Pumpkin Pollinators

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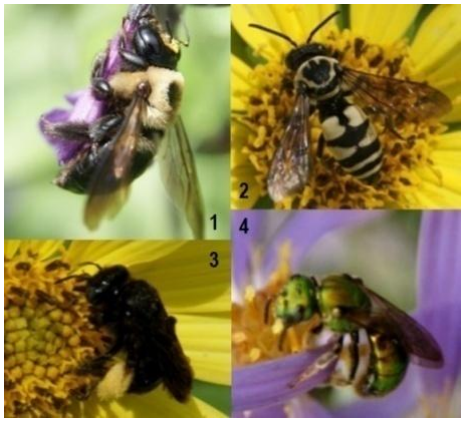
Pumpkin fruit set can be affected by a number of production and environmental factors. For example, high plant densities can limit the plants' access to light, hindering the photosynthesis process and the production of sugars, which in turn delays the flower and fruit set. Excessive plant growth in response to higher-than-recommended nitrogen applications can also delay flowering and fruit set. Drought can lead to a higher than normal male/female flower ratio, resulting fewer fruits per plant. Too much moisture in the soil for long periods can shut down the pumpkin plants' roots, debilitate the plants and cause flower and fruit abortion. Flower bud abortion can also occur if temperatures are in the high 70's at night or in high 90's during the day for several consecutive days. Another factor that can diminish fruit set is poor pollination, when flowers abort or fruits are misshapen due to a lack of sufficient pollinator activity.

Each pumpkin plant has both male and female flowers, with the first eight flower buds appearing on a new plant usually forming only male flowers. Typically, the first female flower opens approximately one week after the first male opens. The flowers are short-lived (several hours), blooming at dawn and closing in most cultivars well before noon. Pumpkin plants set fruit only if pollinated by insects, and fruit quality is enhanced by intensive pollinator activity. Male flowers produce nectar and pollen, while female flowers offer higher quantities of nectar but no pollen[i]. Bees visiting flowers vector pollen from the male flower to the female. Pumpkin pollen is relatively large and sticky, and bees are usually the best pollinators. In the Northeast U.S., the most frequent and important pumpkin pollinators are honeybees, bumblebees, and squash bees, although the flowers will occasionally be visited by many other solitary bees, including carpenter bees – *Xylocopa virginica* (1), cuckoo bees – *Triepeolus remigatus* (2), longhorned bees – *Melissodes bimaculata* (3), and sweat bees – *Augochlora pura* (4)[ii].



Most of the 3,550 bee species in the United States are solitary[iii]. Although solitary bees sometimes nest in high numbers in the same locations for years, each female alone builds and provisions the nest, and lays eggs. Solitary bees usually have one generation per year, with their offspring emerging and resuming the lifecycle the following year. Social bees form colonies where fertilized females (queens) specialize in

laying eggs and unfertilized females (workers) build, provision, and defend the nest. Males of both solitary and social bee species do not help with building, provisioning, or defending the nests. With the exception of the highly social, nonnative honeybees, native social bee species (bumblebees and a few species of sweat bees) are only primitively social, forming annual colonies that perish before or with the first frost. In general, annual colonies produce males and new queens at the end of the season. The new queens leave the colonies, mate, overwinter in the ground or other sheltered cavities, and establish new colonies the following spring.

Successful pollination requires that the pumpkin grower understand the biology of the pollinator species and provide a suitable environment. Equally important, pesticide use in the crop has to be carefully considered to avoid bee kills. Management of the three key pollinator species is described below.

Honeybees – *Apis mellifera*

Although honeybees are regarded as important pollinators for a wide variety of crops, there are several other bee species that are effective pollinators of pumpkins. Surveys

in Maryland, Virginia, and West Virginia have indicated that farms renting honeybees did not have more honeybees working pumpkin flowers than farms that didn't rent them[iv]. Also, compared with bumblebees or squash bees, honeybees start to forage later in the day in the midsummer and are less or not active in inclement weather[v]. In the Northeast U.S., native bees alone can fully pollinate vegetable crops on most farms[vi]. Thus, growers may be able to save costs associated with renting honey bee hives by first evaluating the native bee populations before contracting for honeybee colonies.

If honeybees are needed, farmers should always choose strong honeybee colonies over weak ones. As a result of a higher ratio of forager/housekeeper honeybees, a strong colony with 30,000 honeybees is 1.5 more efficient than two weak colonies, each with15,000 honeybees[v]. A strong colony should have at least six deep frames full of brood and ten frames covered with adult honeybees. The farmer needs to monitor the pumpkin blossoms and aim to have the honeybee colonies delivered only when the female flowers start opening. Not only will this let the plants conserve carbohydrates and utilize them on speeding up the female flowers and fruit production, but it will also allow native bees to better establish themselves in the fields by foraging the male blossoms without competition. When delivered to the farm, honeybee colonies should be evenly dispersed where the crop fields are large, aiming for locations that get early sun and are shaded in the afternoon.

Bumblebees – *Bombus spp.*

In Pennsylvania there are more than a dozen different bumblebee species, with the common eastern bumblebee (*Bombus impatiens*) being the most widespread[vii].

