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Herbicide Resistant Weed Management

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In the past 65 years herbicides have simplified weed management in most crops. Herbicides control a broad spectrum of weeds and in general, are easy, economical, and safe to use. All weed control methods (cultivation, herbicides, flaming, hand-weeding) impose a selection pressure on the population for weed species and biotypes that are tolerant or resistant to the control methods being utilized. Weeds that escape or survive the control method and that are able to reproduce will be the bulk of the weed population that will require control in future years. A single highly effective selection pressure that is used repeatedly with few other methods of control will more rapidly select for weed species and biotypes that are tolerant or resistant to the control method.
The first case of herbicide resistant weeds was reported in a conifer nursery in Washington State in 1968. The weed was common groundsel that had evolved resistance to the triazine herbicides (Ryan 1970). As herbicide use increased and other methods of weed control decreased, herbicide resistant weeds have become more prevalent in recent years, and could make weed management more complex and expensive.

The Weed Science Society of America (WSSA) defines herbicide resistance as "the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type". Nine different herbicide resistant weed species have been confirmed in Washington State, 14 in Idaho, and 16 in Oregon (http://www.weedscience.org/). Redroot pigweed and Powell amaranth populations resistant to photosystem II inhibitors (group 5 herbicides, i.e. metribuzin, atrazine) are present in all three states. Russian thistle, prickly lettuce, and kochia populations resistant to ALS (acetolactate synthase) inhibitors (group 2 herbicides, i.e. rimsulfuron) are present in all three states.

Metribuzin (Sencor) and rimsulfuron (Matrix) are the only two herbicides registered for postemergence broadleaf weed control in potatoes, and represent the two classes of herbicides, triazines and ALS inhibitors, with the most reported cases of resistant weeds world wide. These two herbicide classes are also commonly used in crops rotated with potatoes, such as corn, wheat, and alfalfa. World-wide, the most frequently reported triazine resistant weeds are common lambsquarters, redroot pigweed, and common groundsel. New cases of ALS inhibitor resistant weeds have increased at a greater annual rate than any other herbicide mode of action.

Sethoxydim (Poast) and clethodim (Select) belong to the acetyl CoA carboxylase (ACCase) inhibitors family of herbicides, which also has had resistant grass weeds develop at a relatively fast pace. Few weeds have evolved resistance to chloroacetamides [metolachlor (Dual), dimethenamid-p (Outlook)], protoporphyrinogen oxidase (Protox) inhibitors [flumioxazin (Chateau)], dinitroanilines [pendimethalin (Prowl), trifluralin (Treflan)], and glyphosate (Roundup) despite extensive use of these herbicides. Use of these herbicides is considered a low risk for the selection of herbicide-resistant weeds.

More complex, integrated weed management (IWM) systems are usually required to keep herbicide resistant weeds from becoming prevalent. IWM includes utilizing practices such as, rotating herbicides with different mechanism of action, and utilizing tillage, grazing, mowing, burning, cover crops, narrow rows, increased

seed density, fallow, and crop rotations. For the most part, triazine and ALS resistant weeds have been successfully controlled by the use of herbicides with alternative mode of action (Heap, 1997). However, knowing which herbicides will control various herbicide resistant weed biotypes is critical in managing the herbicide resistant weed populations.

The potential problem with the approach of controlling herbicide resistant weeds with an herbicide with a different mode of action is the selection for multiple herbicide resistance. If weed populations evolve with multiple resistance to ALS and triazine herbicides in potato cropping systems, no postemergence herbicide alternatives will be available for control of those species. Such multiple resistance has developed in waterhemp in Illinois (Patzoldt et al. 2002). Using herbicides that fail to control the resistant weed populations will result in continued increases in herbicide resistant weed populations. In most cases of herbicide resistance, growers have had to utilize integrated weed management systems that rely on multiple weed control methods and tactics to control resistant weed populations. Knowing the extent of herbicide resistant weed populations and their response to current potato herbicides could help growers manage herbicide resistant weeds in the most economical way and delay or prevent increases in herbicide resistant weed populations.

No formal attempt has been made to survey potato production areas for herbicide resistance. Poor weed control may be caused by a number of factors other than herbicide resistance, such as, improper herbicide choice or rate, improper application or incorporation of herbicide, poor timing of herbicide application, and weather conditions not favorable for herbicide activity or weed growth when herbicides applied. It is important to determine if a weed control failure is in fact due to herbicide resistance or other factors.

