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WESTERN ALFALFA SEED GROWERS
2024 WINTER SEED CONFERENCE
PROGRAM
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Sunday, January 28

5:00 PM – 7:00 pm – Opening Social *Sponsored by* – ***Allied Seed***

Monday, January 29

7:30 AM – **Registration Desk Opens** – Trade Show Ongoing
8:30 AM – **Conference Kickoff –** Shane Johnson, Western Alfalfa Seed Growers Association
8:40 AM – **Intelligent Precision Spraying** – Tom Gauthier, Founder & CEO, AgTechLogic
9:30 AM – **Precision Agriculture through Drone and AI Technology** – Justin Clune, Skysense
10:10 AM – **Let's Talk About Alfalfa Seed – Using Social Media to Tell Your Farms Story** – Bethany Jones, Communications Director, Ag Association Management
10:40 AM – **Break – Raffle Drawing** – *Coffee and Breaks Sponsored by* – ***DSV/Northstar Ltd.***
11:00 AM – **NAFA Update** – Beth Nelson, President, National Alfalfa & Forage Alliance
11:30 AM – **Grower and Industry Survey –** Doug Walsh, Washington State University
12:00 PM – **Lunch & Raffle Drawing –** *Sponsored by* – ***Legacy Seeds***

Research Session – Moderated by

1:20 PM – **Testing the safety for alfalfa leafcutting bees of a new insecticide useful for Lygus bug control –** Diana Cox-Foster, USDA-ARS PIRU, Logan, UT
1:40 PM – **Pathogen and pesticide screening in managed Nomia melanderi populations -** Diana Cox-Foster, USDA-ARS PIRU, Logan, UT
2:00 PM – **Assessment of seasonal and yearly variability of alfalfa leafcutting bee (Megachile rotundata) parasite infestation in seed production fields -** Lindsie McCabe, USDA-ARS PIRU, Logan, UT
2:20 PM – **Identifying wild populations of alkali bees (Nomia melanderi) to support sustainable development of managed populations with genetic analysis -** Jon Koch, USDA-ARS PIRU, Logan, UT
2:40 AM – **Break – Raffle Drawing** – *Coffee and Breaks Sponsored by* – ***DSV/Northstar Ltd.***
3:00 PM – **Enhancing & Protecting Populations of Alfalfa Seed Pollinators -** Doug Walsh, WSU, Prosser, WA
3:20 PM – **Pesticide Transfer in Alfalfa Leafcutting Bee Nests –** Calvin Luu, Utah State University
3:40 PM – **Investigating botanical derivatives for chalcid wasp control in alfalfa leafcutter bee incubators** – Jennifer Retzlaff, Research & Extension Manager, Alberta Alfalfa Seed Commission
4:00 PM – **Raffle Drawing/Announcements**
4:00 PM – 5:30 PM – **Presenter's Meet and Greet Social & Researchers Poster Panel –** *Sponsored by* – ***Mr. Pollination Systems***

Tuesday, January 30

7:00 AM – **WASGA Board of Directors Meeting**
8:30 AM – **Registration Desk Opens** – Trade Show Ongoing
9:00 AM – **Welcome** – Shane Johnson, Western Alfalfa Seed Growers Association
9:10 AM– **DLF Seed Company** – Doug Gross, Director, North America Production, DLF
9:50 AM – **Alfalfa Seed Production in Australia** - Ben Farmer, Wilkei Seeds, Keith, South Australia
10:30 AM – **Break – Raffle Drawing** – *Coffee and Breaks – Sponsored by* – ***DSV/Northstar Ltd.***
10:50 AM – **Canadian Seed Report: "Current State of Alfalfa Seed in Alberta" –** Jennifer Retzlaff, Research & Extension Manager, Alberta Alfalfa Seed Commission
11:20 AM – **US State of the Industry Report –** Dr. Emily Meccage, Research & Development Lead, Forage Genetics International
12:00 PM – **Raffle Drawing/Announcements/Conference Adjournment**

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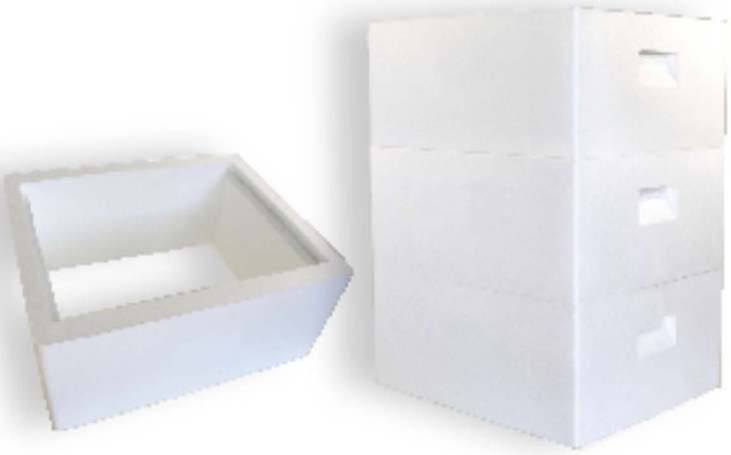

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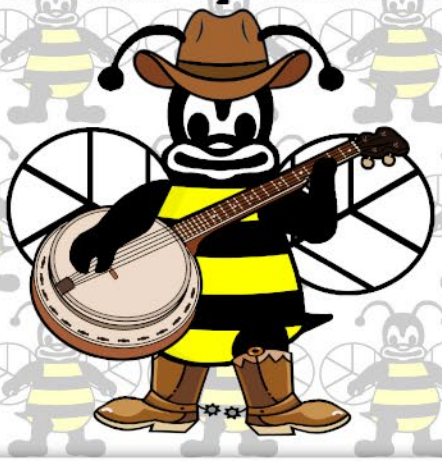

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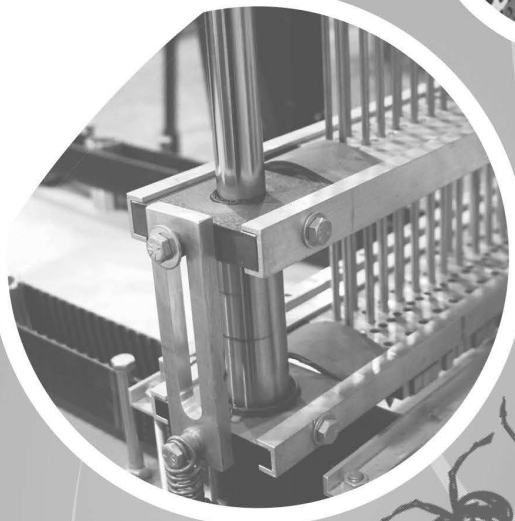

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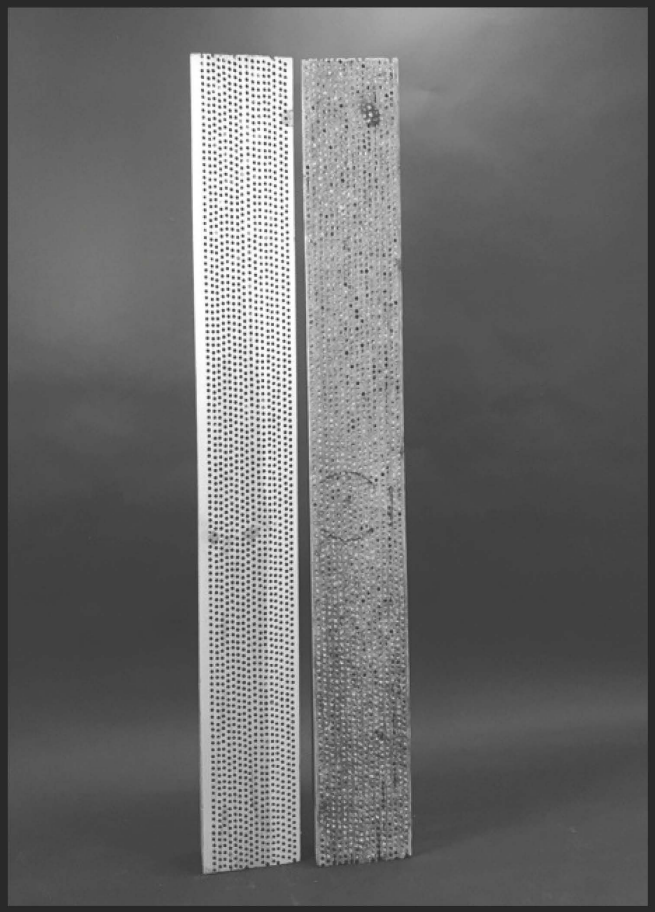

Project Title: Testing the safety for alfalfa leafcutting bees of a new insecticide useful for Lygus bug control

Year(s) of Study: 1 year, March 2023 - February 2024.

Lead Investigator / Affiliation:

Kelsey K. Graham, Research Entomologist, USDA-ARS Pollinating Insects – Biology, Management, & Systematics Research Unit, Logan, UT.

Collaborating Investigator(s) / Affiliation(s):

Douglas Walsh, Department of Entomology, Washington State University

Hyperlink to research website and/or curriculum vitae: https://www.ars.usda.gov/people-locations/person/?person-id=55990

Introduction and Justification

Alfalfa (*Medicago sativa*) is an important agricultural commodity, generally ranking third or fourth in highest production value of all crops in the United States. But insect pests, particularly the Western tarnished plant bug (*Lygus hesperus*), or 'Lygus bug', can cause significant damage to alfalfa produced for seed. Management of this pest is heavily reliant on chemical control, and many synthetic pesticides available for use can pose significant risks to beneficial insects, such as pollinators. Alfalfa seed production is reliant on managed pollinators, especially alfalfa leafcutting bees (*Megachile rotundata*), for pollination. Without effective pollinators, seed growers cannot produce profitable yields. Growers must balance the need for pest management with the risks to pollinators. It is therefore important to increase effective Lygus bug control options that have minimal risks to bees.

