. This Lygus bug management program can also manage other insect pests like weevils and aphids. More than half of the listed insecticides for Lygus in the 2005 PMSP are no longer in production due to human and environmental health risks. New narrow-spectrum insecticides registered since 2005 for both Lygus bugs and weevils lower risks for non-target species and allow growers to apply insecticides more safely during bloom.

Of the surveyed growers who sprayed pesticides during bloom, 66% used flonicamid, a selective insecticide that was not available to growers in 2005. Though most growers in 2017 still applied an organophosphate or pyrethroid spray pre-bloom, the introduction of new insecticides can help the industry shift away from these broad-spectrum pesticides.

Alfalfa seed stakeholders in 2005 were concerned about Lygus bug resistance to the commonly used organophosphates and pyrethroids. A series of research studies performed since the 2005 PMSP did not discover significant insecticide resistance in Lygus bugs in Washington, Idaho or Oregon. In addition, the new narrow-spectrum insecticides represent new modes of action, giving growers more options for management and reducing the number of needed organophosphate and pyrethroid sprays. Of the growers surveyed by the 2017 PMSP work group, 66% used three or more unique modes of action in their Lygus management programs.

The 2017 PMSP also mentions that the sampling method for Lygus bugs has been more standardized. Growers commonly sample for Lygus bugs with a 15-inch diameter sweep net. Using the sweep net improperly can greatly influence the number of insects caught and thus the estimated number of insects in the field. Using a standardized sweep method allows growers to accurately estimate population levels in their fields and apply pesticides when treatment thresholds are met.

Based on a priority from the 2005 PMSP, researchers have been studying the feeding behaviors of several insect predators to see if they can affect Lygus populations. The beneficial insects that naturally occur in alfalfa fields selectively feed on aphids,

