Title: Are more bees better? Pollinator diversity and efficiency in southeastern blueberries

Progress report, 2011-08

Research project

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Objectives

1. To determine pollinator diversity and abundace in southeastern blueberries
2. To determine efficiency of pollinator species present in blueberries
3. To determine the impact of cultural practices on pollinator abundance, diversity, and efficiency

Justification

Southeastern states contribute at least 30% of North American blueberry production. Blueberries are grown throughout the region, but the largest acreage is in Georgia and North Carolina. (Agricultural Statistics Board, 2009). These two production regions differ significantly in their production practices. On the one hand, North Carolina blueberries are grown on approximately 6,000 acres, and of this area, 75% is planted in southern highbush (*Vaccinium corymbusum*) varieties and 25% in rabbiteye (*V. ashei*) varieties. Of the southern highbush production, 90% occurs in four southeastern counties: Bladen, Duplin, Pender, and Sampson (Cline, et al. 2004). Plantings in these counties often cover hundreds of contiguous acres. On the other hand, the 9,500 acres of blueberries grown in Georgia are roughly 90% rabbiteye with the remaining acreage southern highbush (Krewer, et al. 1999). These differences in productions systems are important when considering pollination. Blueberry pollinators have been studied in highbush systems in Michigan (the largest blueberry producing state; Tuell, et al. 2009) and in the Pacific northwest (Dogterom and Winston, 1999). While prior research on honey bee and native blueberry pollinators in the southeast has primarily been conducted in Georgia on rabbiteye varieties (specifically Climax, Tifblue, and Premier), there has been little to no work on the southern highbush varieties grown elsewhere in the southeast.

Blueberry growers have become increasingly concerned in recent years about achieving adequate pollination (Bickers 2008), and there is growing interest in optimizing current pollination strategies using honey bees while integrating alternative pollinators (including bumble bees and other native pollinators). Some growers have been experimenting on their own using bumble bees for pollination, but replicated research on these methods in the southeast is lacking. Obtaining high quality honey bees is also becoming difficult. For example, in North Carolina there was an estimated 10,000 colony shortfall for pollination rentals in 2004 (Collins, 2004). Given the standard ratio of three beehives per acre in blueberries, this represents a significant decrease in the total possible yields across the region.

We need to determine the relative abundance of honey bees, bumble bees, and native pollinators in the blueberry varieties grown in other areas in the southeast. In doing so, it is critical to understand their ability to pollinate these varieites and their interaction with the surrounding environment. We particularly need to assess pollination needs for our most common southern highbush varieties.

Methodologies

Sites were established in 2010 at 7 locations spanning North Carolina. Sites were selected to represent geographical and production diversity and included coastal, Piedmont, mountain, organic, and conventional locations. (Figure 1) Each location was visited a minimum of 2 times, at least once to collect pollinator diversity data and conduct pollinator efficacy experiments and at least once to collect fruit samples from cages. Results from 2010 indicated that daily conditions at each site (cloud cover, wind speed, and percent bloom) heavily influenced pollinator activity, abundance and diversity. Therefore, we decreased the total number of sites visited in 2011 to 4 and visited each site up for 4 times each during bloom. At each site visit, 3 distinct activities were conducted. Transect walks to count pollinators at flowers were conducted either hourly (2010) or 4 times per day (2011) at 2 locations per site. Pan traps (replicated by color; white, yellow, and blue) to passively collect pollinators for identification were placed at 2 locations (in crop and outside of crop) for a full day. Single visit pollination efficiency was measured by excluding pollinators via cages pre bloom at each site and then exposing virgin flowers to single visits by pollinating species. Flowers were labeled and fruit collected ca. 50 days post pollination to assess seed set. In 2011, videos of foraging pollinators were recorded at each of the locations and are being used to determine if handling time and visitation rates differ between bee species and with respect to bee diversity and abundance.

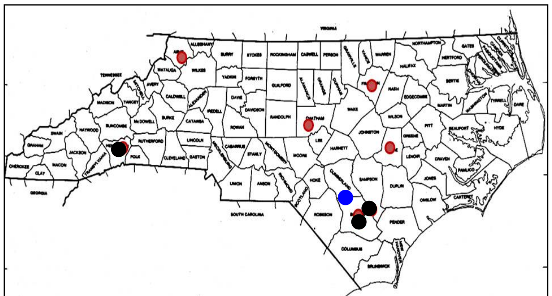

Figure 1. Blueberry pollination sampling sites, 2010 (red), 2011 (blue), and both years (black).

