Pollen Movement from Alfalfa Seed Production Fields

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Abstract

An alfalfa pollen flow study was conducted near Fruita, CO (Mesa Co.) during the summer of 2006 with he objectives of determining the distance that bees transport Roundup Ready® alfalfa pollen under local field conditions, and estimating the role alkali bees play in alfalfa pollen transport in the area. We harvested seed from feral alfalfa plants at 23 sites on roadsides, abandoned fields, and edges of active hay fields within two miles of Roundup Ready® alfalfa seed fields. We also collected bees from these sites throughout the alfalfa bloom season to determine which species were moving pollen. The harvested seed was planted and seedlings treated with Roundup® to assay for the presence of the Roundup Ready® gene. The gene was found at 83% of the collection sites, out to a distance of 1.7 miles from the pollen source. Alfalfa leafcutter bees and honey bees were the most common bees collected at the seed harvest sites. Honey bees appeared to be the most important bee involved in long distance pollen transport. More *Melissodes* and *Anthophora* species than alkali bees were captured at the seed collection sites. Alkali bees played a minor role in long distance transport of pollen under these conditions.

Introduction

Roundup Ready® (RR) alfalfa is grown for seed on approximately 900 acres of land near Fruita, Colorado (Mesa County). It has been produced in the area since 2004. These seed production fields are pollinated primarily by managed alfalfa leafcutter bees, *Megachile rotundata*, but many native bees, including alkali bees, *Nomia melanderi*, are present in the fields. Several alkali bee nesting sites are known in the vicinity of the RR seed production fields, and alkali bees are at times very common in the area. Table 1 lists bee species that have been captured in alfalfa seed production fields near Fruita.

We conducted a research program in 2006 to:

1) Determine the distance that RR pollen is moving from alfalfa seed production fields.
2) Estimate the role of alkali bees in pollen movement from the seed production fields.

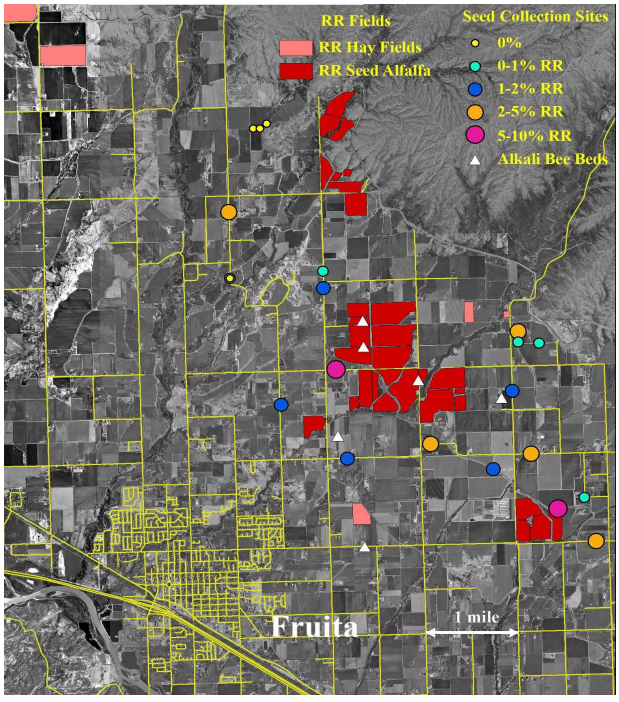

Figure 1. Location of RR seed fields (red) and hay fields (pink), seed collection sites (circles coded by amount of RR seed found), and alkali bee beds.

3) Determine which bee species were active in moving RR pollen from seed production fields.

Methods

The RR fields we used as the study site are located approximately 2 miles NW of Fruita CO. They are isolated from other RR alfalfa seed production by 7 miles of open farm and range land. There were several RR alfalfa hay fields planted in the area in the fall of 2005 and spring of 2006. First and second cuttings in these fields were taken no later than early bloom growth stage, so the amount of RR pollen from these fields was relatively small and present only for a few days For the purposes of this study we assumed that the RR alfalfa seed production fields were the sole source of RR pollen. Figure 1 shows the location of RR seed production fields and RR alfalfa hay fields in the study area.

We located sites in the area where feral alfalfa plants produced seed. The sites were at different directions and distances from seed production fields. Distances to seed fields were measured on a straight line basis, using aerial photographs imported into ArcMap 9.1. Our most distant site was 1.7 miles from the nearest seed field. Seed was collected from 23 sites.

