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Wyoming Producer Priorities and Perceptions of Alfalfa Insect Pests

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Abstract

Although insect pest management in alfalfa (*Medicago sativa* L. [Fabales: Fabaceae]) hay remains a major challenge in the Western United States, we know comparatively little about the producer priorities and perceptions of alfalfa insect pests. Given the importance of alfalfa to Wyoming agriculture, we sought to better understand producer priorities regarding insect pest management in alfalfa. We developed a survey instrument that was mailed to 3,141 individuals by the National Agricultural Statistics Service (NASS). We received 634 returned surveys, a response rate of 20.7% of all Wyoming alfalfa producers. Respondents were asked to list all insect pests they had encountered in their experience growing alfalfa, and then to select the most problematic from the list they generated. Sixty-six percent of respondents named alfalfa weevil *Hypera postica* (Gyllenhal; Coleoptera: Curculionidae) as the most problematic insect pest they had encountered. Eighteen percent of respondents named grasshoppers (Orthoptera) as most problematic, and 8% of respondents named aphids (Hemiptera: Aphididae). Producers indicated a variety of agronomic, economic, biological, and weather-related reasons that rendered these insects as problematic pests. For each of the three most problematic pests, insecticide application and early harvest of hay were practiced by the largest number of Wyoming producers according to our survey results. For all three of these pests, insecticides are both used most often and considered most effective by the most respondents. These findings suggest an important opportunity for future research on integrated insect pest management.

Key words: alfalfa, *Medicago sativa*, survey, farmer knowledge, *Hypera postica*

Alfalfa (*Medicago sativa* L. [Fabales: Fabaceae]), a perennial legume harvested most often for hay, is the largest acreage crop in the state of Wyoming, valued at \$158 million in 2015 (USDA-NASS 2015). Insect pest management in alfalfa remains a major challenge not only in Wyoming but throughout the Western United States, with considerable research focused on the biology and management of pests such as alfalfa weevil *Hypera postica* (Gyllenhal; Coleoptera: Curculionidae) and aphids (Hemiptera: Aphididae) (e.g., Evans and England 1996, Rand 2013, Pellissier et al. 2016). However, we know comparatively little about the priorities and perceptions of alfalfa insect pests by producers. Alfalfa pests can be managed with a diversity of practices but it is largely unknown whether producers utilize all of these practices or not and which they prefer.

Studies that deliberately examine producer priorities are critical given the potential for ‘expert’ scientist priorities to vary from those of the producers they serve (Jabbour et al. 2013, Zwickle et al. 2014). Scientists have also observed links between social dimensions such as farmer knowledge with biological dimensions like pest infestation levels (i.e., Wyckhuys and O’Neil 2007, Jabbour et al. 2014, Liebig et al. 2016). For example, interviews with organic farmers in New England revealed farmers with higher levels of knowledge about

weed management also had lower actual weed seed densities on farm (Jabbour et al. 2014). When farmers were asked about biological pest control in Honduras, they were more likely to mention easily observable organisms like birds and ants, rather than parasitoid wasps which are generally smaller in size or ground beetles which are more active at night (Wyckhuys and O’Neil 2007). Finally, recent research (Noy and Jabbour 2017) suggests farmers are most likely to go to other farmers for advice on a variety of issues including pest management, further underscoring the importance of understanding farmer perceptions and pest management strategies. These examples highlight how farmer perceptions importantly pattern both interventions and outcomes. Information from the producer perspective provides a launch pad for targeted farmer education efforts. This direction can be critical in resource-limited support organizations, whether cooperative extension or nonprofit organizations.

