PROJECT REPORT

Alternatives to Burning and Their Effects on Insect, Weed, and Disease Pests in Alfalfa Seed Fields

Submitted 6-27-06

Background

In cooperation with the Washington State Alfalfa Seed Commission, we are in the process of evaluating the costs and benefits of burning alfalfa seed fields in Washington State by testing cultural and chemical alternatives to burning. Our project uses a multi-disciplinary approach, coordinating weed science (directed by Dr. Rick Boydston, USDA-ARS), plant pathology (directed by Dr. George Vandemark, USDA-ARS), and entomology (directed by Dr. Douglas Walsh, WSU). Industry outreach will be directed by Sally O'Neal Coates, WSU Research and Extension Communication Specialist. The project began Fall 2005 and will be completed January 2007. This is our second report; please see also the Project Report submitted 2-9-06.

Objectives

1. Evaluate the efficacy of alternatives to field burning on insect, weed, and disease control. **In progress. This report focuses on the progress of this objective.**

2. Determine the costs and benefits of field burning and alternative practices. **Data are being gathered.**

3. Develop a long-term follow-up plan for field burning as directed by state guidelines. **To be undertaken after research is complete and data are analyzed.**

4. Disseminate key results of this research to growers via meetings, publications, and the Internet. **Preliminary information communicated at alfalfa seed field days June 20 and 21; primary information dissemination to take place September 2006-January 2007.**

Procedures

1. Plots to be established in Touchet, fall 2005. **Complete.**

2. Proposed field treatments to include burning, heat treatment with steam, flash freezing with carbon dioxide, field stubble removal, conventional tillage, insecticide and herbicide application, and a non-treated control. **Complete.**

3. Field efficacy to be evaluated for all major pest groups: weeds, insects, diseases. **In progress.**

4. Direct efficacy of treatment to be measured via burying of wire mesh packets containing pests which will subsequently be monitored after treatment. **In progress.**

5. Information dissemination. **In progress. Alfalfa field days conducted June 20-21. Results to be published and formally disseminated this fall/winter.**

The Treatments

Our treatments consisted of the following:

1. leaving field stubble and not burning (control)
2. burning stubble
3. leaving stubble and heating with steam
4. leaving stubble and flash freezing, which was accomplished by a combination of nitrogen gas (N_2) and/or dry ice (solid carbon dioxide/CO_2)
5. removing stubble via mowing
6. burying stubble via tilling
7. leaving stubble and applying pesticide

Burning, freezing, mowing, tilling, and pesticide application took place on February 14, 2006. The steam treatment was performed on March 15, 2006, as the steaming equipment was unavailable at the earlier date.

Burned

Mowed

Tilled

Control (residual left)

Spring alfalfa following Chateau treatment (above) and spring alfalfa in untreated control (below).

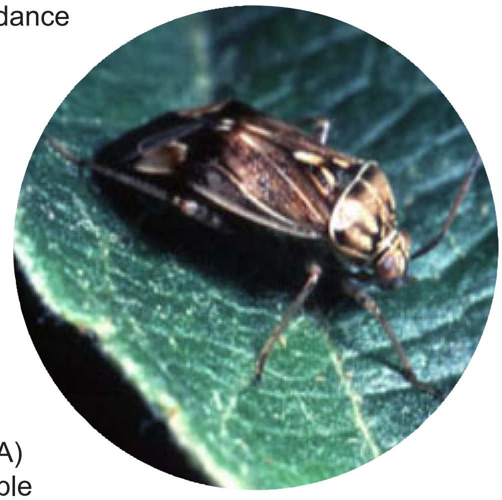
Field Notes

Field burning likely plays a positive role in reducing prickly lettuce seed viability, but use of effective herbicides probably has more total impact on prickly lettuce populations in alfalfa seed production.

Alfalfa spring growth was similar among all treatments except the tilled plots, which reduced height by about 40% in late April.

Insect Surveys

Our team surveyed insect populations on four dates (March 20, April 10, April 24, and May 10, 2006) using two separate techniques, 15-inch sweep nets and 0.5m^2 ground transect squares. Insects were sight identified, quantified per sample, and recorded in a field notebook.



The insect abundance estimates were entered into an Excel spreadsheet and imported into Statview™ (SAS 2001) Populations of individual insect species were analyzed by analysis of variance (ANOVA) within each sample date. When differences in population counts were observed at the 5% confidence level, pairwise t-tests were conducted between the non-treated control and each respective treatment.

