Quantifying the Role of Shelterbelts (Tree Plantings) as Early-season Resources for Honey Production and Hive Growth of Managed Honeybees

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Summary

We are evaluating the use of shelterbelts as early season foraging resources for managed honeybee (Apis mellifera) hives. We monitored 48 hives at 24 sites with varying distance to and composition of shelterbelts between May and September 2020. Here we present preliminary results from the first year.

Introduction

Globally, native and managed pollinators are experiencing broad-scale population declines, causing a reduction in available pollination services (National Research Council et al., 2007; Potts et al., 2010). Pollinators, however, are extremely important for humans economically and for global food security (Gallai et al., 2009; Klein et al., 2006; Potts et al., 2010).

The European honeybee (*Apis mellifera*) is the primary commercial pollinator in North America and the most widely used and managed pollinator in the world. Since the mid-1900s, the U.S. Department of Agriculture has tracked and documented an overall decline in managed honeybee hives (National Research Council et al., 2007).

Similar to declines in other pollinators, factors including parasites, pests and pathogens interact, weakening populations (National Research Council et al., 2007; Potts et al., 2010). The declining population is unable to keep up with the demand for their pollination services (Aizen and Harder, 2009; Delaplane and Mayer, 2000; Kearns et al., 1998; McGregor, 1976).

In the U.S., honeybee pollination is estimated to be valued between $15 billion and $18.9 billion annually (National Research Council et al., 2007). In 2019 alone, 157 million pounds of honey were produced with a value of more than $309 million (U.S. Department of Agriculture, National Agricultural Statistics Service, 2020).

In addition to their importance throughout the U.S., honeybees are an important species for the northern Great Plains (NGP) region. After a mass transport of honeybee hives back to the region in early spring, the NGP hosts about 1 million honeybee hives and leads the country in honey production. Therefore, honeybee declines are of particular concern for the region (Otto et al., 2016; U.S. Department of Agriculture, National Agricultural Statistics Service, 2020).

Increasingly, land-use changes reduce forage availability for honeybees throughout the year and influence their survivorship (Smart et al., 2016). These changes limit forage and nutrient diversity necessary for honeybee survival and hive growth (Smart et al., 2016).

One potential solution to lessen future declines in honeybees is to promote forage diversity specifically at times when it is lacking (Decourtye et al., 2010; Dolezal et al., 2019). Early spring floral resources often are limited in grasslands, and flowering trees and shrubs could fill this niche and provide crucial resources in a time of need.

Around the world, trees and shrubs have been highly documented as important honeybee resources, especially during the spring (Brodschneider et al., 2019; Couvillon et al., 2014; Lau et al., 2019; Sponsler et al., 2020). Tree and shrub plantings in the NGP are commonly known as shelterbelts and were planted as windbreaks and to provide soil stability, as well as numerous services for human use (Gardner, 2009; Johnson and Beck, 1988).

The goal of our study is to determine if early flowering trees and shrubs planted in the NGP provide essential resources to fill early season forage gaps for honeybees. Specifically, our main objectives are: 1) identify tree species found in North Dakota shelterbelts that are used by honeybees and 2) quantify the relationship between honeybee hive growth and shelterbelt cover across varying spatial scales.

Study Area

This study took place near the Hettinger Research Extension Center (HREC) near Hettinger, N.D., in Adams County, and the Central Grasslands Research

Extension Center (CGREC) near Streeter, N.D., in Stutsman and Kidder counties. On average, annual temperatures are 43.5 F at the HREC and 41.3 F at the CGREC, with respective annual precipitations of 17.08 inches and 18.40 inches (Arguez et al., 2010).

Both regions are highly influenced by agriculture. In 2019, the leading land/crop categories in the three counties surrounding the centers were grass/pasture, spring wheat, soybeans and corn (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019).

Honey producers and their relative apiary densities in the surrounding counties are high. Adams County has eight registered apiaries per 10,000 hectares (ha), with 13 per 10,000 ha in Stutsman County and 11 per 10,000 ha in Kidder (Otto et al., 2016).

Both regions contain shelterbelts that feature various deciduous and coniferous tree and shrub species. Shelterbelt tree species regularly include eastern cottonwood (*Populus deltoides*), elm (*Ulmus* spp.), Russian olive (*Elaeagnus angustifolia*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*) and various conifers. Common lilac (*Syringa vulgaris*) and common caragana (*Caragana arborescens*) also are frequently planted shelterbelt shrubs (Van Enk et al., 1980).

Methods

Site Selection

Honeybees may travel a range of distances to forage. Therefore, to test the use of shelterbelts as forage resources, we chose sites in western (HREC) and central (CGREC) North Dakota that varied in nearby tree cover densities at various distances (250 meters [m], 500 m, 1 kilometer [km], 2 km, 2.5 km and 3 km) around hives.

Using North Dakota Forest Service-mapped tree cover data, we chose sites in each region to fill a gradient of tree cover densities (high-low). We selected sites with a majority of anthropogenically planted tree and shrub cover to avoid largely natural tree cover associated with waterways.

Vegetation Surveys

We mapped all tree rows (clusters of more than two individual plants of typically one tree or shrub species) that fell within a one-mile radius of the apiary. Mapping included species types, individual counts and geographic locations.

Following site mapping, we conducted weekly drive-by surveys throughout the season at each site. During weekly drive-bys, we categorized tree and shrub rows by average floral resource percent of flowering categories (adopted from Brereton et al., 2004). We compiled these data to document species phenology by region and to record nearby tree and shrub composition.

