Supplementing pumpkin fields with beehives: Is it worth it?

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Vine crops such as pumpkin, squash, cucumber and watermelon are some of New York's most valuable vegetable crops. These crops require pollination by bees, the most well-known of which is the honey bee, *Apis mellifera*. Honey bee hives are placed in vine crops during the time they need to be pollinated. Unfortunately, Colony Collapse Disorder (CCD), parasitic mites, viruses, and pesticides continue to cause significant losses in populations of honey bees throughout the US. Fewer honey bee hives are now available for vine crop growers and the cost of renting hives has increased from approximately $30 per hive to ≥$75 per hive. Consequently, growers will continue to pay more for renting hives, unless alternative pollinators are identified to service their vine crops. Previous research has shown that on an individual basis, the common eastern bumble bee, *Bombus impatiens*, was the most efficient pollinator of pumpkin compared with other common species including the honey bee and squash bee, *Peponapis pruinosa*. The common eastern bumble bee is an efficient pollinator, naturally abundant and available commercially, making it a perfect candidate as an alternative pollinator to the honey bee in pumpkin fields. The goals of our research were 1) to determine if pumpkin fruit yield could be increased by supplementing fields with bumble bee hives, and 2) to produce guidelines for deciding whether or not to supplement pumpkin fields with bees.

Will fruit yield increase if bumble bee hives are placed in pumpkin fields? In the Finger Lakes Region in 2011 and 2012, the potential for increasing pumpkin yield by either supplementing fields with commercially produced common eastern bumble bees or with locally rented honey bees was explored. Fields ranged in size from 1 to 25 acres; fields of similar size were grouped and randomly assigned one of the three supplementation treatments (i.e., bumble bee hives, honey bee hives or no hives). The stocking densities for bumble bees was one QUAD (=4 colonies) per 2 acres and for honey bees was one hive per 3 acres. The jack-o-lantern variety, 'Gladiator', was planted in all fields. Ten seedlings were transplanted into each of three locations in the field (=30 plants per field). In September, when the crop was mature, all marketable fruit were counted and weighed. Data were analyzed using ANOVA and treatment means were compared ($P<0.05$). The average fruit weight per pumpkin plant in fields supplemented with commercial bumble bees did not differ significantly from fruit weight in fields supplemented with honey bees or those that were not supplemented (**Fig. 1**).

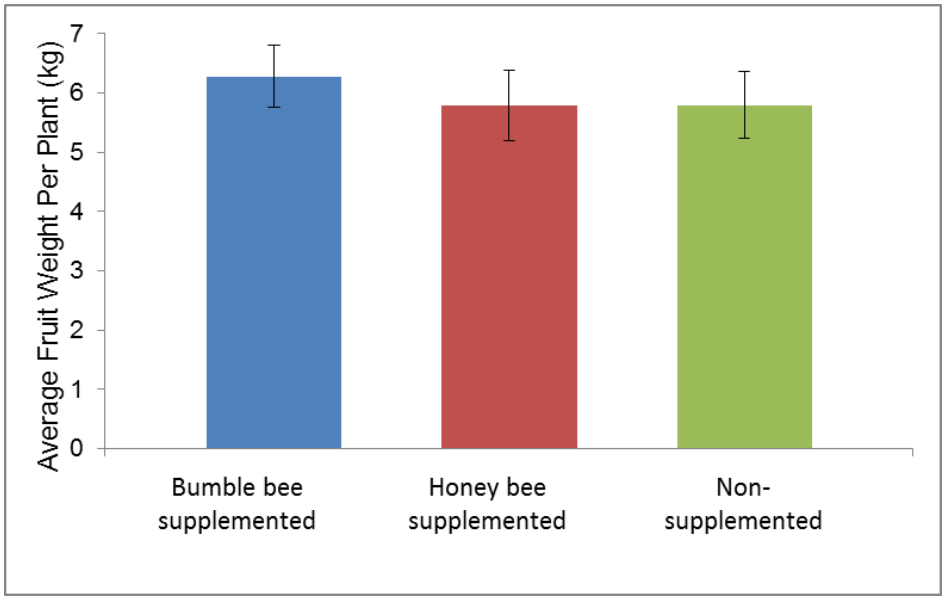

Fig. 1. Mean (± SEM) pumpkin, *Cucurbita pepo*, var. 'Gladiator', fruit yield from fields supplemented with commercial bumble bee colonies (*n*=12), honey bee hives (*n*=17) or were not supplemented (*n*=14) in New York averaged across 2011 and 2012. Plants typically produced 1.5 fruit per plant, regardless of treatment.