A relatively new chemical control option for Lygus bug is the insecticide Sefina (BASF; active ingredient: afidopyropen). Afidopyropen is a derivative of pyripyropene A, which is produced by the fungus *Penicillium coprobium*, and has strong insecticidal activity against Hemipterans (true bugs; including Lygus and other plant bugs, as well as aphids, and leafhoppers). Sefina is registered for use on alfalfa for Lygus bug control, though is not commonly applied by seed producers. Toxicity studies on honey bees and beneficial insects show it to be relatively safe (Horikoshi et al., 2022; Koch et al., 2020); however, the label indicates that there are "some short-term behavioral effects on adult [honey] bees." Evaluating potential behavioral effects of Sefina exposure on alfalfa leafcutting bees is therefore of great interest given their critical importance for pollination. If bees are foraging at reduced rates due to effects from pesticides, this could have significant implications for seed production.

Transform (active ingredient: sulfoxaflor) is another registered insecticide used in Lygus control, and can be applied during bloom. Though most growers will take precautions to limit bee exposure to Transform as it has been known to cause behavioral impacts. Therefore, identifying if Sefina is a safer option compared to Transform would provide additional Lygus bug control options during bloom when bees are critical to production. Here, we measured the effects of both Sefina and Transform on alfalfa leafcutting bee nesting behavior. We used production of nest cells, which include a pollen provision made entirely of alfalfa pollen and nectar (as that was all that is available to them), as a proxy for foraging activity and pollination.

Research Update:

Objective 1: Measure effects of Sefina (afidopyropen) and Transform (sulfoxaflor) exposure on leafcutting bee (*Megachile rotundata*) behavior and clarify exposure routes.

Methods:

Nine screened field cages (6.2 x 6.2 x 2 m^3) were erected at the USDA ARS PIRU research alfalfa planting in Logan, UT. A polystyrene bee board (30 holes) with paper inserts was then secured to a metal pole 1.5 m above the ground at the center of each cage. Alfalfa leafcutting bees (*Megachile rotundata*) were purchased from Jim Watts and then managed accordingly for release in late June. We released 20 males and 10 females into each of the nine cages on June 28,

2023. Females were individually marked with Testors enamel paint on the back of their thorax prior to release in the cages to allow for identification of individuals.

In the first week of data collection (July 3 – 7), we collected baseline nesting behavior data. This included recording new nest cells constructed each day and recording completed (capped) nests. Completed nests were replaced with empty straws, and completed nests were x-rayed to confirm the number of nest cells constructed.

Monday through Friday we also did 20 minutes of observations in each cage in the morning (between 9am and noon) and afternoon (1pm to 4pm) where we recorded which paint marked bees were actively provisioning and in which straw. This was to allow us to determine how many bees were actively foraging each day, as this could impact nesting production. Additionally, we used GoPro cameras to record one hour of nesting activity at each nest block in the morning (9am and noon) and in the afternoon (2pm to 5pm). Videos were then used to determine average foraging trip lengths in each treatment group as well as other behaviors such as guarding and attempts to enter the wrong nest. Foraging behaviors have been known to be impacted by pesticide exposure in other studies (Artz and Pitts-Singer, 2015).

In the second week of data collection (July 9 – 15) we applied treatments. In the evening of July 9, three cages received applications of Sefina at the label rate (10 fl ozs/acre), three cages received applications of Transform at the label rate (2.75 oz per acre), and three cages received a water control. We then continued the data collection as described above the rest of the week.

In the third week (July 16 – 22) we applied treatments again (evening of July 16th), and continued with data collection as above. However, we did not apply Transform again in the third week, as we had 100% mortality of bees in those cages within 48hours after the week 2 applications. On July 25th, we pulled all nest blocks and recorded final nest cell production and completed nests.

Results and Conclusions:

During the first baseline week (prior to any applications), we found no significant difference in average number of nest cells produced per day or the number of completed nests between three treatment groups (control, Sefina, and Transform) (one-way ANOVAs; nest cell production: $F_{3,41} = 1.54$, $p = 0.23$; completed nests: $F_{3,9} = 4.09$, $p = 0.08$). This indicated that all treatment groups started the experiment with equal nest production (Fig. 1).

After applications were made at the start of the second week, there was a significant reduction in average number of nest cells produced per day in the Transform cages compared to the control cages and Sefina cages ($F_{3,49} = 9.20$, $p < 0.001$), and Transform cages produced fewer completed nests compared to the other treatment groups

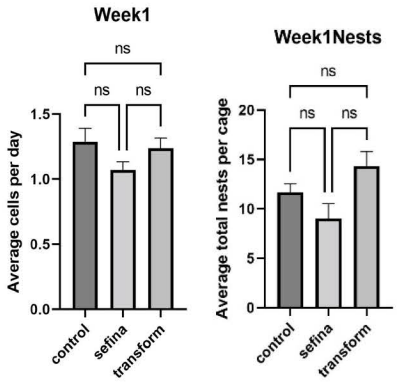

Figure 1. There was no significant difference in average nest cells produced per day or total nests produced per week between treatment groups in the first (baseline) week. ns = Not significant.

($F_{3,9} = 7.16$, $p = 0.03$) (Fig. 2). All bees in the Transform cages died within 48hours of the application, so it is not very surprising that overall nesting production dropped off. There was no significant difference in nest cell production or number of completed nests between the control cages and those that received a Sefina application (Tukey's: $p > 0.05$).

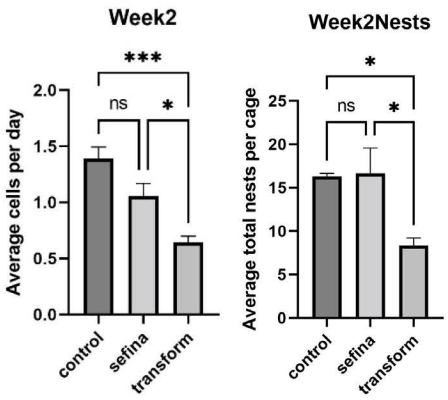

Figure 2. Bees in Transform cages produced significantly fewer nest cells per day and total completed nests compared to those in control and Sefina cages in Week 2. * = statistically significant difference.

Finally, in the third week, which only included control and Sefina cages as all Transform bees had died, there was no significant difference between the control and Sefina cages in average cells produced per day (Unpaired t-test; $t = 0.02$, $df = 17$, $p = 0.99$) or number of completed nests (Unpaired t-test; $t = 1.75$, $df = 4$, $p = 0.16$) (Fig. 3).

Throughout the experiment there was no significant difference in nest production between control cages and those that received applications of Sefina. We therefore expect that floral visitation and pollination rates were similar in control and Sefina cages. Given these results, we conclude that Sefina is a safe option for Lygus control during bloom when pollination is needed. Nonetheless, we recommend applying in the evening when bees are not active, as was done in this experiment. On the other hand, Transform did have a negative effect on nesting, and all bees died with 48hours of the application in Week 2. Given these results, we recommend that Transform be used with abundant caution to minimize bee exposure, as it may result in high bee mortality. However, we plan to conduct this experiment again in 2024 as the 100% mortality due to Transform exposure was somewhat surprising. This insecticide is labeled for use during bloom and has low mortality to honey bees 3 hours from the application according to the label. We did all of our applications in the evening, and therefore expected residues to be at safe levels by morning. This year we will explore potential causes of the high mortality such as increased humidity in the cages which may have resulted in higher than expected residue concentrations in the morning after the application.

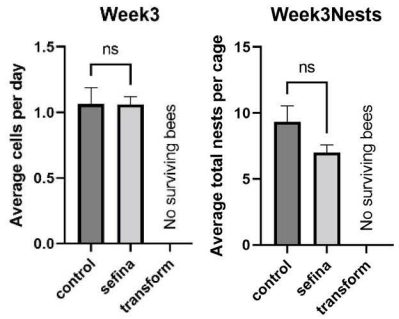

Figure 3. There was no significant difference in cells produced per day or total nests produced between control and Sefina cages in Week 3. The Transform cages were dropped from the experiment as there were no surviving bees after Week 2.

We have not been able to extract all the data from the video files yet. This is a tedious process that takes hours of careful data collection per video, which is ongoing. Though we do not expect to find significant behavioral impacts from Sefina given that nesting production was not impacted. However, we are excited to explore the intricacies of alfalfa leafcutting bee nesting and foraging behavior that can be gleaned from the videos.

Objective 2: Measure typical pesticide exposure and identify sources of pollen for leafcutting bees (*Megachile rotundata*) and their offspring during pollination of alfalfa grown for seed.

Unfortunately, we were not able to complete Objective 2. The Cornell Chemical Ecology Core Facility (CCECF) shut down in 2023 in order to revamp their equipment to be able to provide additional pesticides for screening in the future. We therefore used the funds allocated for Objective 2 to support additional team members for Objective 1, which was very much needed given the labor required. However, these leafcutting bee pollen provision samples are still in our freezer, and we intend to get them analyzed when the CCECF is accepting samples.

