Notes from the Lab:

The Latest Bee Science Distilled

by Scott McArt

Midwestern corn and soy landscapes can be good for bees when native prairie habitat is included.

If you live in the Midwest, or anywhere else where corn and soy dominate the landscape, you're aware of what a "green desert" looks like. It's a landscape that's filled with single-species monocultures of plants that provide bountiful food for humans, but very little food for bees during most of the growing season.

As the human population continues to grow, we're seeing more and more of these landscapes as our increasing demand for food production wins out over native habitat. Furthermore, as farm technologies for insect and weed management become more efficient, there's the potential for non-target insecticide exposures and fewer flowering weeds in agricultural landscapes. Both of these factors can add additional stress on bees.

But just how bad are corn and soy landscapes for honey bees? And what if we stopped planting every square inch of the Midwest with corn and soy? Could honey bees thrive in "green deserts" if they also had access to "watering holes of native prairies"? These are the topics for our twenty-seventh "Notes from the Lab," where we highlight **"Native habitat mitigates feast-famine conditions faced by honey bees in an agricultural landscape,"** written by Adam Dolezal and colleagues and published in the journal ***Proceedings of the National Academy of Sciences of the United States of America*** **(2019).**

For their study, Dolezal and colleagues set out to test how honey bee colonies performed in one of the most intensively farmed areas in the world: Iowa. Iowa is dominated by agriculture, with 73% of the state's land planted in annual crops such as corn and soy, and 93% of the state dedicated to some form of agriculture. Despite this dominance of agriculture, the remaining non-cropped portions of the land surrounding soybean fields have been shown to positively influence insect communities within those fields. Thus, Dolezal and colleagues were interested in testing whether the amount of this non-cropped land surrounding soybean and corn fields (i.e. cultivated cropland) also impacted honey bee colony performance.

The authors set up multiple apiaries adjacent to commercial soybean fields that were either surrounded by a majority of cultivated cropland within the typical flight radius of honey bees (84% corn and soybean; "high cultivation" areas) or a minority of cropland (38% corn and soybean; "low cultivation" areas). The other types of land surrounding the crops included woodland, grass/pasture, and urban development. They monitored the colonies every two

A honey bee works a soybean blossom. Photo by Adam Varenhorst

Honey bees in hives placed near flowering prairies in late summer and early fall were much healthier than those left near soybean fields after August, the researchers found. Pictured here are study co-author, Ashley St. Clair (at hives), and Zoe Pritchard, 2018 Iowa State University graduate in biology and environmental studies. Photo by Amy Toth

weeks throughout the growing season (May-October), recording colony weight, adult and brood populations, lipid content in nurse bees, and pollen collected by foragers.

Because they noticed the striking pattern that colony weight and other performance metrics always decreased in the second half of the summer (in both the low and high cultivation areas), co-lead author Ashley St. Clair (a PhD student at the time) conducted a follow-up experiment. For this experiment, as colony weight started to decline in July, they moved half of the colonies to prairie habitats while the other half were kept at an apiary in cultivated land. They monitored total colony weight and lipid content of nurse bees within each group of colonies through the end of September.

So, what did they find? Did the colonies in low cultivation areas perform better than colonies in high cultivation areas? No and yes. In the first half of summer (May, June and July), colonies in landscapes with low cultivation gained less weight and had a lower rate of growth than colonies surrounded by high cultivation (compare the orange and purple bars on the left side of Fig. 1). This resulted in fewer bees in the colonies in low cultivation areas compared to high cultivation areas by mid-summer. Then, in the second half of summer (August, September and October), colonies in both the low and high cultivation areas lost weight, but the colonies in high cultivation areas declined at a greater rate (compare the orange and purple bars on the right side of Fig. 1). In other words, colonies in high cultivation areas experienced a bigger boom in terms of growth (left side of Fig. 1), but also a bigger bust in terms of weight loss and bee population decline (right side of Fig. 1).