Could fruit yield increase if more bumble bees hives were placed in pumpkin fields? In the Finger Lakes Region in 2012 and 2013, the potential for increasing fruit yield by increasing the stocking density of bumble bee hives in pumpkin fields was examined. Commercial fields were supplemented with bumble bees at the recommended density (1 QUAD per 2 acres; *n*=10), 3 times the recommended density (3 QUADs per 2 acres; *n*=10) or not supplemented with bees (*n*=10). The same procedure described above for comparing fruit yield in pumpkin fields supplemented with bumble bee hives, honey bee hives, or no hives was followed. Increasing the density of bumble bee hives in pumpkin fields did not increase pumpkin fruit weight per plant or bumble bee visits to pumpkin flowers **(Fig. 2)**.

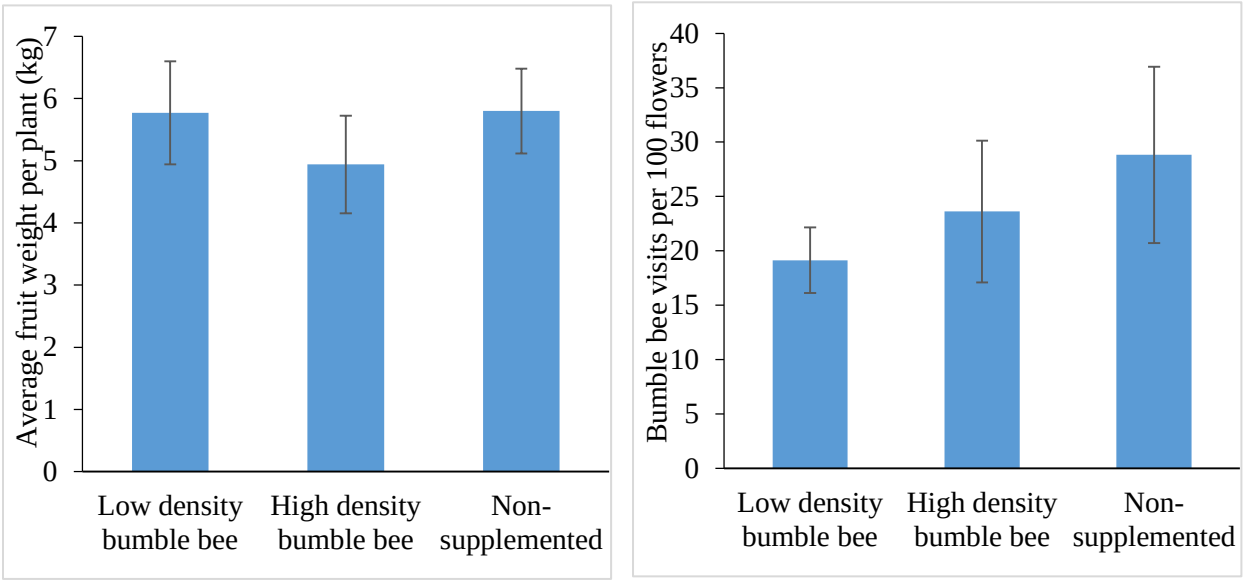

Fig. 2. Mean (± SEM) pumpkin, *Cucurbita pepo*, var. 'Gladiator', fruit yield and bumble bee visits from fields supplemented with commercial bumble bee colonies at a low density of 1 QUAD per 2 acres (*n*=10), bumble bee colonies at a high density of 3 QUADs per 2 acres (*n*=10) or were not supplemented (*n*=10) in New York in 2012 and 2013.