References

Artz, D.R., Pitts-Singer, T.L., 2015. Effects of fungicide and adjuvant sprays on nesting behavior in two managed solitary bees, Osmia lignaria and Megachile rotundata. PLoS One 10, 1–19. https://doi.org/10.1371/journal.pone.0135688

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Koch, R.L., da Silva Queiroz, O., Aita, R.C., Hodgson, E.W., Potter, B.D., Nyoike, T., Ellers-Kirk, C.D., 2020. Efficacy of afidopyropen against soybean aphid (Hemiptera: Aphididae) and toxicity to natural enemies. Pest Manag. Sci. 76, 375–383. https://doi.org/10.1002/PS.5525

Project Title: Assessment of seasonal and yearly variability of alfalfa leafcutting bee (*Megachile rotundata*) parasite infestation in seed production fields

Lead Investigator / Affiliation:

Lindsie M McCabe & Theresa Pitts-Singer

USDA-ARS Pollinating Insects Research Unit
Email: Lindsie.McCabe@usda.gov

Introduction: Natural enemies are one of the leading causes of mortality in alfalfa leafcutting bee (ALCB: *Megachile rotundata*) populations in the western United States. Most enemies are parasites and parasitoids, including *Monodontomerus*, *Pteromalus*, *Tetrastichus Melittobia*, Meloidae, and *Sapyga*. These different insects can all have detrimental effects on unique life stages of ALCB populations (Pitts-Singer and Cane 2011); furthermore, some of these pests do not have recommended control measurements. Levels of even 1% parasitism can have determinantal economic impacts (Eves et al. 1980). While we know the general life history of these insects, what is lacking is the seasonal timing in which they infest the ALCB nests in the field. Understanding the pest's life history and timing of activity in the field is important for managing these species.

Environmental conditions such as temperature and humidity can affect the reproductive success of ALCBs, mainly in the increased mortality of the immature stages as well as increased incidence of pollen ball cells (Pitts-Singer and James 2008; James and Pitts-Singer 2013). However, what is relatively unknown is how these different environmental conditions could impact the infestation rates and timing in ALCB populations during the nesting season, rather than changes in temperature during developmental periods. Here we will examine if timing and environmental conditions correlate with parasite and parastioid occurrence rates under field conditions where ALCB commercial populations nest in dense numbers.

Objective(s): Our project addresses the seasonality of pest infestations in a northern Utah commercial alfalfa field in a two-year study.

Methods: This experiment took place over the course of two years on commercial alfalfa farms in Trenton, UT (year 1 & 2), Malad City, ID (year 1) and Clifton, ID (year 2) where a typical stocking density of ALCBs was released (4-5 gallons of bees per acre). Shelters with parts of polystyrene bee boards having paper straws inserted into nesting holes were provided for bees. Each week, for a total of nine weeks, from the release of bees to the end of alfalfa bloom (June– August), we collected a sample of nests. We sampled from three domiciles at each location (180 -540 straws each week). Within each domicile, four board faces were sampled. On each board face we inserted a diagonal transect of straws in three sections of the board, roughly 30 straws per section. The straws in which nests were made were pulled once a week and brought back to the lab to monitor development of bees or pests within. Additional nests were also brought back after being in the field for two and three weeks in order to capture the parasitoids that use mature larvae as hosts. These diagonal transects were arranged so that we can test nest placement in relationship to where infestations take place. We examined the nesting straws collected weekly; nesting straws from these fields were x-rayed every three days to look at parasitism, pollen balls, chalkbrood, and second generation bees. Additionally, HOBO dataloggers were placed in each of the 10 boards to correlate temperature and humidity with infestation throughout the nesting season.

Results and Discussion: We found that weather events predicted the occurrence of three pests in two farms. Both sites responded to these weather conditions in the same predictable manner regarding pest occurrences ($t = -0.475$, $p = 0.649$). In the samples we took, we found the two kleptoparasites: a meloid beetle and the wasp *Sapyga.* We found two parasitoids: *Pteromalus*

and *Melittobia*. We also found the predator *Trichodes. Pteromalus* and Meloidae were not detected at levels that could be included in this Year 1 analysis.

We found that *Melittobia* occurrences were predicted by mean temperature during alfalfa bloom. When mean temperature was low, *Melittobia* numbers were the greatest ($t = -2.271$, $p = 0.040$, Figure 1). Minimum relative humidity was also marginally significant, where slightly higher *Melittobia* incidents were detected with higher relative humidity ($z = 1.819$, $p = 0.092$). There was no interaction effect between mean temperature and minimum humidity.

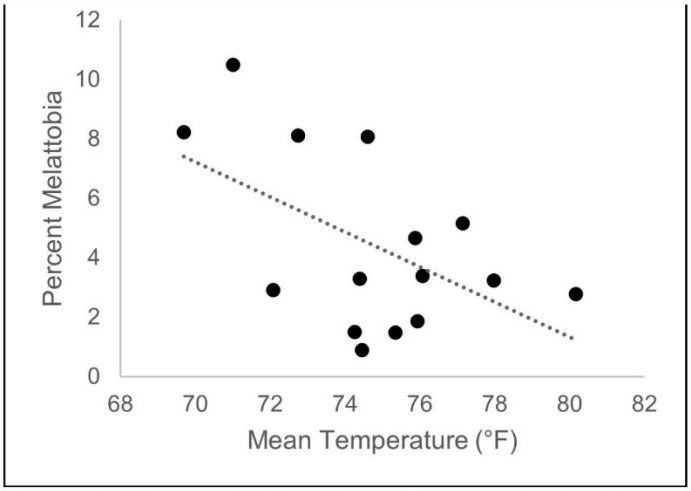

Figure 1: Percent *Melittobia* cells to total ALCB cells in relation to mean temperature. Dotted trend line denotes significance.

Sapyga incidents were correlated with both temperature and humidity. As maximum temperatures increased so did number of parasitized cells by *Sapyga* ($z = -1.839$, $p = 0.053$, Figure 2A). Additionally minimum relative humidity predicted the number of parasitized *Sapyga*

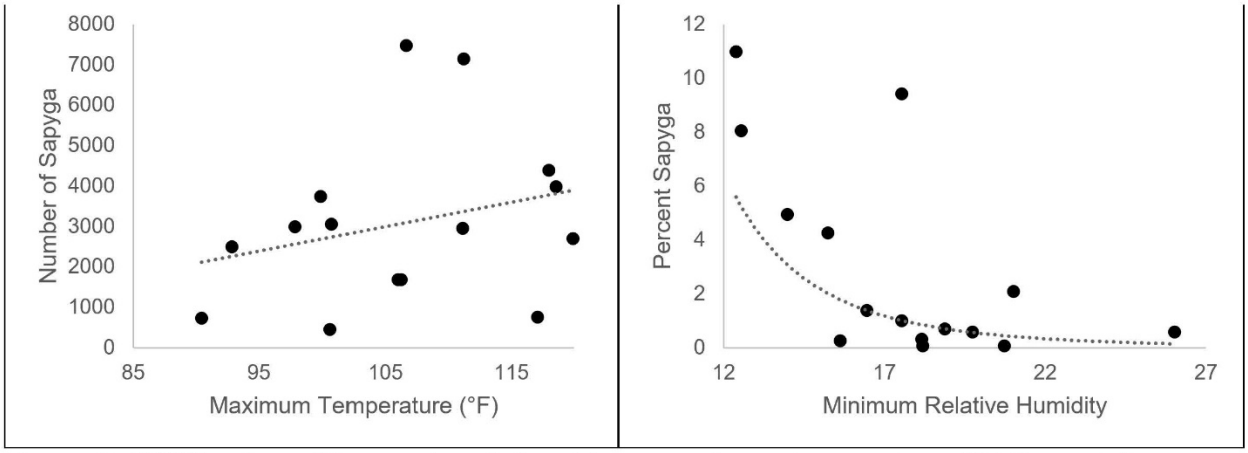

Figure 2: (A) Number of *Sapyga* in relationship to maximum temperature. (B) Percent *Sapyga* cells to total ALCB cells in relationship to minimum relative humidity. Dotted trend lines denote significance.

cells; when humidity was low, *Sapyga* infestation was the greatest ($z = -2.859$, $p = 0.013$, Figure 2B). The interaction between maximum temperature and minimum relative humidity was the greatest predictor of *Sapyga* incidents ($t = 1.225$, $p = 0.024$). This means that during hot dry times of the season, there is a greater probability of *Sapyga* parasitizing ALCB.

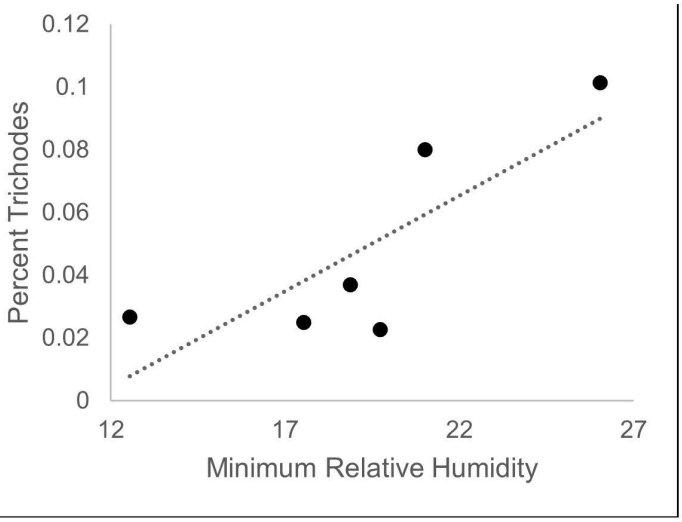

Figure 3: Percent *Trichodes* cells to total ALCB cells in relation to minimum relative humidity. Dotted trend line denotes significance.

Finally, we found that *Trichodes* incidents were predicted by minimum relative humidity; as minimum relative humidity increased so did *Trichodes* incidents ($t = 5.484$, $p = 0.047$, Figure 3). None of the parasites had a relationship with mean or maximum humidity nor minimum temperatures.

Based on this data we were able to create a phenology model for each pest species using growing degree days (GDD) based on the amount of GDDs above 60°F. We found that for *Sapyga* there are two spikes of infection one at 190 GDD and the other one at 325 GDD (Figure 4). *Melittobia* has a small peak at 190 GDD but a more noticeable peak at 340 GDD. *Trichodes* and *Pteromalus* have consistently low instances of occurrence with no noticeable peaks throughout the season. Additionally, we plotted the instance on chalkbrood on to this phenology model and found that chalkbrood also spikes about 190 GDD and rapidly increases starting at 340 GDD until ALCBs are removed from the field. The second spikes seem to align tightly with the emergence of second generation ALCBs.