Well that's interesting, why might that be? While the bees foraged for nectar and pollen at multiple plant sources, clover was the dominant pollen source and did not differ in trapped pollen between low and high cultivation areas. But more importantly, the bees foraged for nectar from both clover and soybean, and both of these plants were likely to have been more abundant at the high cultivation areas. Soybean flowers were more abundant for the simple reason that more soybean was grown in the high cultivation areas. Clover flowers may have been more abundant in the high cultivation areas since field edges containing clover are commonly adjacent to soybean fields.

Supporting the importance of soybean and clover nectar, colony weight gain at both the low and high cultivation areas corresponded perfectly with soybean and clover bloom, and declines in weight occurred once soybean and clover stopped blooming. Thus, soybean and clover are prob-

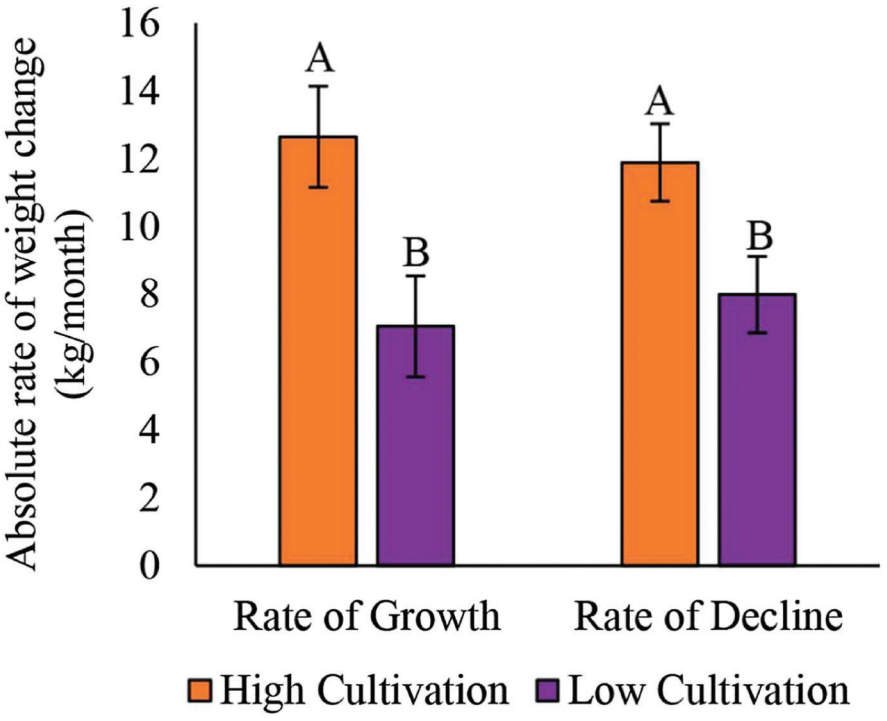

Fig. 1 *Apiaries in high-cultivation landscapes grow and decline at a faster rate. Apiary-averaged absolute rate of weight growth and decline in colonies surrounded by high- (orange bars) and low-cultivation (purple bars) landscapes in 2015 and 2016, mean ± SEM. Rate of growth includes all time points from May, June, and July. Rate of decline includes all time points from August, September, and October.*

ably the major determinants of boom and bust for honey bees in Iowa.

What about the colonies that were moved to prairie in late summer? Did that help avoid the bust? Yes. And this is a very important result. Once colonies get past July in soybean-dominated Midwest landscapes, they're not growing. That means they have to live off their honey reserves until May of the following year — essentially a 9- or 10-month period of nectar famine. That's a long time for honey bees to make it through on reserves, which may partially explain why colony losses can be particularly high in Midwestern states like Iowa. However, when the authors moved half of their colonies to prairie as they started to decline in mid-July, those colonies were immediately rescued and actually gained weight until the fall (see Fig. 2 top panel). The move to prairie corresponded with greater lipid content in nurse bees in September (Fig. 2 bottom panel), a sign of good nutritional status going into fall as those important winter bees are being produced.

OK, I'm a Midwestern beekeeper and I can't move my bees to prairie habitat in July. What can I do? Dolezal and colleagues' study indicates that having more prairie in proximity to your bees will improve season-long consistency of floral resources for those bees (and other insects, too!). So, instead of moving your bees to prairie, why not bring the prairie to you? This is actually much easier than it sounds. In fact, any Midwestern farmer or landowner can restore prairie habitat on their land, and payments for prairie strips are now part of the Conservation Reserve Program as provided for in the 2018 Farm Bill.

