

Understanding Roundup Ready Alfalfa

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Comments at the end of this document are from MAFRI Business Development Specialist - Forage Seeds, Dr. Doug Cattani.

A number of concerns have been raised about the release of Roundup Ready (RR) alfalfa, the first biotech trait in alfalfa. Many of these concerns have been fueled by misinformation. In this article, we provide a scientific perspective on these concerns that we hope will inform.

Concern 1. Once you release this gene – you can't call it back.

Over 300,000 acres of RR alfalfa have been planted for hay over the past 2 to 3 years, with a limited amount planted for seed. The real question is whether you can continue to plant conventional alfalfa seed and the answer is a resounding 'yes' – all of the seed currently for sale is 'conventional' – and you only need to test it (or ask the seed company to test it) with inexpensive test strips to make sure it does not contain the gene if you don't want it. Conventional alfalfa seed will continue to be available after Roundup Ready alfalfa is released.

Concern 2. Won't contamination from neighboring fields result in all seed being Roundup Ready, eventually?

No. Seed production methods and isolation distances currently recommended by seed companies should keep adventitious (unintended) presence at a very low level in non-GE seed. A gene will increase in a population only if the new gene gives the plant an advantage over other plants and the conditions creating the advantage are consistently present. Conversely, if plants are grown in an environment where the gene provides no advantage, the gene is more likely to remain in the population at very low levels or to be lost from the population. The formulas for computing these changes in gene frequency can be found in most books on population or quantitative genetics, such as Falconer and MacKay, 1996, Introduction to Quantitative Genetics, Longman Press. Thus non-GE seed will always be available.

Concern 3. Won't my neighbor's Roundup Ready hay fields contaminate my conventional or organic alfalfa hay production through pollen and gene flow?

No. There is almost zero probability of gene flow among hay fields. For this to happen all the following must occur:

- fields must flower at same time.
- Insects (primarily bees) must be present to move pollen (it does not blow in wind).
- plants must remain in field 4 to 6 weeks after flowering for viable seed production.
- seed must shatter, to fall to ground and establish on soil surface.
- seedlings must overcome autotoxicity to germinate.
- seedlings must overcome competition from existing plants.

Pollen moves among alfalfa plants only when carried by pollinators such as bees, and honey bees generally do not like to pollinate alfalfa and prefer other plants. Alfalfa seed takes many weeks after flowering to mature sufficiently to germinate and longer to shatter and fall onto the ground. Alfalfa is grown for hay is typically cut too frequently for this to occur. In the off chance some seed is produced, alfalfa seed does not readily spread, e.g. by wind. Alfalfa does not germinate well on the soil surface. Germination will be further reduced by alfalfa autotoxicity (chemical from existing alfalfa inhibiting new alfalfa seed germination and growth) from existing planting in the hay field (this is why interseeding alfalfa to thicken a stand generally fails). Germinating seeds must compete with established plants for water, nutrients and sunlight. Data has shown that interseeded plants generally die during the first growing season. Thus, if a grower takes care to plant conventional seed, it is very unlikely that the Roundup Ready gene will move to their hay fields. (See Gene Flow in Alfalfa: Biology, Mitigation, and Potential Impact on Production, Special Publication of the Council for Agricultural Science and Technology (CAST) at <http://www.cast-science.org/displayProductDetails.asp?idProduct=157>)

Concern 4. Will the seed companies be able to keep seed from being contaminated?

Yes, the greatest real potential for pollen flow and contamination is during seed production. The seed industry has agreed on a field tagging procedure in areas where RR alfalfa seed will be grown so neighbors and other seed companies will know where RR seed is being produced. 30% or more of total seed production is produced by seed production companies for export and must be non-GE alfalfa seed; thus it is in the seed companies' own best interest to control seed production to continue to produce the non-biotech seed. This large volume of export seed production is much more significant economically to the seed industry than the less than 1% of total seed market for organic seed production. However, concerns and methodology for exported seed will make non-biotech seed available to organic and other growers indefinitely.

Concern 5. Won't feral alfalfa be a source of contamination?