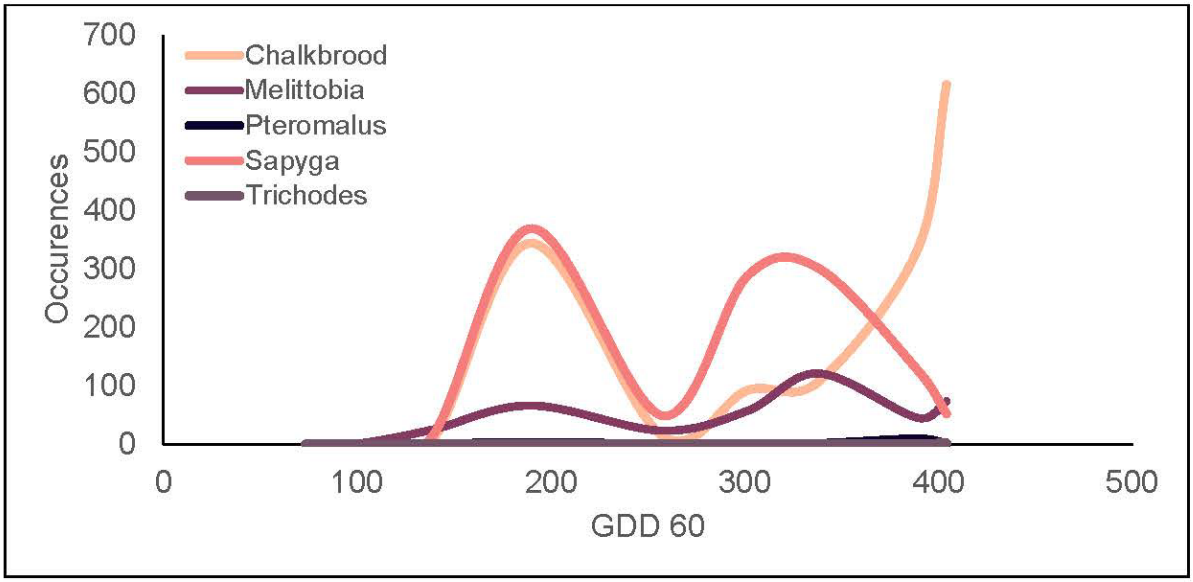

Figure 4: Phenology model for four ALCB pest species and chalkbrood. Model is based on growing degree days above 60°F. Model is generated from two years of data at two locations, one in northern Utah and the other in Southern Idaho.

Conclusions: Extreme weather and climate events can dictate how pestiferous insects respond to their environment and, therefore, when they infest ALCBs. By using a phenology model based on GDD instead of time of year we can more accurately predict when pests will be the most prevalent in the environment. Our phenology model suggests that applying mitigation measures at GDD 140 and 260 may prevent sever infections. Additionally, assessing how much effort "second generation" bees pollinating alfalfa field could limit secondary infections in bees if they are removed from the field prior to GDD 260.

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Report: Identifying wild populations of alkali bees (*Nomia melanderi*) to support sustainable development of managed populations with genetic analysis

Year(s) of Study: 1 year, March 2023 - February 2024.

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Background. Population declines of managed alkali bees represent a significant loss in investment for growers who construct and maintain bee beds, and a loss in future pollination potential. There is a ***critical need*** to identify wild populations of alkali bees that may serve as candidates to augment managed populations with new genetic diversity. In the absence of such knowledge, the alkali bee beds may become jeopardized due to reduced genetic diversity, inbreeding, and ultimately population loss. In this application we propose to compare population genetic diversity of managed alkali bees in the TGL area with wild populations of alkali bees in western North America. The results of our study will support the goal of growers in ensuring a sustainable alkali bee population.

Objectives. Our research goal is to provide alfalfa seed growers knowledge on the availability of wild alkali bee populations and their potential to support managed populations in the TGL area. This knowledge is important to growers in making effective breeding and translocation decisions across bee beds. In this report, we present the status of our proposed research objectives: 1) determine historic population genetic diversity of alkali bees and 2) determine contemporary population genetic diversity of alkali bees.

Methods. To achieve the goals of Objective 1, we sampled historic specimens of alkali bees in northern Utah. However, majority of the specimens were collected in the 1960s and 1970s and yielded limited extracted DNA for amplicon sequencing. Alternative DNA extraction approaches will be necessary to achieve suitable template DNA for downstream PCR techniques. Thus, to achieve the goals of Objectives 2, we tested novel microsatellite markers to estimated population genetic diversity. However, the markers tested thus far demonstrate limited polymorphism, likely due to low population genetic diversity associated with managed alkali bees. Thus, we elected to estimate population genetic diversity with reduced representation genome sequencing. Specifically, we used ddRAD techniques to identify thousands of single nucleotide polymorphisms (SNPs) to estimate population genetic structure and diversity across managed and wild alkali bees.

Preliminary results. In total, 95 alkali bees were submitted for population genomic analysis. Bees represented the following alkali bee beds in the TGL: Russel, Byerley, Riverside, and Buckley. The wild population included in the analysis were from Challis Hot Springs, Idaho. All specimens were submitted to one lane of 300 bp single-end Illumina sequencing. The experiment resulted in 85,248,305 total sequencing reads. After removing 46,493,543 million reads with low quality bases, missing barcodes, or missing RAD tags (Table 1), we mapped 38,754,762 reads to the 95,883 scaffolds of the alkali bee reference genome (Kapheim et al. 2019). After removing 10 specimens that did not achieve high data quality, the remaining specimens 85 specimens achieved >99% mapping rates to the alkali bee reference genome.

Table 1. Summary of initial data quality check in Stacks 2.64 (Catchen et al. 2011, 2013).

	# of reads
Total sequences	85,248,305
Reads containing adapter sequence	298,450 (0.4%)
Barcode not found	28,038,484 (32.9%)
Low quality	2,696,755 (3.2%)
RAD cut site not found	15,459,854 (18.1%)

The raw output of the populations algorithm in Stacks consisted of 80,209 SNP loci (effective per-sample coverage: mean = 7.3x, standard deviation = 3.7x, min = 1.0x, max = 23.3x). With the resulting VCF file, we then applied a strict data filter that incorporated a mean allele frequency of 0.01, thinned SNP to 10,000, minimum mean depth value of 10x, and max-missing of 50%. This strict filtering procedure resulted in 1552 SNPs out of a possible 5667 SNP sites for 85 individuals. These SNPs were then used to analyze the population genomic diversity of the alkali bees.

Population genetic diversity of bees sampled from bee beds is lower compared to the wild, unmanaged population in Challis Hot Springs, Idaho. Expected heterozygosity (H_e) of the bees sampled from the bee beds are as follows: Russel (H_e = 0.111, n = 9), Byerley (H_e = 0.113, n = 21), Riverside (H_e = 0.114, n = 14), and Buckley (H_e = 0.114, n = 21). However, the expected heterozygosity of bees sampled from Challis Hot Springs, Idaho (n = 19) is H_e = 0.141. Furthermore, we detected significantly more private alleles (PA) to the Challis Hot Springs population [(mean PA = 4.02 ± 0.15 standard error (SE)], compared to the four managed bee beds in the TGL area [Russel (mean PA = 0.04 ± 0.01 SE), Byerley (mean PA = 0.07 ± 0.02 SE), Riverside (mean PA = 0.05 ± 0.01 SE), and Buckley (mean PA = 0.06 ± 0.02 SE)]. As expected, there is limited population genetic differentiation between the managed bee beds, with F_{st} values ranging from 0.0003 to 0.0038. However, there is larger population genetic differentiation between the managed bee bed population and the Challis Hot Springs, Idaho population, with F_{st} values ranging from 0.1332 to 0.1371. Finally, discriminant principal components analysis identified two genetic clusters emerging from the dataset. Cluster 1 is composed of bees that are associated with four managed bee beds analyzed, whereas cluster 2 is composed of bees that are associated with the Challis Hot Springs, Idaho population (Figure 1).

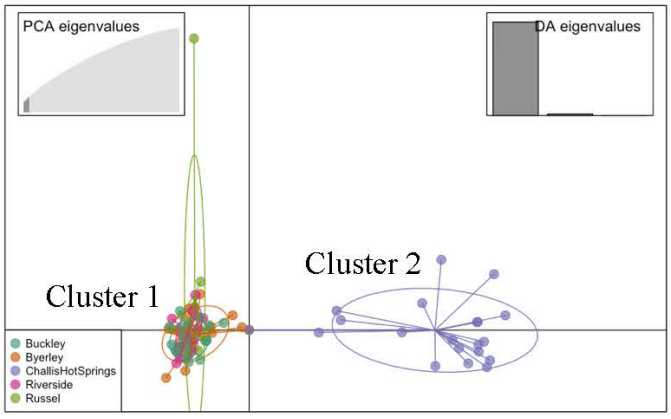

Figure 1. Discriminant principal components analysis (dPCA) of the population genomic diversity associated with managed bee beds (Buckley, Byerley, Riverside, and Russel) and a wild Springs population from Challis Hot Springs.

Conclusion. Expected heterozygosity (H_e), a measure of genetic diversity, is lower in the managed bee beds compared to the wild population of alkali bees. Furthermore, there is little evidence for population differentiation across the managed bee beds based on dPCA and pairwise F_{st} values. Based on private alleles (PA), the wild Challis Hot Springs, Idaho population is associated with unique genetic diversity that is not found in the managed hot springs. Overall, the managed bee

beds have limited genetic variability and do not possess any unique alleles in comparisons to wild alkali populations.