Results

Objective 1. Pollinator diversity & abundance

Pan trap collected bee samples are in the process of being identified, but to date we have confirmed at least 21 genera (of 55 in NC) and 5 families (of 5 in NC) present in our blueberry systems (Table 1). Many of the NC genera that are not present are parasitic or only have one species found in NC. In previous southeastern studies, twenty seven different bee pollinators have been observed on rabbiteye blueberries (Cane and Payne 1993), and to date, we have identified 20 species in NC southern highbush blueberries. This number will increase as we identify *Andrena* and others to species.

Table 1. Bee families and genera identified to date.

Family	**Genera**
Andrenidae	*Andrena*
Apidae	*Apis* *Bombus* *Ceratina* *Habropoda* *Nomada* *Xylocopa*
Colletidae	*Colletes*
Halictidae	*Agapostemon* *Augochlora* *Augochlorella* *Lasioglossum* *Sphecodes*
Megachilidae	*Megachile* *Osmia*

Using transect walk data, species diversity ranged widely between sites (Table 2). Our two pollinator sampling methods appear to differ somewhat in the species they detect. Small native bees (Andrenidae, Colletidae) were collected more frequently in pan trap samples than they were observed in transect walks. This may be due to differences in floral handling strategies, which we hope to capture in our ongoing analysis of video data. We will next be relating species abundance and diversity to

Table 2. Species diversity at Sites sampled in 2010 and 2011, selected sites. Higher numbers indicate greater species diversity.

Year	**Site**	**Species Diversity (Shannon Index)**
2010	2	0.162728042
2010	1	0.480380855
2010	4	0.876771534
2011	2	0.290853627
2011	3	0.628509747
2011	1	0.521018758
2011	4	0.772571415

Objective 2. Single visit efficiency

Single visit pollination efficiency, as measured by seed set, varied both between sites and by pollinator (Figure 1). The specialist, *Habropoda laboriosa* (southeastern blueberry bee), was not necessarily the most efficient pollinator, while the functional group of small native bees were generally the most efficient pollinators. Nectar poaching by *Xylocopa* carpenter bees also contributed pollination services and was, in some cases, comparable to those proved by honey bees (*Apis mellifera*). *Bombus* species were also generally efficient pollinators, likely due to their large size and ability to sonicate flowers.

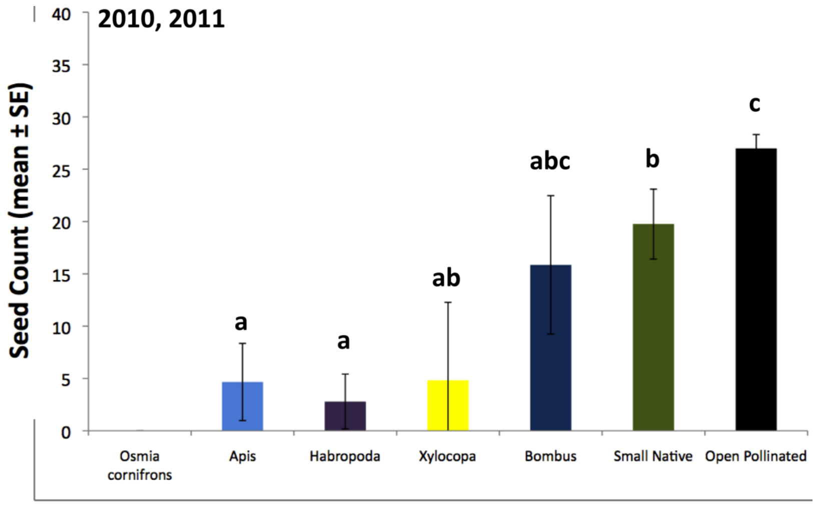

Figure 1. Single visit pollination efficiency, Site 1, combined data from 2010 & 2011. Data from Site 1 are presented, which are representative of data from other sites, although efficiencies of observed pollinator species varied between sites as did the species complex observed.

Objective 3. Effects of cultural practices

Our field sites include large, conventional plantings and small, organic plantings. We have collected pesticide spray records from each monitoring site and will compare these to bee abundance and diversity data. Next year, we will begin to assess the impact of pesticide use patterns on intraspecific (genetic) bee diversity as well as interspecific diversity.

Conclusions

Bee diversity and abundance differs significantly between fields in the southeast and also varies within a site temporally. The blueberry community include a large number of bee species and families, which differ in their pollination efficiencies. Our results to date indicate that bee diversity may enhance total pollination and individual pollinator efficiency, and these questions are being explored further.

Impact Statement

We have described and quantified the services of the southern highbush pollinating bee community in the southeast. Our results suggest that a diverse group of bees visit highbush blueberries, and that the efficiency of the community varies temporally and geographically.

Presentations, 2011

Rogers, S. November 14, 2011. Pollination by Apis *and non-*Apis *bees in North Carolina blueberry agroecosystem. Entomological Society of America. Reno, NV.*