The Washington State Potato Commission has funded our group to survey growers, extension personnel, and the potato industry for suspected herbicide resistant weeds, collect weed seed from suspected fields, and conduct dose response studies on herbicides in question. If herbicide resistant weed biotypes are confirmed, response of the weed to other potato herbicides with different modes of action will be tested. As part of our effort to contact industry personnel with knowledge of possible herbicide resistant weed populations in the Columbia Basin we'd like to ask for your help in identifying herbicide resistant weed populations in potato or fields rotated to potato. Anyone who observes or has observed poor weed control following known herbicide applications and who suspects herbicide resistant weeds are present should contact Rick Boydston, (509) 786-9267 or rick.boydston@ars.usda.gov.

Herbicide resistance may be first recognized by poor control of a particular weed species that is normally controlled by the herbicide. Loss of efficacy will usually increase over time with repeated use of the same herbicide or an herbicide with a similar mode of action. Poor weed control can result from other problems such as herbicide application problems or unusual weather conditions following an herbicide application. If other normally controlled weed species are controlled, or there is a previous history of herbicide failure on the same species in the same field, herbicide resistance might be expected. One might also notice a lack of herbicide injury symptoms on weed escapes adjacent to dead or dying weeds of the same species.

We'd like to collect weed seed from fields believed to contain herbicide resistant weed biotypes during the 2010 growing season. Plants will be grown from the collected seed and subjected to a range of doses of the herbicide in question. Dose response curves of the weed population will be compared to the response of a typical susceptible population (indigenous population) of the same species. The GR50 (dose required to reduce shoot weight by 50% relative to untreated plants) of the resistant and susceptible populations will be determined. If resistance is confirmed, the susceptibility of weed resistant biotypes to herbicides registered in potato with different modes of action will be tested.

We are soliciting growers, extension personnel, field personnel, pesticide manufacturer representatives, and other people knowledgeable of the potato industry to contact us if known or suspected herbicide resistant weed populations are present in their fields.

Anticipated Benefits: Information gained will confirm herbicide resistance in the Columbia Basin potato growing region and establish the response of the herbicide resistant weed biotypes to herbicides with other modes

of action. The information could be used to improve management of herbicide resistant weed populations and to delay development of herbicide resistant weed populations. Assessing and monitoring of herbicide resistance and developing strategies to delay herbicide resistance has proven to be less costly than waiting for herbicide resistance to develop and dealing with it after it develops.

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WSPC Research Review Process and Meeting Dates Finalized

The potato commission is about to embark on another fall and winter of hard work on reviewing and planning it's research program. All documents describing the process are posted on the website:

www.potatoes.com/research.cfm

Below are a couple excerpts. Check the website for all the details!

Goals (of the research review and planning process)

1. Build communication, cooperation, and understanding among the commission, other industry members, and the scientific community.
2. Develop an overall research program that is a collaboration between industry and scientists and their institutions aimed to maintain or improve profitability of Washington potato growers.
3. Form strong cooperation among the Pacific Northwest potato commissions and scientists to achieve maximum benefit from all research dollars in the region.

2010-2011 Review and Reporting Schedule

1. **October:** Meetings of subject-matter committees.

Plant Protection: October 27, 9:00 am - 4:00 pm, WSPC Office, Moses Lake
Crop Management: October 28, 8:30 - 10:30 am, WSPC Office, Moses Lake
Variety Development/Breeding: October 28, 10:45 - 12:00 noon, WSPC Office, Moses Lake
Economic, Sustainable, and Value-Added Research:** October 28, 12:45 pm - 3:00 pm, WSPC Office, Moses Lake

4. **February:** Research results and proposals presentations.

February 15 - 16, 2011, Pasco.

It May Look Like Early Blight, But It Could be an Impatiens Necrotic Spot Virus Infection

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Just about everyone who works on potatoes is used to seeing the necrotic lesions caused by early blight (*Alternaria solani*). This fungal disease is common wherever potatoes are grown and can cause significant yield losses due to early senescence of the foliage and the production of tuber lesions. The necrotic lesions on the foliage are round to irregular in shape, may show concentric rings within the necrotic tissue, and the lesions are frequently bounded by a leaf vein.

In April and May of 2010, leaf symptoms similar to those described above were observed in greenhouse-grown potatoes in the USDA-ARS facilities at the Irrigated Agriculture Research and Extension Center near Prosser (Fig. 1). Fungicide applications seemed to not reduce the incidence of these symptoms and in early May a planting of approximately 200 cv. Atlantic plants grown from certified mini-tubers in one of the greenhouses rapidly developed necrotic lesions and these lesions were frequently associated with thrips feeding sites on the leaves. The possible association of the symptoms with thrips suggested a virus might be responsible. Symptomatic leaf tissue was tested with the rapid ImmunoStrip ® test (Agdia, Inc.) for Impatiens necrotic spot virus (INSV) and the tests were positive (Fig. 2). Subsequently, additional tests employing the reverse transcription polymerase chain reaction (RT-PCR) also confirmed INSV. Sequencing of the RT-PCR product also indicated INSV was present. Symptomatic potato tissue was used to mechanically inoculate a potato cv. GemStar, in which identical lesions were produced and which also tested positive by Immuno-Strip ® tests. These tests all show that the symptoms were indeed due to INSV. Subsequently, plants in other locations at the facility also tested positive so the decision was made to discard all materials within my research program, costing me months of lost time.