Hive Scales

Using two hive scales per site (Solutionbee LLC, Raleigh, N.C.), we measured hourly hive weights. These weights are used as a proxy for hive growth and an index of honey production (McLellan, 1977). We uploaded and adjusted weights to account for anthropogenic weight gains or losses (adding or removing honeybee supers by beekeepers) to plot hive weight through time.

Pollen Traps and Pollen Collection

To gauge transitions in pollen foraging throughout the field season, we also equipped each site with two pollen traps to collect samples of corbicula pollen from returning bees (Smart et al., 2017b). Pollen traps consisted of two entrances, one that directed bees straight to the hive and one that brushed pollen off entering honeybees.

Weekly, we collected pollen from devices placed on each hive. We then placed collected pollen into labeled storage bags and froze the samples. As most tree species finished flowering (mid-July), we transitioned to a 72-hour every other week pollen trap opening period schedule. We collected and stored this pollen in the same way as previous pollen samples.

To prepare pollen samples, we cleaned, dried and ground 10 grams of each sample into a homogenized powder. Following pollen processing, we will send samples to a lab for floral species identification (Smart et al., 2017a).

Species composition within each sample will help us better understand weekly honeybee foraging habits. We later will compare these pollen sample species compositions with vegetation surveys to understand honeybee floral preference.

Results

During the 2020 field season (May-September), we monitored 48 hives at a total of 24 unique sites (apiaries) in North Dakota. That was 15 sites in the western region and nine sites in central North Dakota.

Hive Weights

Throughout the season, most hives showed similar overall weight change trends (Figure 1). Most hive

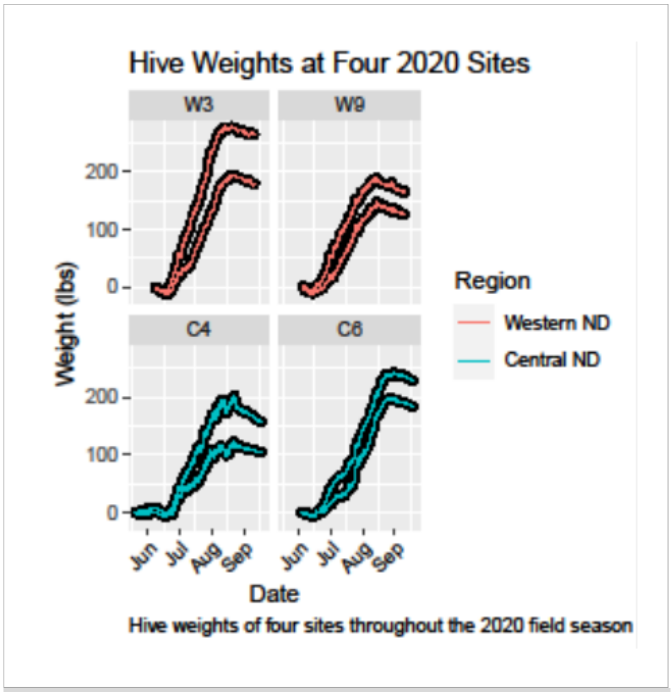

Figure 1. Individual graphs depict hive weights of two hives throughout the 2020 field season (May-September) at four of 24 total sites (two in western and two in central North Dakota). We collected hive weights by equipping honeybee hives with hive scales.

scales documented little weight change between May and July, large daily weight gains between July and mid-August and a slight overall weight loss following a mid-August peak. Figure 1 provides an example of these seasonal hive weight trends at four 2020 sites.

Our two hives at each site often differed in their hive weights throughout the season, with the overall net weight gain varying by hive. Six hives (three per region) had a net loss and five hives had net gains of more than 200 pounds.

Pollen Samples

Pollen samples are in the processing stage and will be analyzed and compared with vegetation surveys in the future.

Discussion

Hive Weight Analysis

Similar seasonal weight trends have been documented in previous NGP literature (Smart et al., 2017b). These overall hive weight trends are connected to photoperiod (daily light period), forage phenology and forage availability throughout the seasons (Couvillon et al., 2014).

Differences in hive weights may be attributed to the age and reproductive fitness of the hive's queen. A queen's age and physical characteristics affect her egg-laying capabilities (Tarpy et al., 1999). Discrepancies in these queen characteristics between hives may contribute to differences in hive composition and available foraging worker bees.

Worker bees forage for nectar and pollen, adding to the overall hive weight by themselves and from the resources they collect (Winston, 1987). A greater number of worker bees may allow some hives to gain weight faster than other hives at the same site, and hives may gain weight at different paces throughout the season.

Future Analysis

Hive weights will be analyzed further to compare tree cover surrounding sites with hive weight change throughout the season. We expect results to show hives near high-density and diverse tree plantings to display significant weight gain trends through time relative to hives in apiaries further from tree plantings.

Additionally, pollen samples will be analyzed further. Following pollen species analysis, we will compare species results with mapped tree cover at each site to understand if honeybees foraged on nearby trees and shrubs. We expect our pollen samples to show that honeybees are foraging on flowering trees and shrubs within nearby shelterbelts.

Challenges

Due to 2020 being the first field season of this study and the nature of the past year, some challenges arose during the 2020 field season. Challenges associated with the timing of data collection and equipment placement restricted the amount of data collected and site selection choices. These issues should not prohibit data collection in the coming seasons.

Conclusions

Our results will explain trends in honeybee hive health and honey production across a gradient of landscapes, which will help influence future apiary management in landscapes with limited early season forage resources.

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