Bumblebees are considered primitively social because the queens start building and provisioning the nest on their own, much like solitary bees. In our area, the bumblebee queens end their hibernation and begin searching for suitable nesting locations, such as mouse holes, sometime in late March. Although bumblebee queens favor specific nest sites, they are also very opportunistic and can take up residence in various sheltered places. Once the nesting sites are secured, queens start collecting pollen and building wax pots that later will be filled with nectar. When the nectar and pollen provisions are sufficient, the queens start laying eggs. After the first batches of workers emerge, the queens minimize their household and foraging activities, and primarily lay eggs. At its peak in late summer, a bumblebee colony can have several hundred workers.

Bumblebees are very important pollinators for numerous crops, including pumpkins. By starting to work earlier in the day, and being active in inclement weather, they are more efficient pollinators than honeybees. Furthermore, they are larger and more hairy than honeybees-- traits that increase their likelihood of vectoring more pollen between flowers. While their abilities as pollinators have been recognized for centuries, only recently (1980's) scientists have succeeded in mass rearing them for commercial pollination. Utilized first in greenhouses for tomato pollination, bumblebee hives are now being tried for field crop pollination as well. As with the honeybees, growers need to carefully evaluate the native bee population before purchasing bumblebees and, in the long term, to implement farming practices that conserve and encourage native pollinators.

Since pumpkins do not flower all season, growers that want to increase wild bumblebee populations on their farms need to have consistent and various sources of bloom that overlap throughout the year. As a rule of thumb, native plant species are the best choices. Not only are they four times more attractive to pollinators[viii], but they also grow usually better in their native range. Reliable pollen and nectar sources on the farm in late fall and early spring are crucial for bumblebee queens' survivability. In the fall, the new queens need to accumulate significant body mass in order to successfully hibernate throughout the winter, and late-blooming plants like goldenrod prove to be an essential resource. Once out of hibernation, bumblebee queens are weak and need early blooming plant species, like maples and willows, for a fast recovery and early colony establishment.

Squash bees – *Peponapis pruinosa*

The most important pumpkin pollinator is the squash bee, a naturalized solitary species that is dependent solely on pollen from pumpkin and squash plants. In our area, most

adult squash bees emerge in early July, and after two to three weeks of pre-nesting activities, females start building and provisioning nests singlehandedly. Squash bees time their foraging activity with the pumpkin flowers, being active between dawn and mid morning. Furthermore, squash bees are faster fliers and much hairier than honeybees, characteristics that greatly aid in efficiently vectoring more pollen. According to recent research, more than 95% of farms surveyed showed that pumpkin flowers are visited most frequently by squash bees, followed by bumblebees, while other bees, including honeybees, are less frequent visitors[ix]. Even so, few farmers are aware of the squash bees and their crucial role in pumpkin pollination[iv].

Squash bees have moved and naturalized in our area by following cucurbit crops (squash, gourds, pumpkins) cultivated by humans. Currently, squash bees are prevalent throughout the United States and the southern part of Canada. In our area, there is only one species of squash bee, *Peponapis pruinosa*, which is active from May to August[vii]. While they can visit other flowers for nectar, they strictly specialize on cucurbit pollen and match their lifecycle with the cucurbits' flowering period. Unlike other male bees, male squash bees can be significant pollinators since their courtship takes place in the flowers, which can increase the pollination process (Wood, 2008)[x]. Squash bees are not dependent on season-long nectar and pollen availability since adults are present and overwintering nests are provisioned only while cucurbit flowers are available. Squash bee larvae spend the rest of the year in the soil between 5 and 10 inches below the surface, either in the field at the base of cucurbit plants, or on the field's edges. Research has indicated that the density per square foot of squash bee burrows is higher in irrigated fields and lower in fields with clay soils.

Because squash bees like to nest mostly in fields at the base of their host plants, deep plowing can destroy most of their brood. Avoiding tilling at least part of the field and letting it to go fallow till the next summer will allow the immature squash bees to develop and emerge as adults the following growing season. Farmers who want to attract more squash bees for pumpkin pollination might be successful by planting strips of summer squash adjacent to the pumpkin field. This can encourage higher numbers of squash bees to establish their nests close to the pumpkin fields and provide superior pollination services. Squash bees forage only up to several hundred yards from their nests, but they can relocate their nesting sites miles away when food sources are unavailable. As a result, the best thing a farmer can do for retaining the squash bees on his farm is to plant (in a rotation system) pumpkin or squash crops year after year.

Pesticide application

Pesticides, especially insecticides, can kill bees. Farmers should avoid spraying fields when crops or weeds are in bloom. If absolutely necessary, pesticides should be applied late in the evening when pumpkin blossoms are closed and there is little bee activity. When choosing between different pesticides, the applicator should opt for liquid or granular over dust formulations, use the least bee toxic pesticide, and apply the lowest effective rate. Pesticide applications should be avoided in the days when low temperatures and dew are forecasted for the night, since this prolongs the toxicity. Pesticide toxicity to bees listed on pesticide labels is evaluated mostly in laboratory conditions and on honeybees. As a result, pesticide toxicity can significantly vary in field conditions and for different bee species.

This article was reviewed by **E. G. Rajotte** and **S. Fleischer**, professors of entomology, Penn State University.

Pictures by the **A. Surcică**

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