Given the importance of alfalfa to Western agriculture, we sought to better understand producer priorities regarding insect pest management in alfalfa. Alfalfa producers are a diverse group, including production of hay, seed, and use for grazing, further motivating detailed information on variation of challenges and practices across this diverse population of producers. Given cattle are a

major livestock component of Wyoming agroecosystems in particular, alfalfa producers may identify primarily as ranchers who also happen to grow hay to feed their own animals. On the other hand, Wyoming farmers also specialize in growth and marketing of alfalfa, sometimes as certified hay or to other high-end niche markets (e.g., goat dairies in the Eastern United States or for export to Asia). These producers may or may not have livestock on their operation. The three primary objectives of our survey were:

- 1) To evaluate producer awareness and knowledge of insect pests of alfalfa
- 2) To identify which insects are most problematic to producers and why
- 3) To describe which insect pest management practices are used most often and considered most effective by Wyoming producers

Methods

Survey Development and Distribution

We developed a survey instrument to evaluate the priorities and perceptions of Wyoming alfalfa producers with a focus on insect pests. The survey included questions about respondents' socio-demographic characteristics; farm size, production, and output; alfalfa insect pests and pest management; and questions about respondents' social networks. We sought feedback from four Extension professionals when crafting our survey instrument. We then piloted the survey with a focus group consisting of six alfalfa producers in southeastern Wyoming. The focus group was held at the local Extension office. The producers were recruited by the county Extension educator according to our request that producers vary according to experience level, market, and scale of operation. The respondents completed the survey in approximately 20 min and we asked them to provide us with feedback about the clarity, substance, and presentation of the questions. We refined the instrument based on their feedback to improve clarity and readability which then informed minor edits of that instrument. The protocol was approved as exempt by the University of Wyoming Institutional Review Board.

For survey distribution we utilized the National Agricultural Statistics Service (NASS), who mailed it to alfalfa farmers on record in Wyoming. The survey was mailed to 3,141 farmers (of 3,246) in March 2015. The U.S. Postal Service was unable to locate 105 of them. Eighty-three surveys were returned uncompleted because farmers reported they did not farm alfalfa or were not farming or refused to respond and/or asked to be removed from the survey list. Farmers were sent one postcard reminder, 2 wk after the initial survey was mailed in an attempt to maximize the response rate (Dillman et al. 2014). Of eligible respondents, we received 634 (20.7%) completed surveys. Raw data from returned surveys were entered by NASS staff, and de-identified data were provided to us. This data forms the basis of our descriptive and correlation analysis.

Results

Respondent Demographics

Eighty-eight percent of respondents were male and 12% were female. Three-fourths of respondents were over the age of 55. Mean years of farming experience was 30.5, and mean years of living in Wyoming was 49.4 yr. This suggests these producers tend to have considerable farming experience and to be familiar with Wyoming growing conditions. Eighty percent of respondents listed irrigated alfalfa acreage in production, 14.5% of respondents listed dryland

alfalfa acreage in production, and 5.5% of respondents indicated they had both irrigated and dryland alfalfa. Alfalfa acreage reported was an average of 123.9 acres. The majority of respondents indicated they grow alfalfa for animal feed, either on-farm to their own animals or to market (Table 1). Only 1.4% of respondents indicated they grow certified organic alfalfa.

Number of Insect Pests Mentioned

Respondents were invited to list up to nine insect pests in alfalfa they had encountered (they were given nine blanks in which to list them). Over half of respondents listed a single insect (55%), about a third (31%) listed two insects, 11% listed three insects, and the remaining 3% of respondents named four to seven insects. The low numbers of insects listed indicates limited experience with or awareness of insects in alfalfa.

Most Problematic Pests

After listing alfalfa insect pests, respondents were asked to draw a star next to the insect pest they considered most problematic. The survey responses varied in taxonomic resolution, with insects identified at the species, family, and order level, almost entirely using common names. Altogether, alfalfa weevil *H. postica* was most frequently mentioned as the most problematic insect pest (65% responses). Grasshoppers (Orthoptera) and aphids (Hemiptera: Aphididae) were the second and third most problematic insect pests, at 18% and 7% of responses, respectively. All other pests mentioned were rarely indicated as most problematic. These cases likely represent producers who have had isolated experiences dealing with pests such as cutworm species (Lepidoptera: Noctuidae), blister beetles (Coleoptera: Meloidae), and root-feeding pests. Cutworms and root-feeding insects such as clover root curculio *Sitona hispidulus* (Fabricius) can damage alfalfa (Weninger and Shewmaker 2014, Blodgett and Peairs 2016). Blister beetles affect quality and markets given their toxicity to horses (Brewer and Peairs 2016). Lygus bugs (Hemiptera: Miridae) are problematic in seed alfalfa (Blodgett 2016). All insects listed are generally considered pest insects of alfalfa with the exception of one listing of lady beetles, which are usually categorized as beneficial because of their predation of aphids and other soft-bodied insects.

