

## HERBICIDE RESISTANCE MANAGEMENT STRATEGIES: TOOLS FOR DEVELOPING A PLAN

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A seminar on managing herbicide resistance was presented at the Idaho Potato Weed Control Workshop

Definitions:

Herbicide resistance: the inherited ability of a plant population to survive a herbicide treatment to which the original population was susceptible

Tolerance: the capacity of a plant to survive a herbicide application at its use rate due to a characteristic of the plant species - this species was never susceptible to the herbicide

Biotype: a naturally occurring individual within a given species that has a slightly different, but distinct, genetic makeup from other individuals

Weed species shift: a tolerant weed may be favored and its population may increase compared to a susceptible species when control measures are not used for the tolerant weed

Mode of action (MOA): the sequence of events in which a herbicide kills a weed

Site of action/Target site: the particular plant function that is affected by the herbicide - specific location(s) where the herbicide has activity within the plant

Herbicide class/group: herbicides with similar modes of action

Cross-resistance: resistance to herbicides with the same site or mode of action or degradation/detoxification method

Multiple resistance: resistance to herbicides with different site or mode of action

Herbicide resistant crop: a crop species not originally tolerant to a herbicide, but which has been altered to be tolerant. Tolerance can be attained via transgenic, mutagenesis, or selective breeding methods.

Resistance occurs through the selection of biotypes naturally tolerant/pre-adapted existing in a susceptible population. The herbicide provides the selection pressure. The biotype has survival and/or reproduction advantages in the herbicide environment. When

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and where resistance occurs depends on many factors such as the initial frequency and fitness of the resistant biotype, herbicide history, and/or cultural practices.

A weed can be resistant by any of the following mechanisms:

- alteration at the herbicide's site of action so that the herbicide does not affect that site
- a weed's increased ability to metabolize/ detoxify the herbicide - the rate is faster than in a susceptible biotype
- sequestration of the herbicide away from the site of action or modification in the uptake and/or translocation of the herbicide to the target site

#### **Herbicide Classification System: History**

Industry reps and weed scientists in Canada, Australia, the U.S., and other countries have been working on a herbicide classification system based on mode of action since 1989. The PNW Bulletin 437 discussing herbicide classification based on mode of action, recommending resistance management strategies and stating current known resistant weeds was published in 1993 - revised in 1999. Herbicide class has been required on Australian labels since 1994. The Weed Science Society of America commissioned drafting of a herbicide classification system in 1995 and 28 classes/groups were determined.

#### **Herbicide Classes**

The following herbicide classes with herbicide examples are commonly used in potato cropping systems:

##### **Group 1: Acetyl CoA carboxylase (ACCCase) inhibitors**

-Achieve, Poast, Hoelon, Fusilade, Assure

##### **Group 2: Acetolactate synthase inhibitors - Imi's/S.U.'s**

-Assert, Pursuit, Raptor, Glean, Harmony Extra, Matrix, UpBeet, Maverick

##### **Group 3: Microtubule assembly inhibitors - DNA's**

-Treflan, Sonolan, Prowl, Balan

##### **Group 4: Synthetic Auxins**

-2,4-D MCPA, Banvel, Stinger

##### **Group 5: Photosystem II inhibitors - triazines/uracils**

-Metribuzin, Velpar, Betamix, Pyramin, Hyvar

##### **Group 6: Photosystem II inhibitors - different binding behavior - benzothiadiazoles/nitriles**

-Basagran, Buctril

##### **Group 7: Photosystem II inhibitors - different binding behavior - ureas**

-Karmex

**Group 8: Lipid synthesis inhibitors (not ACCase)**

-Eptam, Ro-neet, FarGo (thiocarbamates), Avenge

**Group 9: EPSP synthase inhibitors**

-Roundup

**Group 10: Glutamine synthetase inhibition**

-Liberty

**Group 15: Unknown site of action - chloroacetamides**

-Lasso, Frontier, Dual

**Group 16: Unknown site of action – benzofuran**

-Nortron

**Group 22: Photosystem I electron diverters**

-Paraquat (bipyridiliums)

*Knowing the mode of action/herbicide class is the key to planning a management strategy to reduce the potential for resistant weeds. Be aware of the different herbicides used in different crops that may be in the same herbicide class.*

**Herbicide Resistance Management Strategies**

-Rotate herbicides/crops. Use different MOA's and different cultural practices.

-Tank-mix with a herbicides with different modes of action, using herbicides that have overlapping weed spectrum and that allow for economical treatments.

-Cultivation and integrated weed management are important tools for delaying/preventing herbicide resistance.

-Keep complete herbicide/weed control histories to help rotate MOA's and to track weed control in each field.

-Use clean, tested, tagged seed for all your crops

-Plant competitive crops/varieties to enhance weed control.

-Scout before and after application in order to aid in the use of an appropriate herbicide only when necessary

-Do something about escapes/shifts

-Make sure herbicides are applied properly/a good application is made.

-Sanitation - prevent spread of weed seed from field to field by cleaning equipment before moving and by screening irrigation water when possible.

*The more diversity in weed control tools used, the less risk of selecting resistant weeds.*

**Resistance Management Planning Tools**

-PNW 437: Herbicide-Resistant Weeds and Their Management

-Herbicide classification charts

-Management worksheets: herbicide use/MOA histories

*Customize worksheets and planning tools for your own fields/needs.*

### **Resistant Weeds Present in the Pacific Northwest**

**Group 1 ACCase inhibitors:** Italian ryegrass, wild oat

**Group 2 ALS inhibitors:** prickly lettuce, kochia, Russian thistle, Italian ryegrass, mayweed chamomile

**Group 4 Synthetic auxins:** yellow starthistle

**Group 5 triazines/uracils:** common lambsquarters, pigweed spp., common groundsel

**Group 6 nitriles:** common groundsel

**Group 7 ureas:** common lambsquarters, annual bluegrass

**Group 8 triallate/difenzoquat:** wild oat

### **Grower "IF" Questions**

Growers should ask themselves these questions if they suspect herbicide resistance:

- If the same herbicide or class of herbicides has been used in the field for sequential/several years
- If the suspected resistant weed species has been controlled effectively in the past
- If weed control is good on all the other labeled weed species

*If the answers are "Yes" then maybe resistance is involved.*

### **Recommendations if resistance is suspected**

All other possibilities for poor herbicide performance should be ruled out before considering the possibility of resistance misapplication

- environmental conditions
- heavy weed pressure
- skips

If you suspect herbicide resistance:

- Do not re-spray the field with the same herbicide or herbicide class - control the weed(s) with another means
- Do not allow seed to mature
- Report your suspicion to university research/extension personnel/extension educator/crop advisor
- Collect plants or seed that can be used to confirm resistance has developed.

### **Summary**

Herbicide resistance is the inherited ability of a plant to survive a herbicide treatment to which the original population was susceptible. Resistant weeds present in a population can become the major weed in that population through herbicide selection pressure/using the same herbicide or herbicide MOA.

You can prevent or delay the development of resistant weeds in your potato cropping system if you follow a good strategy:

- know your herbicide classes
- rotate crops/herbicides - using different MOA's

- tank-mix herbicides with different MOA's - overlapping spectrum
- use an integrated approach

*The most comprehensive resistant weed management programs are set up before herbicide-resistant weeds become a problem.*