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Enhancing and Protecting Populations of Alfalfa Seed Pollinators - 2023

Doug Walsh
Washington State University, Irrigated Agriculture Research and Extension Center

Introduction:

Pollination by alfalfa leafcutting bees *(Megachile rotundata,* ALCB) or alkali bees *(Nomia melanderi,* AB) is essential for seed set in alfalfa seed production. Bee mortality that results from inadvertent exposure to pesticides can negatively impact bee survival and/or fitness and potentially reduce seed yields. The first objective of our 2023 studies involved involved facilitating the registration of acaricides for spider mite pests of alfalfa produced for seed during bloom by testing the effects of ALCB to direct topical exposure. In 2023 we focused on two candidate acaricides that have been registered on other crops in recent years for spider mite management. These included fenazaquin and acequinocyl. Both of these acaricides would be considered very safe for leafcutting bees at the rates we tested. In our time-tested contact bioassays mortality of ALCB was 4% for acequinocyl and 8% for fenazaquin. We were unable to complete our 2nd objective in 2023 but we have received a larger federal grant from the AFAFP program that we will address this in the next several years For our third objective we conducted our annual survey of alkali bees in Touchet-Lowden alfalfa seed growing district. Unfortunately, the population abundance of alkali bees had been declining over time as the alfalfa seed production in the area declined.

Objectives:

Objective 1. Conduct topical treatment tests on alfalfa leafcutting bees with acaricides. In 2023 we focused on acaricides including acequinocyl and fenazaquin. Both insecticides were applied with a R&D CO_2 sprayer at 26 gal/A using a hand boom to 0.01-acre plots of alfalfa being produced for seed in the Lowden alfalfa seed-growing district on July 11, 2023. Field-weathered residual test exposures on each insecticide were replicated 5 times per candidate insecticide at 1 hour after the acaricides were applied. Samples consisting of cutting approximately 400 cm^3 of foliage from the upper 15 cm of the plants and clipping this alfalfa to 2.5 cm lengths. This hay was then placed into individual plastic Petri dish (15 cm diameter) replicates, the tops and bottoms of which are separated by a wire screen (6.7 meshes/cm) insert (45 cm long and 5 cm wide) to create a cage.

Extant ALCB were collected by sweep net from alfalfa fields grown for seed at the entrance of ALCB domiciles. The bees were tranquilized with CO_2 and put in the Petri dish bioassay cages. Bees in cages were held at 75°F for 8 hrs and mortality counts were assessed at the conclusion of this time period. Bees were considered as "living" if they were capable of flying away after the 8-hour exposure in the bioassay arena. The bees were considered as "dead" if they failed to fly away. Mortality was corrected against control bioassay arenas. Typically control mortality is about 10%. We were unable to capture enough alkali bees to complete these bioassays. Walsh was out of the country the last 2 weeks in June 202.3

Our results were conclusive that the acaricides acequinocyl and fenazaquin could be considered safe for foraging ALCB at the maximum labeled rates (Table 1). Past research has demonstrated that less than 25% mortality in the contact bioassays in 1 hr residues is indicative that these pesticides will not have knock-down toxicity to foraging bees.

Table 1. Corrected mortality of ALCB to 8 hrs of exposure to treated alfalfa foliage collected 1 hr after insecticide application.

Product	Rate per acre	ALCB % Corrected Mortality
Acequinocyl (Kanemite)	31 fluid oz	4%
Fenazaquin (Magister)	36 fluid oz	8%

2. Develop and validate new techniques to assess the sublethal effects of flonicamid and sulfoxaflor insecticides on alfalfa leafcutting bee brood development. We were not capable of completing this objective in 2023.

Objective 3. Conduct an annual census of the alkali bee population abundance in Walla Walla County, WA. Alkali bee emergence hole counts have been recorded annually at the end of the alkali bee nesting season (mid to late July) from 2010 to 2023, in accordance with standardized methods established by Vinchesi and Walsh in 2014. In this method, $0.5m^2$ quadrats made of lightweight PVC pipe, with dimensions of 0.7m by 0.7m, are tossed randomly across each surveyed bee bed 24 times, and the number of emergence holes contained within each quadrat is counted and recorded. The same 13 bee beds were consistently sampled year-after-year and were initially selected for observation due to known history of alkali bee nesting activity, ease of access, and interest from grower collaborators. In 2021 Bed 12 was eliminated from the study because the grower had abandoned it and the bed was condemned by the Washington Department of Transportation since it is in the roadbed of the new Highway 12 upgrade project connecting Wallula to Frenchtown. New beds were added to the survey in 2018 and added to the total count of bees but for consistency we report these data as a separate value and leave a column in Table 2 to represent the original 13 (now 12) beds. At each bee bed, special care was taken to ensure that each quadrat landed in a previously unsampled space. Surveyors "calibrated" their counts at the beginning of the survey by counting three quadrats together to ensure that each person counted the same number of bee emergence holes. For continuity, every year at least one of the surveyors had participated in surveys the prior year. In 2022 all 3 surveyors had multiple years of experience. The emergence hole counts were used to estimate the number of active nests per bee bed using the following formula:

2 x ([Mean number of quadrat counts per 0.5 m2 ± SE] x [2/3] x [surface area of bee bed])

This formula was first proposed by Jim Cane through video observations of nesting activity that found that two-thirds of nest holes were being actively provisioned. The practice of using surface nest holes to estimate alkali bee populations was then validated by Vinchesi and Walsh (2014), which confirmed that surface nest hole counts were tightly correlated with the abundance of belowground prepupae. The above formula has been adjusted to rectify an error in Vinchesi and Walsh in 2014, which failed to account for the use of $0.5m^2$ quadrats instead of $1m^2$ quadrats. As a result, all population estimates previously reported by Vinchesi and Walsh in 2014 were doubled before inclusion here.

Results

From 2010 to 2021 the estimated population abundance of alkali bees varied from a low in 2021 of 1.6 million from the peak of over 9.4 million in 2012 (Table 2). These results have been alarming and it is unfortunate that the alkali bee population dropped so dramatically over that period of time. However, the addition of 3 fairly new and very active bee beds brought the total count to 2.5 million in 2022.

Table 2. Estimated population abundance of alkali bees from 13 managed bee beds from 2010 through 2017, in 16 managed bee beds from 2018 through 2020, and in 15 managed beds in 2022 in the Touchet Valley of Walla Walla County, WA. Bed 12 from the original 13 was eliminated in 2021.

	Original 13 beds	Plus 3 new beds
2010	8,437,000	
2011	5,335,000	
2012	9,428,000	
2013	6,917,000	
2014	4,005,000	
2015	6,177,000	
2016	8,211,000	
2017	7,053,000	
2018	7,354,000	10,294,000
2019	4,763,000	6,550,000
2020	3,590,000	4,564,000
2021	1,601,921	2,505,126
2022	2,279,528	3,272,243
2023	1,919,444	2,932,364

Discussion

Alkali bees continue to serve as an important resource for alfalfa seed growers in the Touchet, Gardena, and Lowden alfalfa seed growing areas. The population abundance of these bees has dropped over several years. Economic issues and low demand for seed led to a decrease in acreage over the past several years. This may have contributed to declines in alkali bees. We anticipated that 2023 would be another low year for alkali bee abundance. However, we had one event in 2014 in which an individual grower had a mishap and treated their fields with their late spring clean-up spray in 2013. This single event led to a dramatic drop in the total abundance of bees in 2014 to just over 4 million bees. However, the bee abundance in this bed recovered to its original population abundance by 2015. Well managed alkali bee beds appear to be very resilient. If economic conditions improve for alfalfa seed growers, we anticipate that alkali bees will prove resilient and rebound.

Publications

Clements, J., J. Barbour, M. Haylett, B. Nelson, B. Bradford, & D. Walsh. 2022. Examining

historical rates of leafcutting bee brood cell pathogens, parasitoids, and predators to establish baseline infectivity rates for alfalfa seed growers. J Econ Entomol. doi.org/10.1093/jee/toac082

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Lygus and Weevil Management on Alfalfa Produced for Seed

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Project Summary: Washington State alfalfa seed growers must control their key crop-limiting pest Lygus bug. Economic control of Lygus requires insecticide applications pre-bloom and during bloom, which unfortunately can coincide with the timeframe during which pollinators can be actively foraging and are provisioning their brood, rendering themselves and the next generation of bees vulnerable to insecticide exposure. This limits the cohort of insecticides available for use during bloom. Hence the need for additional testing. The revocation of the tolerance for chlorpyrifos on alfalfa impacts alfalfa seed growers and will only serve to increase overreliance on synthetic pyrethroids for alfalfa weevil control. Hence we have take a snap-shot on the resistance status of alfalfa weevils in several forage and seed growing areas of Washington State to several commonly applied pyrethroid insecticides.

Project Objectives:
a) Conduct insecticide efficacy tests for candidate Lygus control insecticides for use in the pre-bloom cleanup program.
b) Conduct insecticide efficacy tests for candidate Lygus control insecticides during bloom.
c) Conduct Bioassays to quantify resistance status of alfalfa weevil populations to pyrethroid insecticides.

Progress by objective:
Objective a) Conduct insecticide efficacy tests for candidate Lygus control insecticides for use in the pre-bloom cleanup program. Table 1 details the treatments in our pre-bloom 2022 spray program.

Table 1. Detail of Lygus/aphid pre-bloom sprays on Alfalfa Seed 2022

#	Product	Active ingredient	Rate/acre	
1	Untreated Control			
2	Beleaf 50 SG	flonicamid	2.8	oz/acre
3	Brigade 2EC	bifenthrin	6.4	Fl oz/acre
4	Proprietary	propriatary	81	g/acre
5	Mustang Max	zeta-cypermethrin	4	Fl oz/acre
6	Orthene 97	acephate	1	lb/acre
7	Transform	sulfoxaflor	2.25	oz/acre
8	Steward	Indoxcarb	11.3	Fl oz/acre
9	Sefina	afidopyropen	10	Fl oz/acre
10	Sefina	afidopyropen	14	Fl oz/acre
11	Brigade 2EC	bifenthrin	6.4	Fl oz/acre
	plus Mustang Max	zeta-cypermethrin	4	Fl oz/acre

Insecticides were applied on 6/22/2022 to 4 replicate plots of 12' by 20' per treatment by CO2 powered flat fan boom sprayer. Plots were sampled pre-treatment on 6/21/2022 and 2, 7, 9, and 15 days after treatment on 6/24, 6/29, 7/1, and 7/7/2022, respectively. Sampling was by five 180° sweeps per plot and counting the number of pests including adult Lygus, large and small lygus nymphs, aphids, and alfalfa weevils, and beneficial arthropods including spiders, big-eyed bugs, minute pirate bugs, nabids, lady bird beetles, and lace wing larva capture within the net. Data was entered in spreadsheets. Data was analyzed by analysis of variance and if treatment difference were significant ($p<0.05$) pairwise *t*-tests we completed between the untreated control and each respective insecticide treatment. There were no statistical differences in the abundance of beneficials and were usually low among the samples collected and the data is not shown.

