

# Assessment of Alfalfa Gene Flow Between Fields Planted for Hay Production and Adjacent Fields Used for Seed Production

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The potential for gene flow between alfalfa fields is influenced by whether the alfalfa fields are grown for seed or grown to produce forage<sup>1</sup>. Effective pollen-mediated gene flow can occur in seed fields if physiologically mature seeds are produced on plants within the seed field (sink/recipient plants) that were pollinated by pollen that did not originate within the seed field (source). Forage (“hay”) alfalfa fields have optimum feed value when the plants are primarily vegetative, that is, when the canopy is prebud or has less than 10% of the stems with one open flower (and no seed has been set). Alfalfa fields managed to produce high quality forage will typically have no or only a few open flowers and available pollen. One would anticipate that plants in fields such as this will not attract large numbers of bees foraging for either nectar or pollen, and therefore will likely have a low potential to serve as a source of outside alfalfa pollen.

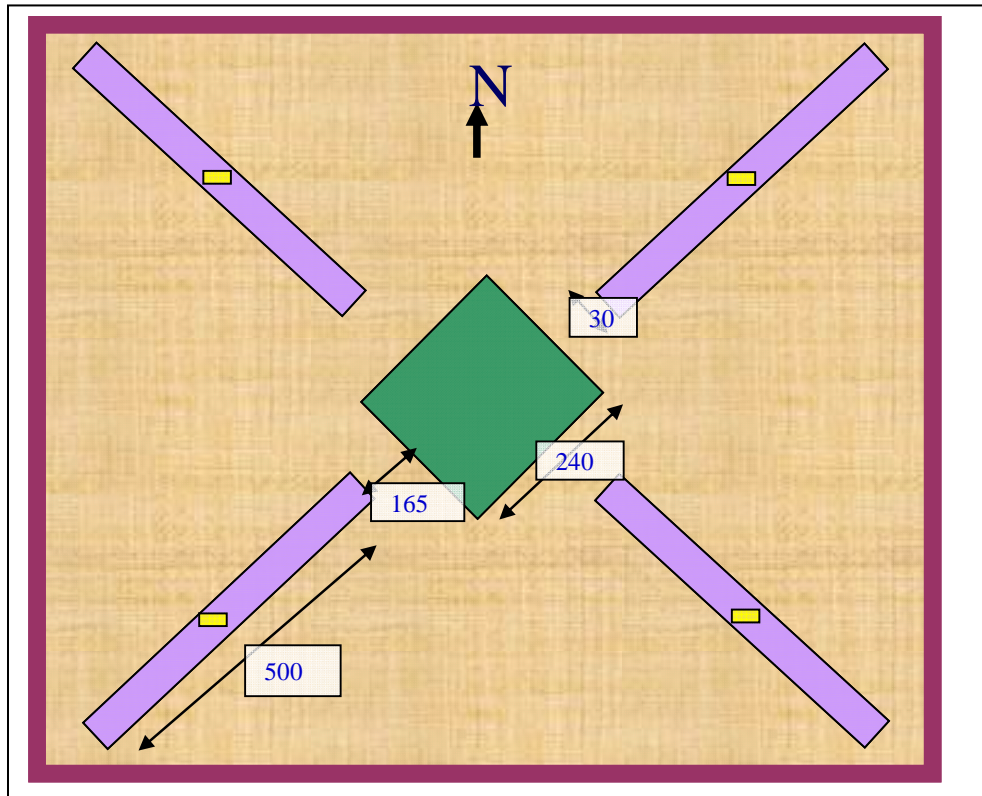
Effective gene flow between alfalfa production fields can be grouped into three categories: Seed-to-Seed, Hay-to-Hay and Hay-to-Seed. This document summarizes available data on the potential for Hay-to-Seed type of gene flow. Two different field studies in which effective gene flow was measured from Roundup Ready<sup>®</sup> hay fields (sources) to conventional seed fields (sinks). These studies used the Roundup Ready trait as a marker tool to easily and accurately measure pollen flow. The initial study was conducted in 2000. Alfalfa leafcutter bees (*Megachile rotundata*) were used as pollinators and the alfalfa hay fields were allowed to go to 50% bloom. (study was described in the 2004 Petition for the Deregulation of Roundup Ready Alfalfa<sup>2</sup>). An additional more extensive study is currently being conducted at the University of California, Davis. This study was initiated in 2006 and is using honey bees (*Apis mellifera*) as pollinators. This study, like the initial study, employs the Roundup Ready trait as a marker. The study consists of a one and one-third acre hay field (source) planted with a Roundup Ready cultivar. Extending from the hay field in four different directions are 1/3 acre seed fields planted to a conventional cultivar (source, Fig. 1). In this study, alfalfa hay was harvested on a 30 to 34 day cycle throughout the 2006 production season. This cutting cycle permitted the forage to reach as much as 20% bloom in any single cutting cycle. The seed fields were located no closer than 165 feet from the Roundup Ready hay field. Seed fields began to bloom on the 4<sup>th</sup> of June

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<sup>3</sup> Putnam, D.H. 2006. Methods to Enable Coexistence of Diverse Production Systems Involving Genetically Engineered Alfalfa. Univ. of Calif. Publication #8193. <http://anrcatalog.ucdavis.edu/pdf/8193.pdf>

<sup>2</sup> USDA Petition for Deregulation: [http://www.aphis.usda.gov/brs/aphisdocs/04\\_11001p.pdf](http://www.aphis.usda.gov/brs/aphisdocs/04_11001p.pdf). and Forage Genetics' stewardship policies and pollen flow research data: <http://foragegenetics.com/News.asp>

2006. Honey bees were placed in these fields on June 22 when the crop was estimated to be at 80% bloom. When the bees were placed in the seed fields, the hay field was at a pre-bud developmental stage. It was harvested on June 28 and again on August 1. At the time of cutting the hay field was at about 20% bloom.