After selecting their most problematic pests, respondents were asked to describe why they identified this pest as the most problematic. We summarized the reasons for the three most commonly selected pests: alfalfa weevil, grasshoppers, and aphids. Responses were coded into six themes (Table 2). Some responses ($n = 74$) were coded multiple times if the content reflected distinct themes. For example, one respondent stated aphids were problematic because they 'move in from outside alfalfa fields a few days before 1st cutting, and chemicals require 10–15 days wait before harvest.' For this response, we coded for landscape-scale, timing, and control required. Most responses ($n = 200$) were coded into a single theme. Ninety-five respondents selected a most problematic pest but did not indicate

Table 1. Alfalfa end-use as indicated by respondents

Use	Percent of respondents
On-farm feed (only)	42.7
Market hay (only)	20.4
On-farm feed & market hay (both)	32.3
Seed (plus other use)	1.1
Seed (only)	0.9
Other use selected	2.7

Table 2. Themes mentioned by Wyoming alfalfa producers to explain problematic nature of insect pests

	Reasons to consider insect pests as problematic (% of responses)		
	Alfalfa weevil (<i>n</i> = 258)	Grasshoppers (<i>n</i> = 72)	Aphids (<i>n</i> = 27)
Yield impact	38.0	37.5	33.3
Crop quality	3.9	0.0	3.7
Control required or difficult	10.1	6.9	11.1
Timing	27.5	22.2	29.6
Weather association	3.5	2.8	3.7
Pest biology	13.6	20.8	11.1
Landscape-scale	1.9	5.6	7.4
Other	1.6	4.2	0.0

a reason. Yield impact, timing, and pest biology were the top three reasons, respectively, indicated for the problematic nature of alfalfa weevil, grasshoppers, and aphids (Table 2).

Reasons for Identifying Alfalfa Weevils as Most Problematic by Wyoming Alfalfa Producers

Yield impact from alfalfa weevil was described as destroying, cutting, eating or loss of alfalfa or tonnage, with one respondent stating, ‘they have a good appetite—sometimes a great appetite. It causes the most damage, most quickly.’ Challenges related to timing included discussion of timing of this pest activity within the season or across years. Respondents indicated alfalfa weevil is most problematic because it is an early season pest, especially damaging to the first cutting but with the potential for damage to multiple cuttings. There is a ‘short time span to control’ because ‘damage comes on quick before harvest.’ Respondents sometimes took a longer-term perspective reporting alfalfa weevils are ‘always there,’ ‘every year no matter what,’ and have ‘been here for years.’ The biology of alfalfa weevil (‘pest biology,’ Table 2) was referenced by those who either thought it was the only insect causing problems in alfalfa or a particularly abundant pest. Some respondents described alfalfa weevil as the ‘only real damaging pest’ or the ‘only insect we encounter,’ ‘the only one we have,’ and so forth. Others highlighted the abundance of this pest, ‘don’t know how to get rid of them, got thousands’ or ‘when they hatch there are millions with big appetites.’

Control was repeatedly indicated as necessary although costly in the context of alfalfa weevil, with a focus on chemical control. Several respondents wrote they ‘need to spray annually.’ One specified ‘I have to spray or I lose a lot.’ Farmers discussed the cost and timing of chemical control: they ‘can’t afford to spray’ or ‘aerial spraying is expensive.’ Depending on their scale, type of irrigation, location, and current infrastructure, aerial spraying may be the only option for some producers. Association of alfalfa weevil with crop quality, weather, or landscape-scale processes was limited. In short, producers mentioned reduced crop quality due to alfalfa weevil; association with hot, dry weather; and weevil infestation as a result of management behavior of their neighbors across the landscape.

Reasons for Identifying Grasshoppers as Most Problematic by Wyoming Alfalfa Producers

Discussion of yield impact by grasshoppers was focused on the sheer extent of damage: ‘eats everything,’ ‘major loss,’ ‘eat all the leaves,’ and ‘when they are bad, they can ruin a crop,’ for example. Timing was again indicated as a reason for the problematic nature of grasshoppers, as with alfalfa weevil. However, in contrast to repeated producer descriptions of alfalfa weevils being ‘always there,’ grasshoppers are problematic due to their cyclic outbreaks and bad years.