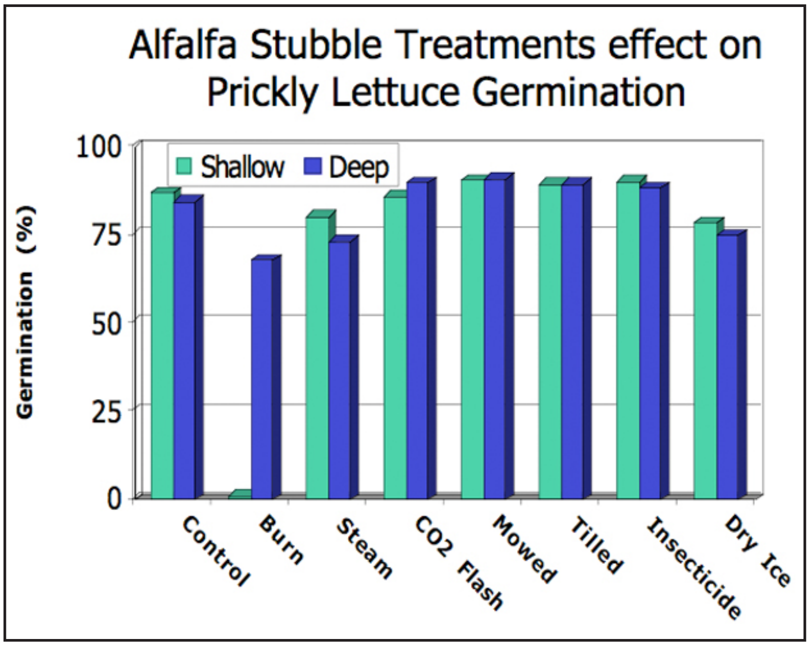
Insect populations within the plots among all the treatments applied were largely unaffected. The only significant population difference we observed was the adult Lygus bug population abundance measurement on March 20. Adult Lygus populations were significantly reduced in the burning, tilling, and insecticide plots. Trends persisted among the other insect species sampled in that the more disruptive treatments, burning, mowing, tilling reduced populations in general. However, differences between treatments did not prove to be statistically significant.

Weed Seed Study

We placed wire mesh packets of prickly lettuce seed at two different depths in each of the research plots prior to conducting the treatments. The packets were retrieved from plots after the burning, steaming, freezing, mowing, tillage, and insecticide treatments had been conducted and the seed was brought to the laboratory for controlled germination.

We found that about 90% of the seed from the mowed, tilled, and insecticide-treated plots germinated—the same germination rate as the untreated control plot. Germination of the seed from the burned plots varied depending upon the depth at which it had been buried. Germination failed almost entirely on seed from the packets buried at the shallow depth of 0.125 inches, but seed buried 0.5 inches had a germination rate of 68%. Both of the freezing treatments resulted in some reduction of germination in the shallow-buried seeds (78% for the dry ice treatment, 86% for the CO2 flash treatment). Prickly lettuce is small seeded and does not germinate from deeper depths, so the shallow burial treatment is the likely the most relevant to alfalfa seed producers.

Steam heat treatment reduced prickly lettuce germination to 80% and 73% for shallow and deep placed seed, respectively, but it must be noted that since the steam treatment took place later than the others, this reduction could be due in some part to the delayed timing of the seed packet placement in the field, which could have induced dormancy.



Burying weed seed packets in the field

Herbicide/Burning Field Trial

Our herbicide trials, begun in Fall 2005, indicated that paraquat (Gramoxone) plus flumioxazin (Chateau) treatments (two different rates) and paraquat plus norflurazon (Zorial) provided 97 to 99% control of prickly lettuce, whereas the paraquat plus diuron (Karmex) treatment controlled the weed 90%.

As planned, the entire trial was burned on February 14, 2006. Following this stubble burning, we found that emerged prickly lettuce seedlings were only partially suppressed.

Next, we made a spring herbicide application to each plot as planned on March 1. Prickly lettuce control from all spring-applied herbicide treatments was 99 to 100% except with norflurazon (Zorial/Solicam), which controlled prickly lettuce 94%. Very little alfalfa injury was noted in March and April from any of the herbicide treatments tested (see photos p. 2).

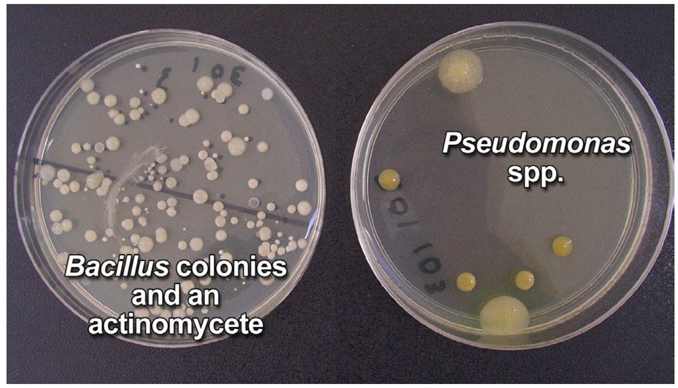
Karmex and Solicam are both labeled for use in alfalfa seed production and both controlled prickly lettuce well applied in fall or spring. Chateau also controlled prickly lettuce well, did not injure alfalfa appreciably, and is being considered for labeling in alfalfa seed production.