**Figure 1.** Field plot design for Hay-to-Seed gene flow study at the University of California, Davis. Center area is a 1.32 acre hay field planted to a Roundup Ready alfalfa cultivar and the radiating arms are 0.33 acre seed fields planted to conventional alfalfa. Center areas of the seed field are honey bee hives.

The choice of 165 ft between the hay and seed field in the California study was based on the minimal isolation standard required between dissimilar cultivars under the California certification standards (AOSCA). Although the California study examined gene flow to a greater distance from the source than the earlier leafcutter study, first year results from the Honey bee study were similar to the results from the earlier leafcutter bee study between 165 and 300 feet from the marker source. Under these conditions, gene flow into the seed field was very low (0.2%) at 150 and 300 ft and, it was rarely detected (0.00 to 0.05%) at distances greater than 350 ft from the source (Table 1).

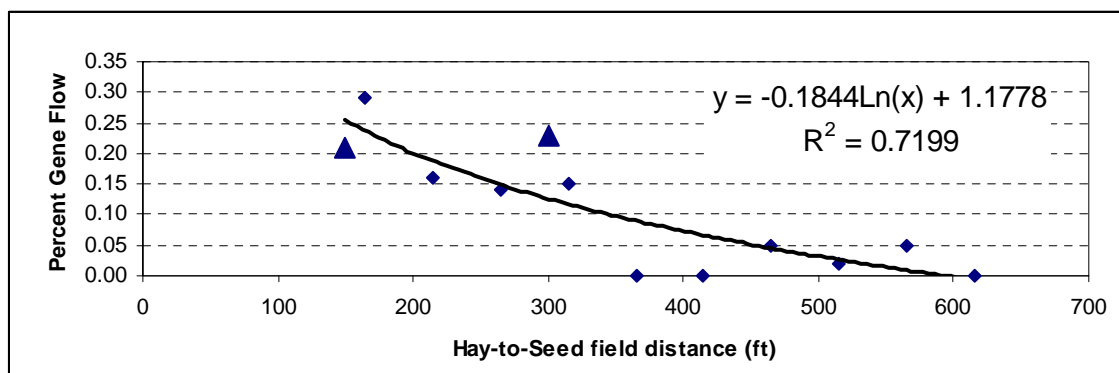
Certified alfalfa seed must be produced using production methods and isolation defined and inspected by state seed certification organizations and organic seed production must be managed according to a plan approved by an accredited organic certifier. Non-certified seed is not officially regulated. Seed producers and regulators recognize that genetic purity of the harvested seed crop is related to physical isolation between the seed field and outside sources of pollen. These results are consistent with existing standards for certified seed production. Additional assurances can be achieved by entering into an Identity Preserved (IP) agreement

with a seed certification association that is a member of the Association of Official Seed Certifying Agencies (AOSCA).

**Table 1.** Observed gene flow from 50% and 20 % hay production plots growing in close proximity to replicated alfalfa seed field plots in 2000 and 2006. These trials simulated delayed harvest hay fields growing near and beyond the AOSCA certified seed field isolation distance (i.e., 165 ft). In 2000, replicated seed plots in Washington were allowed to mature extensively to 50% flower (5X the optimum hay cut stage), stocked with leafcutter bees and separated by 150 or 300 ft isolation from the Roundup Ready® hay field plot. In 2006, replicated seed field plots at the University of California were allowed to mature to 20% flower (2X the optimum hay cut stage), stocked with honeybees and separated by 165 to 615 ft isolation from the Roundup Ready hay field plot.

<u>Isolation</u> Distance from Hay Source	2002 WA (RRA Petition Data, 2004) <sup>a</sup> (Hay cut at 50% bloom)	2006 <sup>b</sup> (Hay cut at @ 20% bloom)
----feet ---	----- percentage	gene flow -----
150	0.21	
165		0.29
215		0.16
265		0.14
300	0.23	
315		0.15
365		0.00
415		0.00
465		0.05
515		0.02
565		0.05
615		0.00

**Figure 1.** Observed gene flow (Y %) from hay field plots growing near replicated alfalfa seed field plots in 2000 (▲) and 2006 (◆). These trials simulated delayed harvest of hay fields growing near and beyond the AOSCA certified seed field isolation standard (i.e., 165 ft). In 2000, replicated hay plots in Washington were allowed to mature to 50% flower (5X the optimum hay cut stage), seed field plots were stocked with leafcutter bees and separated by 150 or 300 ft from the Roundup Ready® hay field plot<sup>2</sup>. In 2006, replicated seed field plots at the University of California were allowed to mature to 20% flower (2X the optimum hay cut stage), seed field plots were stocked with honeybees and separated by 165 to 615 ft from the Roundup Ready hay field plot.



## **Summary**

The hay field plots flowering allowed in these research trials, especially in the Washington, is greater than would usually be practiced by forage producers. Growers will usually manage for optimum forage quality, which minimizes the number of open flowers on the standing hay. These studies indicate that if alfalfa seed growers observe reasonable isolation distances between alfalfa seed fields and forage fields (e.g., seed growers who implement the recognized AOSCA certified seed minimum isolation standard of 165 feet or greater) may minimize or avoid the risk of adventitious presence (AP) of the Roundup Ready or other foreign traits in their seed crop. Additionally, IP programs are a service offered by certification agencies that can be employed by those seed producers interested in following more stringent practices.