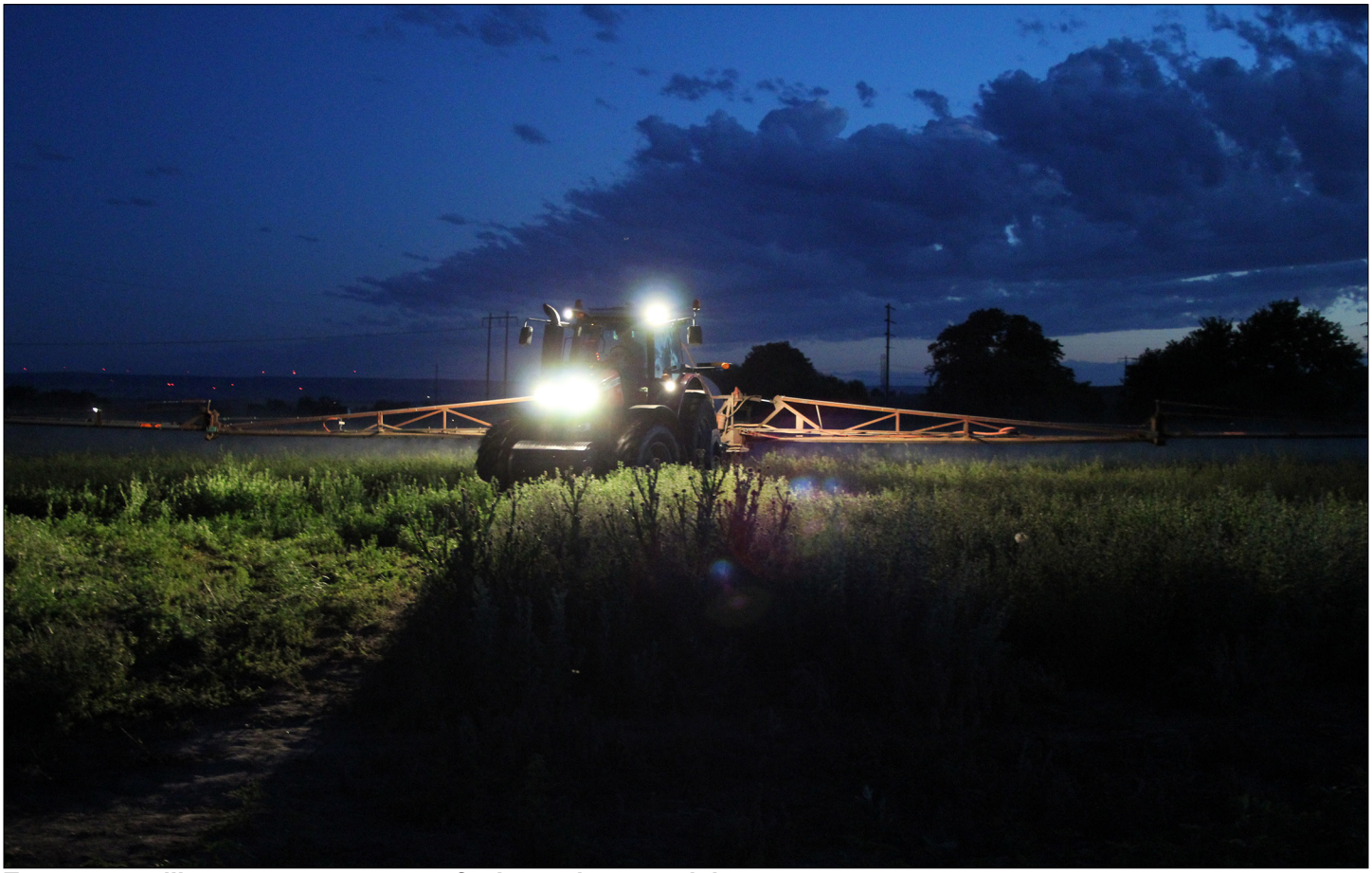

Photo courtesy of Washington State University.

To protect pollinators, growers spray for Lygus bugs at night.

but insecticides can remove aphids without affecting these larger insects. Researchers discovered that, in the absence of aphids, these insect predators feed on Lygus nymphs and adults. However, studies on big-eyed bugs showed that this predator also engages in more cannibalism and feeds on other beneficial predators if aphids are not present. This trend holds true for other predators as well, meaning that predation of Lygus bugs is not currently an effective control strategy.

Weeds

Weeds compete with alfalfa plants, host insect pests and attract pollinators away from alfalfa flowers during bloom. Weed seeds can also contaminate the seed crop. Growers cannot sell their alfalfa seed if it contains the seeds of weeds that are noxious to livestock.

Growers are now less concerned about dodder, a troublesome weed in alfalfa, due to changes in its management. Mature dodder has no roots of its own but instead attaches itself to plants like alfalfa, tomatoes and safflower and takes nutrients from its host plant. Alfalfa seeds and dodder seeds are similarly sized, making post-harvest separation difficult. Growers in 2005 did not have good controls for this weed, but more herbicides have been registered for alfalfa seed that can effectively control dodder pre-emergence. The availability of glyphosate-resistant alfalfa since 2005 has also allowed growers to apply glyphosate to dodder as an early post-emergence herbicide without damaging the alfalfa.

References

Artz DR, Pitts-Singer TL. 2015. Effects of fungicide and adjuvant sprays on nesting behavior in two managed solitary bees, Osmia lignaria and Megachile rotundata. PLOS ONE, 10(8):e0135688. https://doi.org/10.1371/journal.pone.0135688

Hirnyck R, Downey L. (2005, February 23). Pest Management Strategic Plan for Western U.S. Alfalfa and Clover Seed Production. [data file] Available from https://ipmdata.ipmcenters.org/documents/pmsps/WestAlfalfaCloverSeed.pdf.

Hodgson EW, Pitts-Singer TL, Barbour JD. 2011. Effects of the insect growth regulator, novaluron on immature alfalfa leafcutting bees, Megachile rotundata. Journal of Insect Science, 11(1):43. https://doi.org/10.1673/031.011.0143

James RR. 2011. Chalkbrood transmission in the alfalfa leafcutting bee: The impact of disinfecting bee cocoons in loose cell management systems. Environmental Entomology, 40(4):782-787. https://doi.org/10.1603/EN10138

James RR, Pitts-Singer TL. 2013. Health status of alfalfa leafcutting bee larvae (Hymenoptera: Megachilidae) in United States alfalfa seed fields. Environmental Entomology, 42(6):1166-1173. https://doi.org/10.1603/EN13041

O'Neal S. (2017, July 17). Pest Management Strategic Plan—with a Special Focus on Pollinator Protection—for Alfalfa Seed Production in the Western United States. [data file] Available from https://ipmdata.ipmcenters.org/documents/pmsps/AlfalfaSeedPMSP_FINAL.pdf.

Scott A. (2018, June 28) Native bees and alfalfa seed farmers, a NW love story. Oregon Public Broadcasting. https://www.opb.org/news/article/nw-native-bees-alfalfa-farmers/.

Vinchesi A, Lavine L, Cobos D, Walsh D. 2013. Manipulation of soil temperatures to influence brood emergence in the alkali bee (Nomia melanderi). Apidologie, 44(1):286-294. https://doi.org/10.1007/s13592-012-0180-7

Vinchesi A, Walsh D, Broadhead C. 2018. Assessing transportation impacts to alkali bees (Hymenoptera: Halictidae) and alfalfa seed production in southeastern Washington state. American Entomology, 64(1):52-58. https://doi.org/10.1093/ae/tmy011

Changes in Pest and Pollinator Management for Alfalfa Grown for Seed from 2005 to 2017

A publication of the Western IPM Center
2801 Second Street
Davis, CA 95618
www.westernipm.org

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2022-70006-38003. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the U.S. Department of Agriculture.