

## **STEWARDSHIP ISSUES FOR ROUNDUP READY ALFALFA - A High Plains Perspective on the Sustainability of Roundup Ready Cropping Systems**

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Experiments were conducted at three locations: Scottsbluff, Nebraska; Fort Collins, Colorado; and Torrington, Wyoming from 1998 through 2004 to determine if Roundup use patterns in Roundup Ready cropping systems influenced weed control by placing selection pressure on weeds which could lead to weed shifts or the development of Roundup-resistant weeds. Experiments had two main factors, either continuous Roundup Ready corn or a rotation of Roundup Ready corn, sugarbeet, wheat, corn, and sugarbeet. Within each main plot were four weed control treatments: Roundup Ultra Max at 13 ounces per acre applied postemergence twice each spring, Roundup Ultra Max at 26 ounces per acre applied postemergence twice each spring, a rotation of Roundup Ultra Max at 26 ounces per acre applied postemergence twice each spring followed the next year by a non-Roundup treatment, or a non-Roundup treatment each year. The non-Roundup treatment in continuous corn or the crop rotation utilized herbicides that had a different mode of action than Roundup and would provide 95% or greater weed control. Weed seeds in the soil were examined each year before crop planting. Weed density in each plot was measured before herbicide treatment, 2 weeks after the last postemergence herbicide treatment, and at crop harvest when crop yields were also determined. After 7 years, the plots treated with Roundup Ultra Max at 13 or 26 ounces have received 14 applications of Roundup Ultra Max.

After 7 years of study at three locations no weeds have developed resistance to Roundup Ultra Max. Over the 7 year period the weed population at Scottsbluff declined and shifted from a kochia and wild proso millet dominated population to a predominately common lambsquarters population. Common lambsquarters seed in the soil and plants remaining after herbicide application increased to a greater extent in areas treated with Roundup Ultra Max at 13 ounces per acre (half the recommended rate) and in the crop rotation compared to continuous corn. For the first time in 2003, the increase in common lambsquarters density in the half-rate Roundup Ultra Max treatments resulted in a 42% reduction in corn seed yield. At Torrington there was a shift from a grassy weed population to a predominately common lambsquarters and wild buckwheat dominated population. Common lambsquarters and wild buckwheat increased to a greater extent in areas treated with Roundup Ultra Max at 13 ounces per acre in the continuous corn rotation. A similar weed shift was also observed at Fort Collins where common lambsquarters density increased to a greater extent in areas treated with Roundup Ultra Max at 13 ounces per acre. At all three locations there was a shift to a predominately grassy weed population in plots treated with the non-Roundup treatment for 7 years.

Two weed management strategies: Roundup Ultra Max at 26 ounces per acre twice each year and alternating Roundup Ultra Max at 26 ounces per acre twice each year with a non-Roundup treatment were both equally effective in controlling weeds over the 7 year period. Utilizing half of the recommended rate of Roundup Ultra Max places greater selection pressure

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on the weed population and selects for weeds capable of surviving low doses of Roundup. Common lambsquarters growth stage at the time of herbicide application can also influence control. As common lambsquarters increases in size from 4 true-leaves to 8 true-leaves the amount of Roundup Ultra Max required to control 95% of the population increases from 13 to 26 ounces per acre. The rate of Roundup Ultra Max used in the cropping system was the critical factor in bringing about a weed shift. A reduced rate of Roundup put more selection pressure on the weed population than a high rate. Using the recommended rate of Roundup Ultra Max was a key factor in maintaining the sustainability of the Roundup Ready cropping system. Other contributing authors to this project were Steven Miller, University of Wyoming and Philip Westra, Colorado State University.

