2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

PRINICPALS OF WEED RESISTANCE MANAGEMENT

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Abstract

Weed resistance to herbicides is not a new phenomenon but is somewhat less known and experienced than insecticide or fungicide resistance. The first report of herbicide resistance occurred in 1960 with the discovery of Trazine resistant common groundsel (*Senecio vulgaris L.*). Since that time 287 weed biotypes around the world have evolved resistance to herbicides. …

Paper

Weed resistance to herbicides is not a new phenomenon but is somewhat less known and experienced than insecticide or fungicide resistance. The first report of herbicide resistance occurred in 1960 with the discovery of Trazine resistant common groundsel (*Senecio vulgaris L.*). Since that time 287 weed biotypes around the world have evolved resistance to herbicides. Both hairy fleabane (*Conyza bonariensis L.*) and buckhorn plantain (*Plantago lanceolate L.*)are resistant to glyphosate (Roundup) in South Africa. Hairy fleabane has become difficult to control with glyphosate in our California production systems. Reports of poor or ineffective control of lambsquarter (*Chenopodium album L.*) in our Roundup Ready cotton systems have surfaced. And, Roundup resistance horseweed (*Conyza canadensis L.*) has been confirmed in the eastern. U.S.

In California the greatest herbicide resistance problems have occurred in aquatic weeds in rice production in the Sacramento Valley. Many of these weeds species have been selected for resistance to the sulfonylurea herbicide bensulfuron (Londax). Rigid ryegrass (*Lolium multiflorum L.*) has exhibited resistance to Roundup in northern California. With the use of Pyrithiobac sodium (Staple) in cotton, Remsulfuron (Shadeout) in tomatoes, Triflusulfuran (Upbeat) in sugarbeets, Londax in rice, Imazethapyr (Pursuit) in alfalfa and Imazemethabenz (Assert) in wheat, all herbicides that lead to rapid selection for resistant weeds, it is probable that the number of cases in California may increase. In addition the availability of Roundup Ready cotton and corn, and the soon to be released, Roundup Ready alfalfa, may promote the sole reliance on one particular herbicide that will increase the selection pressure on weeds for resistance.

“Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type.” In contrast, tolerance can be defined as the inherent ability of a plant to survive and reproduce with an herbicide treatment at a normal use rate. Resistance may be naturally occurring or induced by such techniques as genetic engineering. Resistance may occur in plants by random and infrequent mutations. Through selection, where the herbicide is the selection pressure, susceptible plants are killed while herbicide resistant plants (biotype) survive to reproduce without competition from susceptible plants. Weed biotypes are naturally occurring plants within a given population that differ slightly in genetic makeup, but cannot be distinguished visually from susceptible biotypes.

Herbicide resistance can either develop into cross or multiple resistance. Weed biotypes that have developed resistance to one herbicide, and are now also resistant to other herbicides with the same mode of action are termed cross resistance. An example is little seeded canarygrass (*Phalaris minor*), in the Imperial Valley of California, has developed resistance to several lipid synthesis inhibitor herbicides including Sethoxydim (Poast), Clethodim (Prism) and Fluazifop (Fusilade). Weed biotypes that have developed resistance to two or more chemically unrelated herbicides with different modes of action are termed multiple resistance. An example is rigid ryegrass which has developed resistance to a number of different herbicide classes including sulfonylureas, dinitroanilines, triazines and substituted ureas.

Weed population shifts can either be due to herbicide tolerance or the development of resistance. When an herbicide does not kill the entire weed population, leaving the resistant biotype to survive and produce seed a shift to the resistant biotype occurs. Weed shifts can also be caused by low herbicide use rates. In a seven year, three location Roundup cropping system study, conducted by Bob Wilson, University of Nebraska, when Roundup was applied at

half the label rate the weed spectrum shifted from kochia (*Kochia scoparia*) and wild proso millet (*Panicum miliaceum L.*) to predominately common lambsquarters. When applied at full label rate, no weeds developed resistance to Roundup.

Factors Leading to the Development of Herbicide Resistance

Factors that can lead to or accelerate the development of herbicide resistance include weed characteristics, chemical properties and cultural practices.

Weed characteristics conducive to rapid development of resistance to a particular herbicide include; annual growth habit, high seed production, relatively rapid turnover of the seed bank due to high percentage of seed germination each year, (i.e., little seed dormancy), several reproductive generations per growing season, extreme susceptibility to a particular herbicide, and high growing vigor of the resistant biotype.

Herbicide characteristics which lead to rapid development of herbicide resistance in weed biotypes include; a single site of action, broad spectrum control, and long residual activity in the soil.

Cultural practices can also increase the selective pressure for the development of herbicide resistant biotypes. In general, complete reliance on herbicides for weed control can greatly enhance the occurrence of herbicide resistant weeds. Other factors include, shift away from multi crop rotations towards mono cropping, reduced or no till productions systems, continuous or repeated use of a single herbicide or several herbicides that have the same mode of action, high and/or low herbicide use rate relative to the amount needed for weed control and growing an herbicide tolerant crop where the same herbicide is applied repeatedly.

Resistance Management

The first step to preventing herbicide resistance is early detection. Scout fields and be on the lookout for patterns that would indicate resistance. Whole fields infested with weeds or strips of weeds does not typically indicate resistance. Patterns of resistance include: patches in fields, patches of dense populations with lessor population radiating out from the central patch escapes scattered in no particular pattern throughout the field, and dead and live weeds of the same species growing side by side after an herbicide application.

Weed management strategies that discourage the evolution of herbicide resistance should include the following:

- Rotate herbicides with a different mode of action
- Use the minimum number of applications of any one herbicide per season
- Use tank mixes of different modes of action when possible.
- Use short-residual herbicides
- Rotate crops with different seasons of growth
- Plant a crop having different registered herbicides
- Do not entirely eliminate tillage from the production system
- Use hand weeding to remove escape weeds preventing them from going to seed
- Prevent weed seed spread by use of clean equipment
- Use certified planting seed

If you suspect weed resistance where herbicide applications have failed to control weeds, to further confirm check the following: 1) only one weed species has escaped, 2) sprayer calibration, 3) were weather conditions favorable for herbicide performance, 4) confirm by re-spraying and, 5) report problem to your University Extension and specialist personnel.

The potential for herbicide resistance should receive serious and thoughtful attention. As weed management systems change with new herbicides and herbicide resistant crops are introduced, resistant management must be an integral part of the production system. If selection pressure is maintained through the continuous use of the same herbicide, herbicide resistance will soon render it ineffective.

References

Prather, T., Ditomaso, J., and Holt, Jodie. Herbicide Resistance: Definition and Management Strategies. ANR Publication 8012.

International Survey of Herbicide Resistant Weeds. www.weedscience.org/in/asp.

Weed Science Society of America. www.wssa.net

WSSA. 2002. Herbicide Handbook, Eighth Edition.