Still skeptical? Check out the new STRIPS program, run through Iowa State University, which provides detailed information and consultation on how to implement prairie habitat that will interfere minimally (or not at all) with crop production while providing the exact type of habitat that Dolezal and colleagues show is critical for bees. In addition, farmers can benefit since the strips dramatically limit sediment and nutrient loss. More information on the STRIPS program can be found here: **https://www.nrem.iastate.edu/research/STRIPS/**

If we're going to improve pollinator health while acknowledging that we as humans also need to eat, innovative solutions such as STRIPS that combine agricultural land with habitat improvements for pollinators are an excellent step in the right direction. Dolezal and colleagues' study shows the problem — lack of food for bees — and the STRIPS program shows a very reasonable and implementable answer. What's not to like?

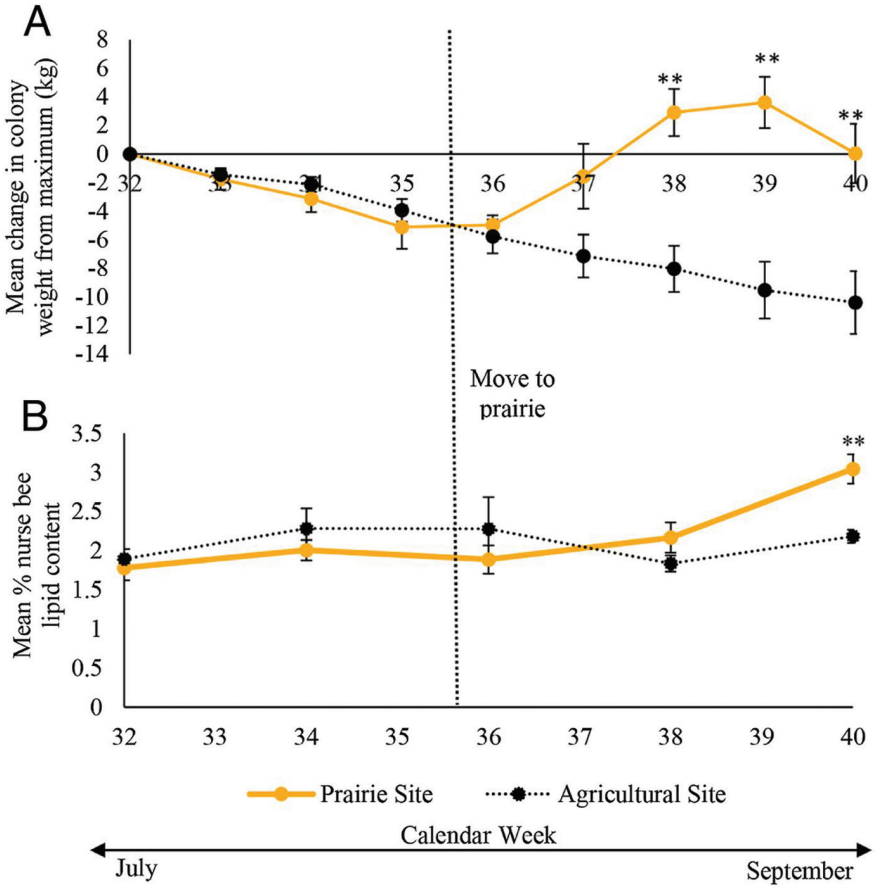

Fig. 2 *Access to prairie arrests and reverses late-season declines in hive weight and body quality. Change in weight of colonies from maximum summer mass (A) and colony percent lipid content of nurse bees (B) moved to a prairie or remaining in an agricultural site from July to September of 2016, mean ± SEM.*

Until next time, bee well and do good work,
Scott McArt

Reference:

Dolezal, A. G., A. L. St. Clair, G. Zhang, A. L. Toth and M. E. O'Neal. 2019. Native habitat mitigates feast–famine conditions faced by honey bees in an agricultural landscape. ***Proceedings of the National Academy of Sciences of the United States of America***. **https://doi.org/10.1073/pnas.1912801116**

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