One respondent explained ‘grasshoppers are common most years and some years they are like the plague’ and another simply stated ‘some years are better than others.’ One respondent focused on the rate of damage, indicating grasshoppers ‘do more, faster, and move in a larger area.’ With regards to the biology of grasshoppers, respondents commented on the generality of grasshopper feeding, stating they are most problematic because they ‘will eat almost any plant’ or ‘everything in sight.’ Visibility was another theme. Several responses indicated grasshopper was selected as their most problematic pest because it is ‘the only insect pest’ they have, although one clarified ‘it’s the only insect pest we have (or are aware of).’ Grasshoppers are much larger than both weevils and aphids, and one respondent simply stated ‘I can see them.’

Difficulty with controlling grasshoppers was mentioned, with respondents indicating they are ‘hard to eradicate’ and ‘spraying doesn’t work and only harms the beneficial insects, and baits do work but on a limited basis.’ In contrast to the discussion of alfalfa weevil, crop quality was not mentioned.

Reasons for Identifying Aphids as Most Problematic by Wyoming Alfalfa Producers

Those producers who listed aphids as the most problematic insect pest most often mention loss of yield of alfalfa, with one stating the alfalfa would be ‘destroyed unless sprayed or crop cut.’ Timing of cutting was also mentioned in conjunction with aphids, with respondents highlighting first cutting ‘can be drastically reduced by a good year for aphids.’ One producer mentioned timing as related to chemical application, specifying ‘chemicals require a 10–15 day wait before harvest.’ Aphid biological traits mentioned as problematic included the reproduction rate, their abundance, their consistent presence each year, and that they ‘seem to be immune to pesticides.’ Another producer mentioned aphids are ‘difficult to control with my limited equipment,’ which may refer to the ability (or lack thereof) to apply pesticides, although this was not explicitly stated. Respondents again referred to the landscape in the context of aphids that ‘move in from outside alfalfa fields.’ Crop quality and weather were rarely mentioned in connection with aphids.

Management Strategies Used Against Most Problematic Pests

Respondents were asked to select all of the management strategies they had used for the insect they indicated as their most problematic pest from a list of provided options. The list of options consisted of insecticide, resistant alfalfa varieties, early harvest, strip harvest, and biological control. We also provided three blank spaces for strategies beyond the five options we provided. If responses listed in the blank spaces were the same as the categories listed above,

Table 3. Management strategies used against most problematic pests (% responses)

	Alfalfa weevil			Grasshoppers			Aphids		
	Tried	Most often	Most effective	Tried	Most often	Most effective	Tried	Most often	Most effective
Insecticide	38.2	55.2	79.8	48.8	52.0	57.1	29.1	76.9	100.0
Resistant alfalfa	7.6	1.7	2.9	3.5	8.0	9.5	9.1	0	0
Early harvest	42.6	35.3	4.8	34.9	28.0	23.8	45.5	23.1	0
Strip harvest	2.1	0	0	3.5	4.0	0	0	0	0
Biological control	5.5	4.3	7.7	2.3	0	0	10.9	0	0
Crop nutrition ^a	0.7	0.9	1.0	3.5	0	0	1.8	0	0
Disturb soil ^a	2.3	1.7	1.9	0	0	0	1.8	0	0
Do nothing ^a	0.2	0	1.0	2.3	8.0	9.5	0	0	0
Graze ^a	0.7	0.9	1.0	0	0	0	1.8	0	0
Other ^a	0.2	0	0	1.2	0	0	0	0	0
Total responses	437	129	109	86	26	22	55	13	12

^aWrite-in responses that did not refer to the five given categories were hand coded into these additional categories.

we merged those counts when summarizing our data. If they were different, we hand coded into new categories including crop nutrition, use of soil disturbance such as harrowing, grazing, and doing nothing (Table 3). Of these, they indicated which strategy they used most often and which strategy they found most effective.