The seed collection sites were located on roadsides, field edges, and waste areas. Except for a single site, no extra management was taken to allow them to produce seed. Site locations, descriptions and distances from RR seed production fields are listed in Table2.

We gathered seed as soon as enough was mature enough to allow for collection of about 1000 seeds. At ten sites, we collected on two dates to determine the amount of mid and late summer pollen flow.

Seed was cleaned in the lab at the Western Colorado Research Center at Fruita. The cleaned seed was sent to Forage Genetics, Nampa ID where it was assayed for the RR gene. They planted the seed in flats, counted the seedlings then sprayed them two times with Roundup® herbicide. The survivors were then counted as an assay for the RR gene. A number of randomly chosen survivors were tested for the RR gene using SDI test strips to test for the presence of the CP-4 gene.

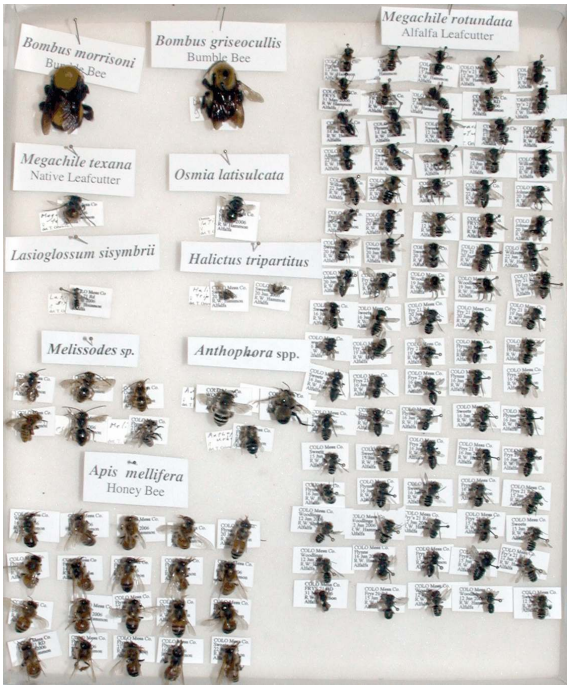

Figure 2. Bees captured at seed collection sites. Leafcutter and honey bees dominated the captures at all sites.

Bees were collected from the seed production fields and seed collection sites on a regular basis, beginning with first bloom in late May. The primary objectives were to find alkali bees and to document the diversity of bees in the area. The collected bees were taken to the USDA Bee Lab in Logan, UT for identification.

It is important to note that the bee collections are not a quantitative representation of species we saw in the field. We quit collecting honey bees and leafcutter bees because they were so common. The focus of the collection was the other bee species, so honey and leafcutter bees areunder-represented in the collection. Bees captured at the seed collection sites are pictured in Figure 2.

Results

The results of the RR seed assays are presented in Table 2 and Figure 1. Seedlings that survived the Roundup® application in the bioassay tested positive for the CP-4 gene, so all surviving seedlings were considered RR. The RR gene was found at 19 of 23 seed collection sites. The percentage of RR seed at sites where it was present ranged from 0.18 to 9.46%.

There was no correlation between distance from RR pollen source and the percent RR seed.

There was significant early season movement of the RR gene. Seed collected as early as mid-July had 0.4% RR genetics present. Two of these sites were within 0.5 mile of the RR pollen source. Leafcutter bees were common at these sites and they were probably responsible for most of the short-distance early season pollen flow. We caught alfalfa leafcutter bees at seed collection sites a full two weeks before managed bees were released into local shelters at seed production fields.

Female alkali bees did not emerge until June 22nd, with the peak of the emergence in late June and early July. The time span between pollination and seed maturity is about 28 days, so movement of the RR gene to seed collected before late July could not have been by alkali bees. One collection site (#26) was located within 200 yards of an alkali bee bed, and tested more than 5% RR seed. This site was 0.5 mile from a RR seed field. A second collection site (#11) was also about 100 yards from an alkali bee bed, but tested only 1.5% positive for RR seed, even though it was only 0.4 miles from a seed field. The mere presence of alkali bees nesting areas in the area did not guarantee high amounts of RR pollen movement.

The percentage of RR seed was apparently unchanged from the first to second seed collection date at 5 of the ten sites that were sampled twice. All of the pollen movement occurred before mid July at four of these sites.

