Pollination of Pumpkin and Winter Squash - Thanks to Bumble Bees!

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In recent years, there has been concern about the present status and future of crops that require pollination by insects in order to set fruit, due to continuing losses of honey bee colonies. There have been several studies of pollination in pumpkins, which have come to different conclusions about the value of supplementing pollination by bringing in honey bee or bumble bee colonies.

Background: Pumpkin and squash flowers open early in the morning, and most pollination happens early – before 11 am. After that, nearly all the pollen is gone from the male flowers, the remaining pollen is rapidly losing viability, and the flowers start to close. Each flower, male or female, is open for only one morning. Whether a female flower sets fruit depends partly on how much pollen is deposited on the stigma, but also on whether the plant has enough resources to support more fruit. The first fruit set on a plant generally gets priority over later female flowers. Pumpkin and winter squash plants have more female flowers than will survive as fruit, and they have many times more male flowers than female flowers.

The scientific literature (mostly from Dr. Chris Wien at Cornell and his students) says that pumpkins need from 1250 to 2000 pollen grains per stigma for full fruit set. This would require multiple bee visits per female flower – estimates are around 8-12 visits.

Three species of bees are the vast majority of visitors traveling between flowers in pumpkin and squash fields: honey bees (*Apis mellifera*), common eastern bumble bees (*Bombus impatiens*), and squash bees (*Peponapis pruinosa*).

My team has been studying pollination of pumpkin and winter squash in Connecticut for the last four years. Here are some of our studies and findings:

1. We compared naturally pollinated pumpkin flowers with those where we manually added pollen in field studies seven times at experimental farms (Griswold in eastern CT, Lockwood Farm in Hamden, and the Windsor Valley Laboratory). Overall, there was no difference in fruit set, survival of fruit to harvest, size of fruit, or number or weight of seeds in these experiments.
2. At about 20 different pumpkin and/or winter squash fields in Connecticut, each year from 2012 to 2015, we visited the field for one morning, took a variety of samples during pollination, and then collected stigmas from female flowers at the end of the morning. We took the stigmas back to the lab, extracted the pollen from the surface, and counted pollen grains deposited on the stigmas. We sampled a diversity of fields available in Connecticut – organic and IPM, very small up to about 5 acres, mostly in the central and western part of the state. We have done this now 80 times, and only once (Griswold, 2012) did we find that the pollen deposition on average was less than 2000 pollen grains per stigma.

3. We started out doing bee counts in the field – walking a straight line in the field and recording the first 100 flowers we encountered – whether the flower was male or female and how many bees of what species were visiting the flower. Overall, the common eastern bumble bee was the most common visitor, although this varied over the summer and at different sites.
4. However, when we tried to relate overall bee counts to pollen deposited in the female flowers, we found no significant relationship. We found a better statistical relationship of counts of just bumble bees (not honey bees or squash bees) to pollen deposition, and a still better relationship of bumble bee counts on just the female flowers to pollen deposition.
5. As a result, in the last two years, we have focused on more detailed studies of bee behavior on the flowers. We have been making timed observations of bees on just the female flowers – watching each bee come and go. We have set up video cameras on female flowers to record bee behavior on the flowers. Although we are still processing these observations and videos and the data from them, what we have seen so far reinforces the importance of bumble bees as pollinators of pumpkin and winter squash. In comparison with honey bees, they are more frequent visitors, and more likely to make contact with the stigma of the flower. We find that female squash bees rarely visit female flowers – they may be mainly harvesting pollen from the male flowers to feed their offspring. Male squash bees visit female flowers and come in contact with other bees that may be present. They may play a role in getting other bees to move from one flower to another, which is what is required for pollination.

Conclusions: At present, the pollinators on any given sunny summer morning in Connecticut are generally adequate for pumpkin or winter squash pollination. We are depending heavily on a single species, the common eastern bumble bee, for much of our pollination. Fortunately, this is a species of bee that seems to be faring very well in spite of the pathogens, pesticides, and other challenges that are affecting honey bees and several other bumble bee species. However, since this one species is very important for pumpkin and squash growers (and many other crops and native plants, too), it is very important to monitor the health and abundance of this bumble bee.