INSV has a large host range and is favored by greenhouse conditions. A few years ago it was reported on greenhouse grown potatoes in New York, where the virus outbreak also resulted in widespread losses of research and breeding materials. The virus is transmitted by thrips, especially the western flower thrips, which is a very common insect in our area. In a similar outbreak here in 2006, we confirmed INSV in some common weeds such as oxalis and nightshade and also found an ornamental planting of petunias to be infected. The wide host range, rapid transmission by thrips, and the difficulty in controlling thrips make this virus particularly difficult to eradicate. Greenhouse operations, such as those used for floral crops or potato mini-tuber production, would seem to be particularly vulnerable. An excellent review on INSV in floral crops was published in 1997 in the journal Plant Disease, Vol. 81, pages 1220-1230.

We recently confirmed INSV infection in cv. Desiree plants at yet another greenhouse facility here. Symptoms were similar to those observed on Atlantic and included necrotic lesions on the petioles, midveins, and at the base of the leaflets (Fig. 3).

As we have learned the hard way, this virus has the capacity to cause rapid and widespread damage to potatoes. Luckily, in the ImmunoStrip ® we have a rapid test to confirm the infection. Once research materials are again up and going in our research project we will be much more vigilant in scouting for INSV infections and will not assume that these circular necrotic lesions are due to early blight.

Figure 1. Necrotic lesions on cv. Atlantic caused by INSV infection.

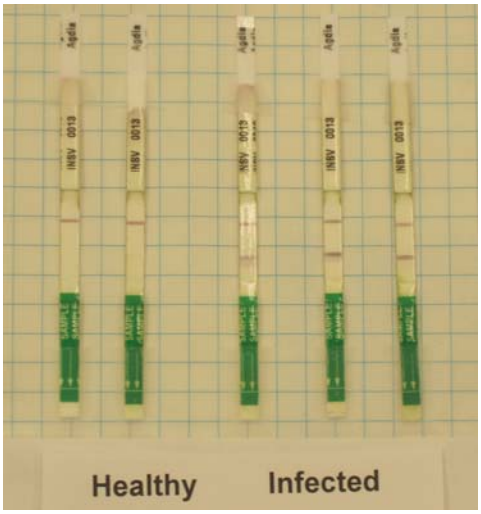


Figure 2. Agdia's ImmunoStrip ® for detection of INSV. The three strips on the right show a positive result, the two on the left are from healthy plants. The test takes approximately 5 minutes.

Figure 3. Necrotic lesions on midveins of cv. Desiree caused by INSV infection.

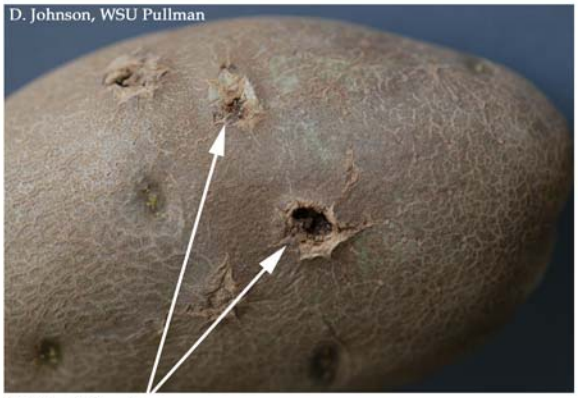
Common Scab

See also: http://www.potatoes.com/research.cfm

Typical superficial scab lesions.

Typical raised scab lesions.

Streptomyces can also cause callus-like lesions on underground parts of stems.



Pitted Scab
This type of symptom is more prevalent in some varieties than in others.

Management

1. Reliable strategies are not known for scab prevention under all conditions (see below).
2. Avoid planting scabby seed tubers.
3. Plant varieties with scab resistance when possible.
4. Avoid application of soil amendments that increase soil pH.
5. A generally healthy crop may help reduce scab intensity on tubers.

General Information

Causal agent and biology: Common scab is caused by several species of *Streptomyces*, a genus of bacteria that is present in all soils in huge numbers. Most soils contain bacteria capable of causing potato scab, but exactly what conditions bring on symptoms is not fully understood. Scab-causing bacteria are constantly changing the arrangement of genes in their DNA, which may explain some inconsistency in field management.

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