Table 2. Pest abundance as adult Lygus and large and small Lygus nymphs and aphids per five 180° sweeps with a sweep net.

1-day Pretreatment

21-Jun Treatment	rate	Lygus Adults	lrg Nymphs	Sml Nymphs	Aphids
Beleaf 50 SG	2.8 oz	15.25	4.50	1.00	95.00
Brigade & Mustang	6.4 & 4 oz	14.50	5.50	1.50	95.00
Brigade 2 EC	6.4 oz	16.50	5.25	3.25	82.50
Mustang Max	4 oz	18.25	6.25	0.00	110.00
Orthene 97	1 lb	16.50	6.00	2.00	132.50
Sefina 10	10 oz	14.75	3.00	1.00	110.00
Sefina 14	14 oz	10.00	5.25	4.75	100.00
Proprietary	81 g	13.25	7.25	1.00	125.00
Steward	11.3 oz	15.50	6.25	1.50	85.00
Transform	2.25 oz	14.00	4.50	2.50	132.50
Untreated	0	11.00	4.75	1.25	107.50

2 days after treatment

24-Jun Treament	rate	Lygus Adults	lrg Nymps	Sml Nymphs	Aphids
Beleaf 50 SG	2.8 oz	10.5**	1.00**	0.00**	38.25**
Brigade & Mustang	6.4 & 4 oz	7.75**	0.25**	0.00**	2.25**
Brigade 2 EC	6.4 oz	8.00**	2.00**	1.25**	3.25**
Mustang Max	4 oz	8.00**	1.25**	1.75**	47.75*
Orthene 97	1 lb	13.50**	1.25**	0.75**	41.50*
Sefina 10	10 oz	9.75**	2.75*	1.50**	23.25**
Sefina 14	14 oz	19.00ns	1.75**	1.75**	18.25**
Proprietary	81 g	26.50ns	4.25ns	2.25ns	56.50ns
Steward	11.3 oz	14.00**	0.50**	0.75**	60.25ns

Transform	2.25 oz	12.50.**	1.25**	0.25**	28.00**
Untreated	0	29.75	5.75	4.25	103.75

7 days after treatment

29-Jun		Lygus			
Treament	rate	Adults	lrg Nymps	Sml Nymphs	Aphids
Beleaf 50 SG	2.8 oz	27.25**	3.00*	12.25ns	45.00ns
Brigade & Mustang	6.4 & 4 oz	20.50**	1.00*	1.75**	11.50**
Brigade 2 EC	6.4 oz	20.75**	1.00*	6.25**	3.50**
Mustang Max	4 oz	20.50**	1.00*	9.00*	6.50**
Orthene 97	1 lb	27.75**	2.00*	5.00**	60.00ns
Sefina 10	10 oz	23.25**	2.75*	17.00ns	5.50**
Sefina 14	14 oz	26.50**	4.75ns	21.75ns	4.50**
Proprietary	81 g	34.50ns	3.75*	15.50ns	25.00ns
Steward	11.3 oz	34.25ns	1.50*	10.00*	78.75ns
Transform	2.25 oz	39.50ns	2.50*	6.00**	41.00ns
Untreated	0	46.00	6.00	15.50	45.75ns

9 days after treatment

1-Jul		Lygus			
Treament	rate	Adults	lrg Nymps	Sml Nymphs	Aphids
Beleaf 50 SG	2.8 oz	22.25	3.25*	5	34
Brigade & Mustang	6.4 & 4 oz	25	0.25*	2.5	3.25
Brigade 2 EC	6.4 oz	23.75	1.50*	4.75	1.25
Mustang Max	4 oz	22	4.00*	11	36
Orthene 97	1 lb	22.5	1.25*	6	15
Sefina 10	10 oz	27.5	4.75*	15.75	8.75
Sefina 14	14 oz	15.75	1.75*	18.25	10
Propriatory	81 g	29.25	6.25ns	14.25	17
Steward	11.3 oz	28.25	0.75*	9	63.25
Transform	2.25 oz	25	3.50ns	9	8.75
Untreated	0	24.5	4	13.5	47.25

15 days after treatment

7-Jul		Lygus			
Treament	rate	Adults	lrg Nymps	Sml Nymphs	Aphids
Beleaf 50 SG	2.8 oz	26.75	5.25ns	18.75	3
Brigade & Mustang	6.4 & 4 oz	31	3.75*	14.25	0.75
Brigade 2 EC	6.4 oz	26.25	8.25ns	21.25	2.75
Mustang Max	4 oz	20	9.25ns	39.5	6.25
Orthene 97	1 lb	26.5	4.75*	17.25	5.25
Sefina 10	10 oz	15.25	9.25ns	48.5	0.25
Sefina 14	14 oz	15.5	8.25ns	39.5	2
Propriatory	81 g	20.75	19.00ns	31.5	5.75
Steward	11.3 oz	23	6.25ns	44	1.75
Transform	2.25 oz	20.5	10.00ns	23	2.5
Untreated	0	15.25	12.25	26.5	0.5

Results and discussion

Many of the insecticides applied knocked back the abundance of Lygus adults in these plots for a short-period after insecticide application. These trials are conducted in an area that has a substantial amount of forage alfalfa and adults quickly move back into treated plots. The older organophosphate and pyrethroid chemistries and Steward and Transform maintained control of Lygus nymphs both large and small for about a week. At 9 days after treatment control was beginning to break for Lygus nymph control with most chemistries. Aphid control was achieved for a week with applications of Brigade, Mustang, a combination of both and Sefina at 1 week after treatment. In early July we finally had a heat wave and aphid populations naturally crashed in these test plots.

Objective b) Conduct insecticide efficacy tests for candidate Lygus control insecticides during bloom.

On July 19 the insecticides detailed below were applied to 4 replicate plots of 12' by 20' in the equivalent of 20 gallons of water carrier per acre. Plots were sampled by

Table 3. Bloom Insecticides applied on July 19, 2022

1	Untreated Control			
2	Beleaf 50 SG	flonicamid	2.8	oz/acre
3	Proprietary	propriatary	81	g/acre
4	Transform	sulfoxaflor	2.25	oz/acre
5	Steward	Indoxcarb	11.3	Fl oz/acre
6	Sefina	afidopyropen	14	Fl oz/acre

Insecticides were applied on 7/19/2022 to 4 replicate plots of 12' by 20' per treatment by CO_2 powered flat fan boom sprayer. Plots were sampled pre-treatment on 7/18/22 and 2, 6, and 9, days after treatment on 7/21, 7/25, and 7/28, respectively. Sampling was by five 180° sweeps per plot and counting the number of pests including adult Lygus, large and small lygus nymphs, aphids, and alfalfa weevils, and beneficial arthropods including spiders, big-eyed bugs, minute pirate bugs, nabids, lady bird beetles, and lace wing larva capture within the net. Data was entered in spreadsheets. Data was analyzed by analysis of variance and if treatment difference were significant (p<0.01) pairwise t-tests we completed between the untreated control and each respective insecticide treatment. There were no statistical differences in the abundance of beneficials and were usually low among the samples collected and the data is not shown.

Table 4. Pest abundance as adult Lygus and large and small Lygus nymphs per five 180° sweeps with a sweep net.

7/18/2022	Pre-Treatment^{ns}		
Treatment	Adult^{ns}	Large^{ns}	Small^{ns}
Untreated	22.25	3.25	5.00
Beleaf 50 SG	29.25	6.25	14.25
Propriatary	15.75	1.75	18.25
Sefina 14	21.00	2.75	9.00
Steward	26.25	4.25	9.25
Transform	17.50	3.50	8.50

7/21/2022	2 Days after Treatment		
Treatment	Adult$^{0.01}$	Large$^{0.01}$	Small$^{0.01}$
Untreated	38.75	10.00	19.75
Beleaf 50 SG	25.00	5.25**	2.00**
Propriatary	21.25**	6.00**	6.00**
Sefina 14	20.00**	5.75**	3.25**
Steward	30.00	4.25**	4.00**
Transform	12.00**	0.25**	1.75**

7/25/2022	6 Days after Treatment		
Treatment	Adult^{ns}	Large^{ns}	Small^{ns}
Untreated	29.50	7.25	10.25
Beleaf 50 SG	21.50	6.00	6.75
Propriatary	30.00	11.00	4.50
Sefina 14	19.25	5.25	4.50
Steward	25.25	8.50	5.50
Transform	16.50	3.00	3.00

7/28/2022	9 Days after Treatment		
Treatment	Adult$^{0.05}$	Large$^{0.01}$	Small$^{0.01}$
Untreated	31.00	15.75	14.00
Beleaf 50 SG	15.00*	12.00	7.75**
Propriatary	29.75	13.00	10.50
Sefina 14	21.25	8.00**	5.00**
Steward	26.25	14.25	7.75**
Transform	24.50	6.50**	4.00**

Given the results of these field trials alfalfa seed growers have some powerful and effective insecticides available for their use during the bloom period.

Objective c) Conduct Bioassays to quantify resistance status of alfalfa weevil populations to pyrethroid insecticides.