Alfalfa leafcutter bees and honey bees were the dominant species taken while sampling bee populations. Previous research has shown that alfalfa leafcutter bees do not transport pollen over distances greater than one mile under most conditions. Honey bees are known to be capable of transporting pollen more than one mile. The other bees taken in the collections that would be capable of transporting pollen to the furthest seed collection site are bumble bees (*Bombus morrisoni* and *B. griseocullis*), *Melissodes* sp., *Anthophora* spp., and *Osmia latisulcata*. Only one alkali bee was taken at a remote seed collection site, although five nesting sites were found in the area. We must assume that most alkali bee foraging was within seed fields or local in nature.

Table 1. Bees found in Fruita CO alfalfa seed production fields. Bees are listed in approximate order of abundance in fields limited to the seed production fields.

Megachile rotundata	Alfalfa leafcutter
Apis melifera	Honey bee
Nomia melanderi	Alkali bee
Melissodes sp	
Anthophora spp (2)	Digger bees
Bombus morrisoni	Bumblebee
Bombus griseocullis	Bumblebee
Lasioglossum sisymbrii	
Halictus tripartitus	
Halictus confusus	
Megachile texana	Leafcutter bee
Osmia latisulcata	

Conclusions

Bees are capable of moving the RR gene at least 1.7 miles. The farthest distance they can move pollen cannot be determined from this project because we found the RR gene at our most distant site from the pollen source. Pollen movement at the furthest site occurred late in the season, since the 8/11 seed collection had no RR seed, while the 9/19 collection had 3.8% RR seed.

Alkali bees were probably of minor importance in long distance pollen movement. *Melissodes* sp., *Anthophora* spp., and *Bombus* spp. were more common in collections than alkali bees. Several other taxa of native bees including *Megachile* spp., *Osmia latisculata*, *Lasioglossum* sp., and *Halictus* sp. are responsible for short and mid range movement of pollen.

Honey bees were probably the most important species involved in long-distance pollen transport. Most of these bees are apparently feral since only one hobby beekeeper could be located in the area.

Acknowledgements
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Table 1. Seed collection site descriptions and RR assay results.

[1] N is the number of alfalfa seedlings tested for the RR gene in bioassays.

		G.P.S.			Collection Dates					
Site	Description	North	West	Distance	1st	% RR	N[1]	2nd	%RR	N
1	Edge of active field	39.233	108.716	0.84	7/10	0.00%	305	9/7	0.00%	51
2	Edge of active field	39.176	108.668	0.44	7/12	0.18%	552	8/16	0.41%	726
3	Edge of active field	39.171	108.650	0.30	7/13	0.42%	475	8/30	1.07%	656
4	Abandoned field	39.209	108.701	0.47	7/28	1.06%	470			
5	Abandoned field	39.197	108.658	0.87	7/26	1.21%	829	9/7	1.40%	358
6	Edge of active field	39.199	108.662	0.72	7/27	0.20%	503	9/7		
7	Edge of active field	39.199	108.661	0.81	7/27	2.81%	178	9/7		
8	Edge of active field	39.197	108.662	0.66	7/27	0.27%	374	9/7		
9	Edge of active field	39.233	108.713	0.65	7/26	0.00%	219			
10	Edge of active field	39.233	108.714	0.73	7/28	0.00%	238	8/16		
11	Edge of active field	39.179	108.697	0.43	7/31	0.70%	1002	9/7	1.50%	467
12	Roadside	39.207	108.701	0.33	8/10	9.46%	560	8/16	9.17%	1669
13	Roadside	39.203	108.701	0.25	8/11	4.50%	977	9/19	4.05%	469
14	Abandon field	39.212	108.729	1.68	8/11	0.00%	398	9/19	3.78%	608
15	Edge of active field	39.170	108.655	0.02	8/11	3.29%	821			
16	Roadside	39.209	108.720	1.31	8/11	0.00%	820	9/19	0.00%	539
20	Abandon property	39.219	108.720	1.04	9/7	0.25%	800			
21	Abandoned field	39.188	108.710	0.28	9/7	0.58%	693			
23	Edge of active field	39.164	108.648	0.40	8/30	1.58%	506	9/25	0.96%	313
24	Abandoned field	39.179	108.660	0.51	8/30	2.23%	764			
26	Roadside	39.189	108.664	0.52	9/7	5.08%	610			
27	Roadside	39.181	108.680	0.26	9/19	2.43%	823			
28	Abandoned field	39.193	108.699	0.15	9/25	2.03%				