While field burning had a positive effect on reducing prickly lettuce seed germination, it had little effect on emerged seedlings. Our conclusion is that field burning likely plays a positive role in reducing prickly lettuce seed viability, but use of effective herbicides probably has more total impact on prickly lettuce populations in alfalfa seed production.

Disease Findings

Our primary objectives for the disease component of the project were to

- survey and identify plant pathogenic soilborne fungi present in the research plot and
- quantify soilborne microbes such as *Bacillus* spp., *Pseudomonas* spp., and actinomycetes (filamentous bacteria) that are associated with suppression of soilborne diseases caused by fungi.

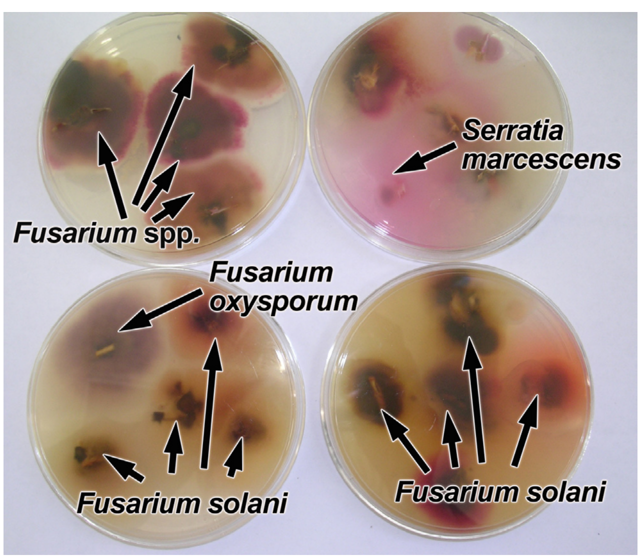


Our first step was to isolate the various fungi from the alfalfa plant tissue. Using one plant from each research plot, we sampled tissue from the crown, taproot, fine roots, and crown bud, plating it onto a general medium likely to reveal any *Fusarium* spp., *Sclerotinia* spp., *Rhizoctonia solani* and oomycete fungi present. We also plated stem and petiole sections in a different manner more likely to detect the presence of *Verticillium* spp. A third method was used on samples from the crown tissue, fine roots, lateral roots, and taproot/fine root junction to isolate *Phytophthora* and *Pythium* spp.

Next, we collected 6-inch x 6-inch x 1-inch soil samples from each plot. We ran these samples through a sieve to detect sclerotia of *Sclerotinia* spp. and also performed a procedure known as “baiting,” in which sterilized cracked cucumber seed is added to the sample to isolate and recover oomycete fungi and chytrid fungi from soil.

“Baiting” soil with cucumber seeds to detect soilborne fungi.

Finally, we quantified the soil bacteria. We found that the soilborne pathogens implicated in alfalfa crown rot complex were present at some frequency in sampled plants of all treatments. Cortical-rotting *Fusarium* spp. (*F. oxysporum* and *F. solani*, primarily) were absent in the burning and stubble removal treatments but were identified at 25% frequencies in all other treatments. *Serratia marcescens*, a bacterium often associated with the crown rot complex, was present in samples of steaming, burning, and stubble removal treatments as well as in the control plot and *Pythium* spp. were present in the steaming, insecticide/herbicide, stubble removal, and control plots. *Phytophthora* spp. were identified in flash freezing and pesticide plots. While visual assessment of the field seemed to indicate the presence of *Sclerotinia sclerotiorum,* we were unable to isolate its sclerotia from the plant material. *Verticillium albo-atrum*, the causal agent of Verticillium wilt, was not detected in any of the plants sampled.



No significant differences were observed among treatments for the number of beneficial *Pseudomonas* spp. and *Bacillus* spp. detected, but a trend was observed in that the highest number of both types of bacteria were observed in the control plots, while the lowest numbers were observed in the burning and stubble removal treatments. Within a plot, populations of *Bacillus* spp. tended to be much higher than populations of *Pseudomonas*. In two plots subjected to burning and in a single plot subjected to stubble removal, no *Pseudomonas* spp. could be detected. These results suggest that additional controlled experiments should be conducted to unambiguously determine if these two treatments suppress growth of beneficial microorganisms that have been implicated in the control of plant diseases.