To quantify the dose response of alfalfa weevil populations in Washington State weevil larva were collected at 4 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 an alfalfa forage field in Goldendale, an alfalfa field at WSU Othello, an alfalfa field near Gardena, and an alfalfa field at WSU IAREC. The 4 insecticides tested included the registered products Warrior II (lambda-cyhalothrin), Mustang Maxx (zeta-cypermethrin), Baythroid (beta-cyfluthrin) and Lorsban Advanced (chlorpyrifos). Serial dilutions were completed for each insecticide in a dilution equivalent to 20 gallons per acre at 100%, 75%, 50%, 25%, 10%, 5%, and 0% of the maximum field rate for Lorsban Advanced and Warrior II 75%, 50%, 25%, 10%, 5%, and 0% of the maximum field rate for Mustang Maxx and Baythroid. 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 morality after 48 hr of exposure due to greater consistency of results. Weevil larva were considered dead when they failed to respond to being touched with a fine camel hair brush.

Figure 1. Dose response of alfalfa weevil populations in percent mortality ± Std error to chlorpyrifos (Lorsban Advanced)at concentrations equivalent to 0, 5, 10, 25, 50, 75, and 100% of the maximum field rate in parts per million (mg/liter)

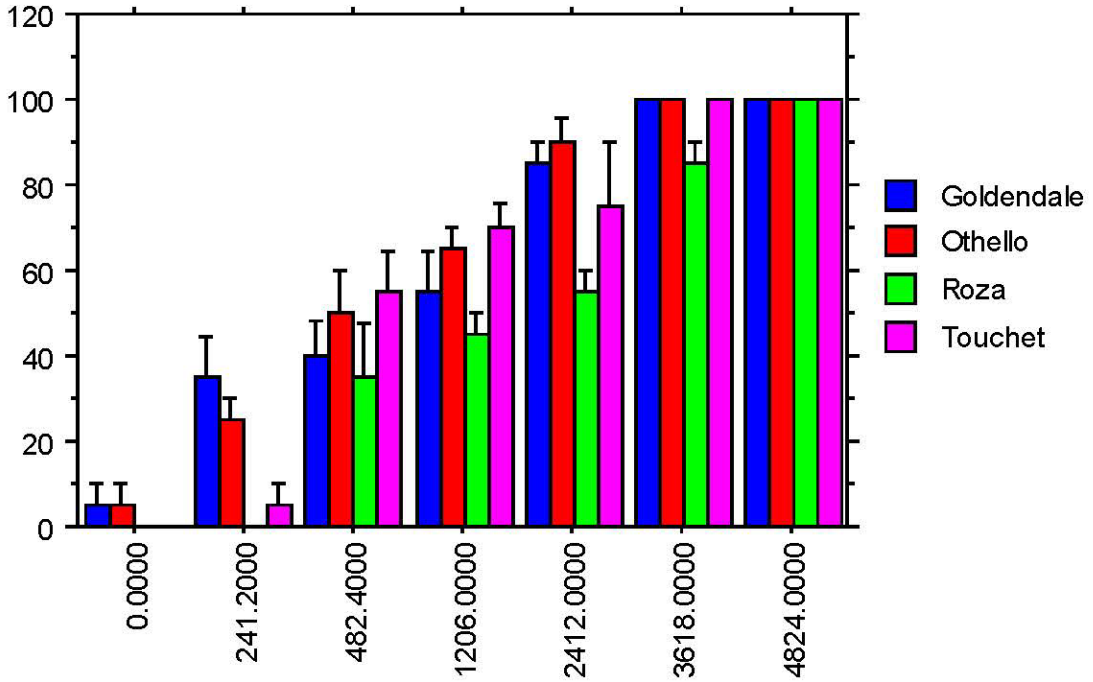


Figure 2. Dose response of alfalfa weevil populations in percent mortality ± Std error to lambda-cyhalothrin (Warrior II) at concentrations equivalent to 0, 5, 10, 25, 50, 75, and 100% of the maximum field rate in parts per million (mg/liter)

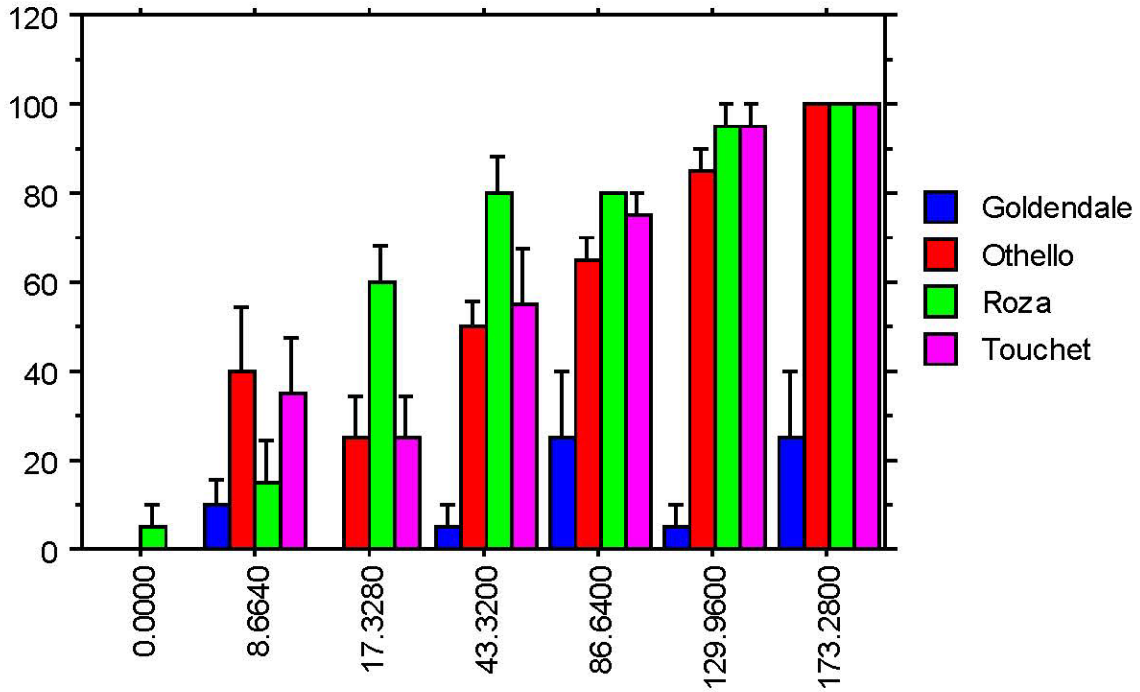


Figure 3. Dose response of alfalfa weevil populations in percent mortality ± Std error to zeta-cypermethrin (Mustang Maxx) at concentrations equivalent to 0, 5, 10, 25, 50, and 75% of the maximum field rate in parts per million (mg/liter)

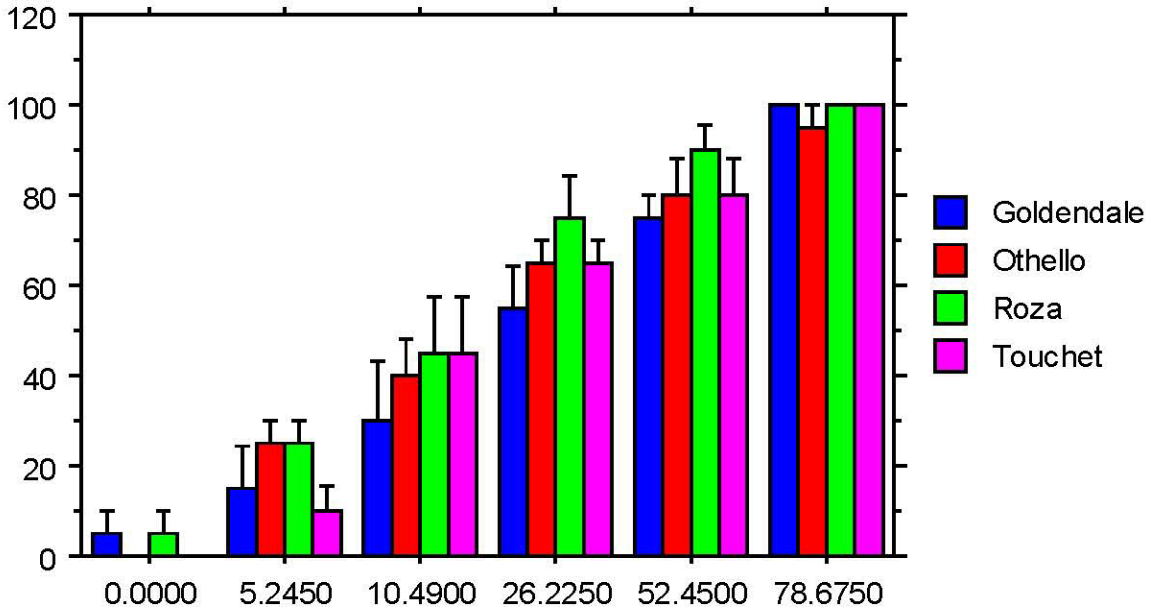
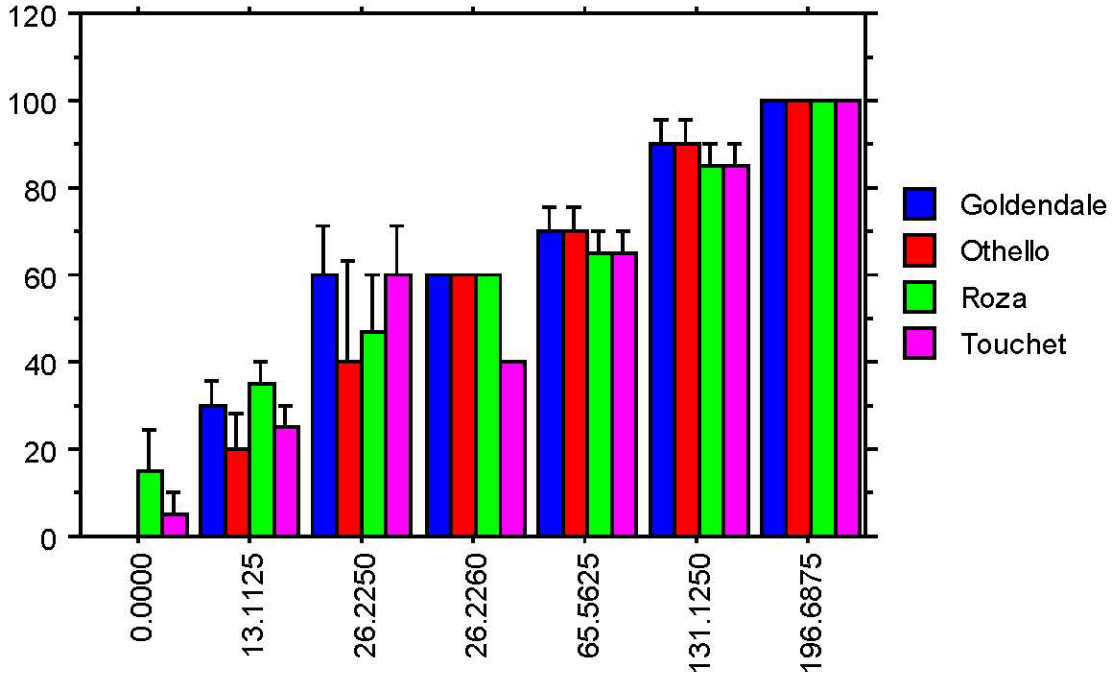