Are there situations where supplementation with bees could improve pumpkin yield? The landscape surrounding pumpkin fields may impact natural populations of wild bees that are important for pollinating pumpkins. While supplementing pumpkin fields with bees does not increase fruit yield on average, there might be circumstances where the landscape surrounding pumpkin fields may not support wild bee populations sufficiently large enough to provide maximum pollination. In such situations, supplementation of pumpkin fields with commercial bees may be important. We investigated features in the landscape that impacted bee visits to pumpkin flowers and fruit yield. Through a series of statistical analyses, we identified two features in the landscape that impact wild bumble bee and honey bee visits to pumpkin flowers and led to greater fruit yield. The first feature was the level of diversity in land-use types across the landscape. High diversity landscapes (many different land-use types and approximately even parcel sizes as shown in **Fig. 3)** had more bumble bees and greater pumpkin yield compared with landscapes that had low diversity. The second feature was the amount of grassland in the landscape (i.e., semi-natural, open-canopy habitats such as fallows, shrubland, weedy ditches and nature preserves). A landscape with greater than 20% grassland was considered sufficient to sustain an adequate population of honey bees for pumpkin pollination.

Guidelines for deciding whether or not to supplement pumpkin fields with bees. The proactive approach described below will only be useful for future growing seasons, unless a beekeeper is willing to supplement a pumpkin field with short notice. The first step is to estimate the number of bees in the field as either "high" or "low". When pumpkin flowers are in bloom, count the total number of honey bees and bumble bees in 60 flowers (male and female flowers), spending 5 seconds counting bees at each flower you watch and then moving on to the next flower. Sample three different locations of 60 flowers each to get an average of the number of each bee species per 60 flowers. A "high" bumble bee density would be greater than 3 bees per 60 flowers. "High" honey bee density would be greater than 10 bees per 60 flowers.

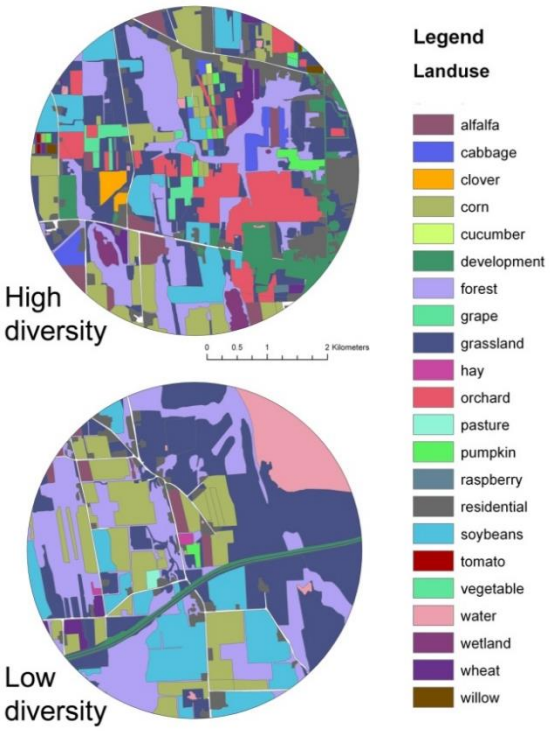

Fig. 3. Examples of high and low landscape diversity surrounding a pumpkin field in the center of each circle (field is light green).

The next step is to identify the diversity of habitats in the landscape and the percent of the landscape that is undisturbed grassland (within a 2 km [~1.25 miles] radius of the center of the field). These two landscape features could be estimated through knowledge of the land-use features surrounding the field or by consulting the Cropland Data Layer produced by the USDA – National Agricultural Statistics Service (http://nassgeodata.gmu.edu/CropScape/).

Combining knowledge of these factors (bumble bee and honey bee density, landscape diversity and percent grassland) will help inform what pumpkin fields should benefit from supplementation with managed bees (**Table 1).**

Table 1. Guidelines for making decisions on whether or not to supplement a pumpkin field with either bumble bee or honey bee hives.

	Bumble bee density			Honey bee density	
Landscape diversity	High	Low	% Grassland	High	Low
High	Supplementing not necessary	Consider supplementing	High	Supplementing not necessary	Consider supplementing
Low	Supplementing recommended	Consider supplementing	Low	Supplementing recommended	Consider supplementing