Feral (wild growing) alfalfa can act as a bridge for moving genes from one seed field to another, and thus should be controlled to prevent gene flow in any area where seed production occurs, whether biotech or not. Feral alfalfa is primarily an issue in portions of Western states because little occurs elsewhere. Feral alfalfa will have low seed production for the reasons described in #3 plus damage from lygus bug and infection from seed-borne fungi when seed develops under damp conditions. Seed from any feral plants will contribute to new plants only over a very short term, but removing feral alfalfa from ditches and roads is a good idea for organic and export growers to prevent gene flow. If feral alfalfa is deemed a problem in a specific area, then it must be controlled as off types of alfalfa and other problem weeds are currently controlled using cultural and other herbicide methods.

Concern 6. Won't hard seed be a source of contamination?

Hard seed of alfalfa generally does not persist for more than one year in moist soils (Albrecht et al. 2008 Forage and Grazinglands), much less after years of hay production. To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting. State Seed Certification Standards already require that the alfalfa seed field's history include a 2-year exclusion period before planting alfalfa for seed.

Concern 7. Much of hay in my area is cut late with mature seed – we have good farmers but weather, equipment problems force late cuttings.

Although late cuttings occasionally happen viable seed development is unlikely. Plants must remain in field for 4 to 6 weeks after pollination of flowers for viable seed to form and longer for seed to shatter. Delaying harvest 1 to 2 weeks due to weather, equipment problems and other issues will cause little to no seed production in hay fields (see item #3). Furthermore, hay harvest should remove this small amount of seed so that it doesn't become a problem.

Concern 8. Organic producers may have difficulty growing organic hay.

No – there is no reason that organic growers can't continue to successfully grow organic hay. In fact, the presence of Roundup Ready alfalfa hay in the marketplace may increase the value of organic hay, for buyers who are sensitive to biotech traits. There are a number of growers who currently grow both Roundup Ready alfalfa and organic hay on the same farm without difficulty. Organic growers should 1) select conventional seed that is tested for the trait if their customers have set a standard of adventitious presence, 2) take simple steps to protect their crop from gene flow and 3) identify hay lots after harvest. Feedstuffs can be tested to ensure low biotech levels desired for these markets. Organic growers currently are certified to show that their crops are not grown with pesticides or non-organic fertilizers, and similar steps can be taken to show that they do not use genetically engineered crops.

Concern 9. Couldn't we lose our entire hay export market?

No. While export growers and buyers are sensitive to the presence of biotech traits in crops, they have developed market-assurance methods to demonstrate that they are marketing non-biotech alfalfa hay, including testing to assure buyers of the non-biotech status of hay. Japan, Taiwan, and Korea (main U.S. hay market) already use biotech corn and soybeans and have accepted some RR alfalfa hay. The European Union has approved use of certain biotech varieties of corn and soybeans in food and feedstuffs. While significant in some growing regions in the US, exported hay represents less than 1 % of total alfalfa hay production.

Concern 10. Isn't the research biased by the seed companies that stand to gain most?

RR technology has been evaluated at many universities. This research is independent of the concerned commercial parties. The goal is to independently test a technology for its viability and environmental safety for farmers and for the general public. These studies must be well-designed, accurate and can only be published after review by anonymous individuals from other institutions selected for impartiality.

Concern 11. Won't the Roundup Ready gene in alfalfa have a negative effect on insects, diseases, other biota, or the environment?

There is currently no evidence that this gene would have a negative effect on insects or animals, or the environment. The Roundup Ready gene has been thoroughly tested as other crops were released (corn, soybeans, cotton) and no impact on any other biota has been found. No toxicology issues have been identified with roundup ready alfalfa fed to animals. In the past ten years, billions of tons of corn, soybeans, cotton and alfalfa have been produced with this gene, and there has been no documented harm to animals, humans or wildlife. In fact the use of Roundup would replace some more toxic pesticides that have been used and found in ground water (e.g. Velpar).

Concern 12. Farmers can't/won't follow stewardship protocols.

All technology requires stewardship by farmers (e.g. fertilizer use, manure management, pesticide use, irrigation). Farmers must be educated about stewardship needed and required to use appropriate stewardship for any technology. The possibility of gene flow is no different in scope than controlling pesticide drift, fertilizer contamination from conventional farms, or for that matter, the influence of weeds from organic fields that may contaminate neighbor's fields. Good farmers know how to do this.

Concern 13. Won't there be weed resistance to Roundup from use of RR alfalfa?