Figure 4. Dose response of alfalfa weevil populations in percent mortality ± Std error to beta-cyfluthrin (Baythroid) at concentrations equivalent to 0, 5, 10, 25, 50, and 75% of the maximum field rate in parts per million (mg/liter)



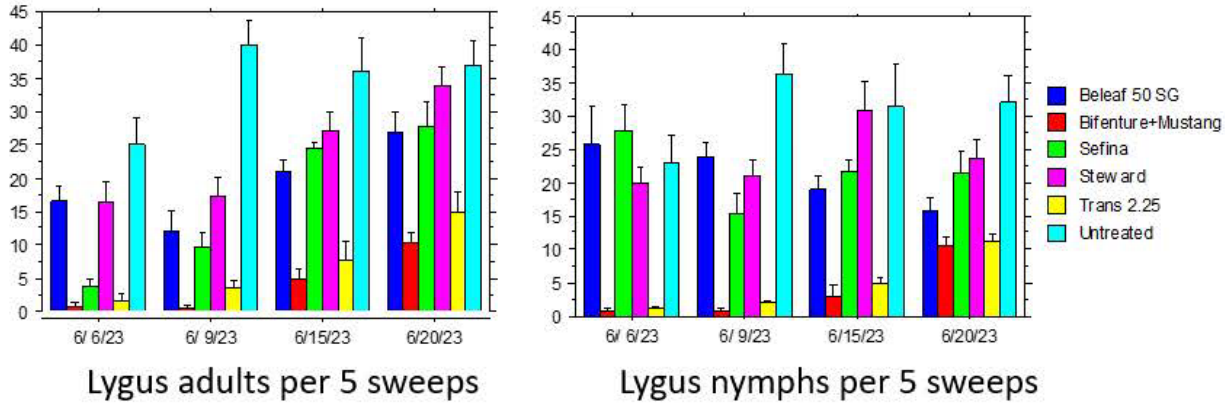
Among all the 4 populations tested against the organophosphate chlorpyrifos and the 3 synthetic pyrethroids, only the Goldendale population exhibited resistance to lambda-cyhalothrin and the Roza population exhibited resistance to chlorpyrifos. The revocation of the tolerance on using Lorsban Advanced (chlorpyrifos) for alfalfa weevil control will only put increased pressure on the synthetic pyrethroids and increase the likelihood of resistance developing to the pyrethroids.

Project Title: Lygus Insecticide Studies 2023
Principal Investigator: Doug Walsh, Coordinator, Integrated Pest Management, WSU

1) Field test candidate compounds and recommended commercially available insecticides for their efficacy against Lygus bugs. A field plot was established on the WSU Roza Unit and the following insecticide treatment were applied to 4 replicate plots on June 5, 2023. Sweep net samples were completed pre-treatment, and 1, 4, 10, and 15 days after treatment. Plots were no longer sampled after 21 days since any treatment effect had eroded. Sulfoxaflor provided better Lygus control than naled and other treatments. We still observe synergy through tank mixing Bifenture and Mustang Max. These could be a powerful combo as a clean-up spray, but both insecticides would be extremely toxic to bees.

#	Trade name	active Ingredient	rate		plot #s
1	Untreated Control				103, 204, 302, 406
2	Beleaf 50 SG	flonicamid	2.8	oz/acre	105, 202, 306, 405
3	Transform	sulfoxaflor	2.25	oz/acre	102, 205, 301, 401
4	Steward	Indoxcarb	11.3	Fl oz/acre	106, 203, 303, 404
5	Sefina	afidopyropen	14	Fl oz/acre	101, 201, 305, 402
6.	Bifenture +	bifenthrin	8.5	Fl oz/acre	104, 206, 304, 403
	Mustang Maxx	zeta-cypermethrin	8.0	Fl oz/acre	

Figure 1. Lygus adults and Lygus nymphs per 5 sweeps at 1, 4, 10, and 15 days after treatment.



Lygus adults per 5 sweeps

Lygus nymphs per 5 sweeps

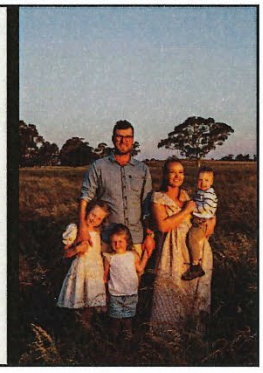
ALFALFA SEED PRODUCTION IN AUSTRALIA

BEN FARMER
NASHVILLE 2024

1

About me

- Married with 3 kids
- Live, work & farm in Keith, South Australia
- Enjoy food & good coffee, music & farming
- Finished University end of 2013 to begin my agronomy career
- Bought our farm in December 2016
- Formed our own seed trading company, Wilkei Seeds, in December 2020
- Committee member of Lucerne Australia since Oct 2022, deputy Chair since Oct 2023



2

LUCERNE SEED PRODUCTION SYSTEM

3

Lucerne Seed Production - Details

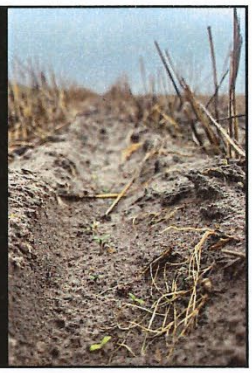
- Soil type
  - *From shallow heavy soil to deep sand*
- Climate
  - *Approx 450mm rainfall*
  - *Temperate climate*
- Irrigation
  - *Center pivots & flood irrigation*
  - *Salinty 3,000 - 7,500ppm*
- Pest management
  - *Native Budworm, Australian Crop Mirid, Green mirid, Blue green aphid & Lucerne seed wasp*
- Pollination
  - *Predominately commercial honey bees*

4

Lucerne Seed Production - System

Establishment:

- 2-3 year sequence
- Wind erosion and insect pest pressure
- Success heavily reliant on rainfall & preparation
- Seed placement
- Planting timing



5

Lucerne Seed Production - System

Paddock preparation:

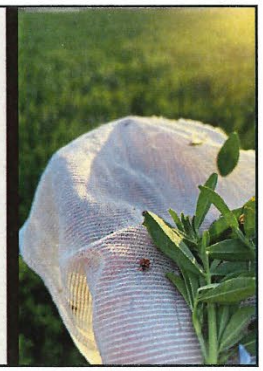
- Weed control and fertiliser
- Hay making
- Seed crop closure timing
  - *Weather patterns*
  - *Lucerne Seed Wasp*
- Irrigation timing/intervals
- Water use efficiency
  - *Approx 4-8 ML/ha*

6

Lucerne Seed Production - System

The growing season:

- Different IPM strategies between consultants
- Varying skill levels between growers
  - *Varying dependence on consultants*
- Pest management
  - *Native Budworm, Australian Crop Mirid, Green mirid, Blue green aphid & Lucerne seed wasp*
- Irrigation strategies
  - *Pivot vs Flood*



7

Lucerne Seed Production - System

Harvest

- Harvest timing
  - *Pod ripeness*
- Windrowing vs Direct heading
- Seed damage/abnormal seedlings
- Weather damage
- Yield expectations
  - *Varieties*
  - *Soil types*
  - *Water quality*

8

Lucerne Seed Production - System

Certification & regulation

- Public vs PBR varieties
  - *Yield potential*
  - *Marketing advantages/disadvantages*
- Certified stand life
- Uncertified seed production – largely Aurora, Dorm 7 & Dorm 8/9

9

Lucerne Seed Production - Business

Marketing:

- Contracted PBR Material
  - Expected prices announced around harvest
  - Payment schedules vary between companies and usually between 90 days and 12 months
- Public lucerne varieties
  - Companies, like Wilkei Seeds, offer current pricing and often shorter payment terms
  - Common varieties such as Aurora, Sequel & Siriver

10

LUCERNE AUSTRALIA

INDUSTRY CHALLENGES/OPPORTUNITIES:

- Peak industry body – Lucerne Australia represents seed producers in all aspects of production
  - *Insect & weed pest resistance*
    - Identifying & quantifying
  - *Emergency us permits*
  - *Various variety trials*
    - Irrigation and fertiliser
- Information and knowledge transfer
  - *IPM strategies and irrigation management*
- Marketing information is limited
- Growers lack a comparable competing crop type to lucerne

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