## **STEWARDSHIP ISSUES FOR ROUNDUP READY ALFALFA - A California Perspective on Roundup Ready Alfalfa**

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**The definition of stewardship is: “The careful and responsible management of something entrusted to one’s care.”**

The careful and responsible management of the Roundup Ready trait is the responsibility of regulator agencies, Monsanto and Forge Genetics, and growers. It is in the best interest of growers to carry out best management stewardship practices in order to maintain this new weed control strategy.

Extensive testing has been regulated by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Biotechnology Regulator Service. Food and feed safety assessments demonstrated equivalence to conventional alfalfa varieties with an EPA analysis providing support for a reduction in the potential risk to human health and the environment with the use of glyphosate, as compared to some currently used herbicides.

Forge Genetics and Monsanto are committed to commercialization of Roundup Ready alfalfa in a manner that is sensitive to disruption of existing markets. Applications to deregulate Roundup Ready alfalfa have been developed and commercial releases will be coordinated with Japanese approval. Pollen flow studies with honey bees are now underway to be used by Forge Genetics to establish isolation distances from seed fields. Monsanto has developed a technology, stewardship agreement which growers sign as well as providing an online stewardship course for grower education.

Management of pollen flow will be a concern and challenge for growers. Hay fields will have to be planted the established isolation distance from seed fields. Since there are no sexually compatible food crops or weeds to alfalfa, out crossing is of minimal concern. But, feral and volunteer alfalfa plants could be a concern and control will be most important. Volunteer alfalfa plants will need to be effectively controlled in rotational crops such as cotton and corn. Road side and ditch bank feral alfalfa plants will be another concern. Cutting schedules in hay will have to be diligently adhered to so that the hay is cut at early bloom stage before pollen is produced.

Effective removal of old alfalfa stands will need to be monitored closely. Alfalfa fields are primarily removed by mechanical cultivation, but sometimes herbicides are used instead, alone or in combination with cultivation. Since glyphosate will not be effective in removing Roundup Ready alfalfa, other means will be needed. Trials conducted in California indicated treatments containing 2,4-D and dicamba tended to be most effective, but use and crop rotation

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restrictions may prevent their use. Alfalfa control was 100 percent with all herbicides evaluated when followed by cultivation.

As with any herbicide program, herbicide resistance management is key to stewardship of Roundup Ready alfalfa. This becomes more of a concern as acreage treated with glyphosate increases. The Roundup Ready technology is already available in many crops, including cotton, corn and soybeans. Glyphosate resistance has already been identified in ryegrass and horse weed or mareetail. Reduced control of lambsquarters and barnyardgrass have been reported. Continued use of glyphosate on hard to control weeds such as stinging nettle, cheeseweed and hairy fleabane can be the cause of weed species shift. Although, this problem is not unique to glyphosate, but common for other classes of herbicides. The development of weeds with resistance to glyphosate is thought to be less likely than other herbicides, as glyphosate has no soil residual activity and glyphosate has a unique mode of action. Conversely, Roundup Ready crops offer an option for managing weeds with resistance to other herbicides. Resistant management strategies including rotations of herbicides with different modes of action, using recommended rates of herbicides, monitoring and control of escape weeds, use of certified seed, cleaning equipment and crop rotation are needed to prevent resistance.

Particular thought and considerations must be given to rotating to subsequent crops. The question becomes: "Should one Roundup Ready crop be rotated with another Roundup Ready crop?" Probably not. Following Roundup Ready corn with Roundup Ready cotton has caused problems with the control of corn in the cotton crop. Using Roundup Ready technology in the same field too frequently may result in weed species shifts or resistance.

Roundup Ready alfalfa will give growers a control option that will provide broad spectrum control with simplicity. It provides an alternative system that can be used in Ground Water Protection Areas of the Central Valley of California where some commercially standard herbicides are restricted. It will likely have a large effect on weed control options available for alfalfa potentially enhancing yield and quality. Economic benefits will depend upon technology fees and pricing structure not yet provided. The major concerns associated with Roundup Ready technology: weed resistance, weed species shifts and pollen flow will be addressed with best management practices.