Weed resistance and weed shifts are issues with all herbicides. New management programs have always resulted in shifts in weed pressure. For example, no-till crop production has resulted in different weed problems than when crops were grown with conventional tillage. Resistance to glyphosate has occurred in row crop situations. Inclusion of alfalfa might actually slow increase of resistant populations of weeds because an additional mechanical control (frequent hay harvest) is being added to the weed management program. Techniques are readily available to avoid weed shifts or weed resistance using the Roundup Ready system as detailed in a recent article (Orloff et al., 2008).

Concern 14. Risk far outweighs reward/Do we really need this? Are we willing to take this kind of gamble?

There is also a risk with NOT moving ahead with a technology that has clear potential benefits to farmers and the environment. Currently, many animals are killed or hurt each year by weedy alfalfa fields – something that Roundup Ready technology could help address. Also, some of the conventional herbicides have been found in well water – something not true with glyphosate. Additionally, Roundup Ready alfalfa would allow farmers to control tough weeds for which no other good method of control exists (e.g. winter annuals such as chickweed, wild garlic, wild onion, perennials such as dandelion, difficult weeds such as nutsedge and dodder, and poisonous weeds such as groundsel).

Further, if this breeding methodology is permanently banned, it would mean fewer genetic advancements for alfalfa in the future. Some traits currently under development, such as a low lignin gene that could mean higher forage yield and fewer cuttings for farmers, a leaf retention gene to retain leaves through harvesting process, genes which confer pest resistance, or genes to increase bypass protein, would never be available to farmers. It is not reasonable or fair to farmers to restrict a technology from use in alfalfa that is available in other crops.

A series of articles on biotech alfalfa and coexistence of GE and conventional alfalfa seed and hay production is available at <http://www.alfalfa.org/CSCoexistenceDocs.html> and <http://alfalfa.ucdavis.edu/+producing/biotech.aspx>.

In summary, it is essential that alfalfa growers and the industry understand how to use this important new genetic tool, while at the same time, protecting those farmers who don't wish to adapt it. Research has proceeded with great deliberation in the development of Roundup Ready alfalfa and shown it to be a good tool that will benefit many farmers. Like every other tool, it must be used with care and appropriate stewardship. It is important for the industry to manage for coexistence of biotech-adapting and non biotech-adapting farmers, since other important biotech traits are being developed which might be much greater benefit to farmers and society.

Comments from Dr. Doug Cattani, MAFRI

Concern 1. The answer is not a resounding yes, but that the levels are low enough at this point to escape detection at the level of the testing (the only true yes answer is if all seeds are tested but this is a destructive test therefore impossible to carry out).

Concern 2. Contamination from neighbouring fields. As mentioned seed fields are the most vulnerable and it is stated that the distances for certified production will result in low levels of contamination.

Concern 3. Hay fields can pass along genes to feral populations, and we have number of these in Manitoba (Bagavathiannan & Van Acker, Dec. 2008 MFC Newsletter).

Concern 4. Yes companies will attempt to keep the fields separate however, the current production isolation guidelines are not effective in reducing the risk to zero.

Concern 5. See above and it would be impossible to control all alfalfa outside of fields. Unless the companies are providing the resources to eradicate the feral alfalfa, then it will not be done as there are too many other problems that the current resources are required for.

Concern 6. Hard seed. Tests have indicated a short life in the soil, however where and how the test was conducted needs to be examined in order to ascertain the reliability of the estimates (seed buried together in permeable sacks has been shown to underestimate the longevity of seed in the soil (Van Mourik et al. 2005). Also, one of the authors of the study is the head of FGI, the marketers of RR alf.

Concern 7. The authors state that this is generally not a problem but can happen.

Concern 8. Organic growers and conventional seed. Testing seed does not totally eliminate the potential, however it does reduce the potential. If organic protocols allow for a low level of adventitious presence then this may not be a problem.

Concern 9. Probably no.

Concern 10. Yes.

Concern 11. Correct.

Concern 12. Stewardship guidelines. Many producers attempt to follow the guidelines however small errors do occur and therefore there is potential for escape. Acts of nature do not follow signage and keep out if instructed to.

Concern 13. Weed resistance. Correct, as we increase the use of any herbicide resistance becomes an issue.

Concern 14. Depends upon your definition of progress?