We present the results for alfalfa weevil, grasshoppers, and aphids (Table 3). For each of the three most problematic pests, insecticide and early harvest are the practices the largest number of Wyoming producers in our survey have tried. For all three of these pests, insecticides are both used most often and considered most effective by the most respondents. For alfalfa weevil, respondents used insecticide (55% of responses), early harvest (35%), and biological control most often (4%, Table 3). These response rates shift when respondents indicated which management practices are most effective against alfalfa weevil, with most respondents indicating insecticides are most effective (80%), with biological control lagging in popularity (8%), followed by early harvest (5%). For both grasshoppers and aphids, insecticide was identified as the most effective tool and the one used most often.

Taken together, respondents reported having tried all of the offered pest management choices and more included as write-ins, far fewer producers tried any of the management practices other than insecticide and early harvest. Insecticide was used most often and was considered most effective for these three pests. Thus, there is the opportunity for educators and industry to inform producers of approaches that integrate insecticide use with other practices such as grazing for alfalfa weevil or resistant alfalfa varieties for aphids, as well as to explore if current insecticide use impacts the potential for biological control in this system.

Conclusions

This survey represents novel information about Wyoming alfalfa producers' perceptions of insect pests and effective and popular management strategies. Producers most often indicated that alfalfa weevil was the most problematic pest, offering justification for continued research and education efforts surrounding this pest insect in particular in the intermountain West region. Although we only surveyed Wyoming producers, reports from entomologists in Montana, Utah, Colorado, and Nebraska imply this challenge continues regionally (personal communication to the author). The limited emphasis paid to other pests could be due to less extensive infestation of fields or less awareness of their activity, for instance since soil-dwelling pests are less visible.

When discussing weevils, grasshoppers, and aphids, producers referred to the surrounding landscape, specifically management by neighbors, as a factor driving pest abundance in their fields. A large body of research indicates landscape composition (i.e., proportion of crop vs. natural habitat) surrounding an agricultural field can impact the density of pest, natural enemy, and pollinator insects (Chaplin-Kramer et al. 2011, Chisholm et al. 2014). However, the details and scale of this vary according to the insect species, target crop, and region. Some producers noted the impact of neighboring fields was dependent on whether those fields were sprayed or not. No producers discussed the concept of secondary pest outbreaks, which occur when insecticide application for a target pest leads to high numbers of another pest species, potentially due to nontarget mortality of beneficial predators and parasitoids. However, this may be partly due to the structure of the survey and the question wording, which asked about why the selected pest was the most problematic. Reports of increased aphid densities because of a neighbor spraying could be a secondary pest outbreak, as has been documented in Utah alfalfa (Evans et al. 1993), rather than insect movement between fields. This topic could be a target for future outreach efforts in Wyoming.

The discrepancy between 35% of respondents indicating they utilized early harvest most often to manage weevil but only 5% indicating it is most effective highlights an opportunity for research and Extension professionals to investigate elements of best practices for early harvest. Alfalfa weevil is largely controlled by biological control agents in the Eastern part of the country (Tooker 2013). These biological control agents, parasitoid wasps, were also released in the West (Bryan et al. 1993) and alfalfa weevils infected with some of these species have been found in recent years in Wyoming (Brewer et al. 1997, Pellissier 2016).

Published research from throughout the intermountain West has shown high variability in weevil parasitism rates across sites, indicating existing populations are not always able to control weevil to the level preferred by producers (Al Ayedh et al. 1996, Rand 2013). Given the lack of detail in the survey options, we do not know if Wyoming producers were referring to parasitoid wasps when they selected biological control, or if they purchase lady beetles or other natural enemies. To date, there is no evidence that releases of purchased lady beetles reduces alfalfa weevil densities in the field. Harrowing and grazing were write-in answers for ways to manage alfalfa weevil. Both of these management strategies have potential to manage alfalfa weevils, as reviewed by Pellissier et al. (2016). Altogether, our survey results provide important, timely information about insect pests and their management strategies among Wyoming

alfalfa producers. Our survey can be used by researchers in other geographical contexts and examining other crops to better understand farmers' perspectives, challenges, and management strategies when dealing with insect pests. The challenges range from agronomic, economic, biological, and weather-related, and each require different interventions, which can inform future work by researchers, scientists, and Extension educators.

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