Pollination of Blueberry Crops in Pennsylvania

Blueberry (Vaccinium spp.) is a high-value and economically important fruit crop native to Pennsylvania and Eastern North America. Nationally, the total value of the blueberry crop was $797 million in 2018 (USDA NASS).

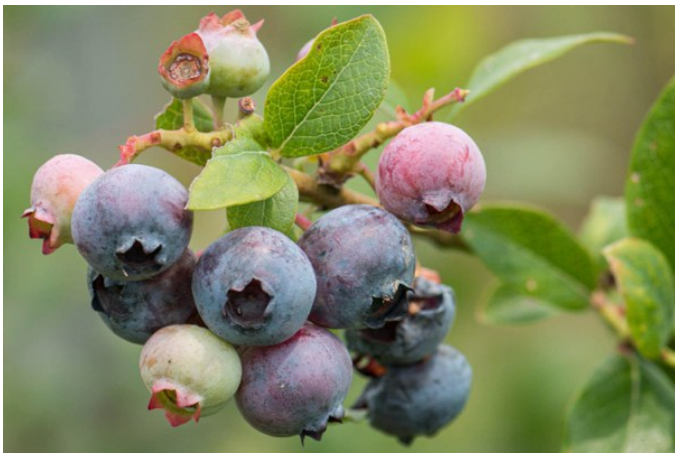

Photo: Margarita M. López-Uribe, Penn State

Demand for blueberries in Pennsylvania is also high; prices range from $2-5 a pint (USDA NASS). There are four native blueberry species to Pennsylvania: Low sweet blueberry (*Vaccinium angustifolium*), lowbush blueberry (*V. pallidum*), sour-top blueberry (*V. myrtilloides*), and the highbush blueberry *V. corymbosum*, which is the most often cultivated species on commercial production farms. Common varieties of *V. corymbosum* in Pennsylvania include Duke, Patriot, Bluecrop, Jersey, and Elliott, among others. While these different varieties vary in their capacity to self-pollinate, sufficient pollination is crucial for maximum yield. This article provides information about the pollination biology and requirements of blueberries and general recommendations for improving blueberry pollination in Pennsylvania.

Pollination biology and requirements

Highbush blueberries produce small bell-shaped pendulous flowers with short anthers hidden inside the white or pink corolla and a stigma that sticks out near the opening (Figure 1). In order to set fruit, a sufficient number of viable pollen grains must be transferred from the anther to the stigma of the same variety (self-pollination) or a different variety (cross-pollination). After pollination is complete, corollas often drop off leaving only the stigma and sepal attached to the ovary that will develop into the fruit (Figure 1). Needs for cross-pollination vary across varieties. Some such as Duke and Bluejay do not need cross-pollination, while Elliott, Bluecrop, and Legacy benefit from cross-pollination but can set fruit with pollen from the same variety.

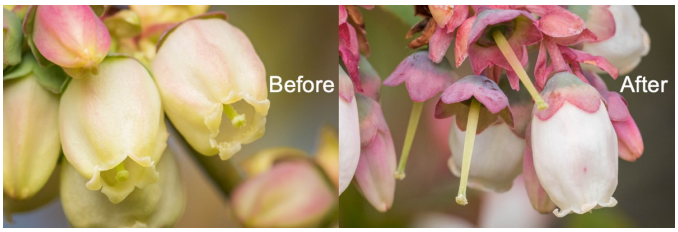

Figure 1. The shape of blueberry flowers. Before pollination (left), the white or pink corolla covers the anthers and stigma. After pollination (right), the corolla drops off and the stigma of the flower gets exposed. The presence of corollas on the ground is generally a sign that pollination has occurred. Photos: Nash Turley, Penn State

Blueberry flowers have poricidal anthers (i.e., the pollen is released through pores) that require sonication or “buzzing”. This behavior is necessary for the pollen to be released from the flower and become available to be picked up by a pollinator and transported to a different flower. Blueberry pollen is sticky and is not easily transported by the wind. Because of these traits of blueberry flowers, the most efficient pollinators of this crop are wild bees, many of which can perform buzz pollination and transport the pollen on their hairy bodies. Honey bees are not able to perform buzz pollination. As a result, pollination efficiency by wild bees is three times higher than pollination by honey bees. On average, when pollinating blueberries, honey bees transfer 11 pollen grains to the stigma per flower visit, compared to ~45 pollen grains transferred by wild bees (e.g., bumble bees and mining bees) (Javorek et. al., 2002). Despite their inability to buzz

pollinate, honey bees are still crucial pollinators to commercial blueberry farms where large acreage of blueberry bushes require pollination and low abundance of wild bees may be available. However, pollination by honey bees alone is not enough to achieve maximum yield. Therefore, in all cases wild bees are helpful, or even necessary, to get the best results (Reilly et al 2020).

Pollinators of Blueberry

Since Pennsylvania lies within the native range of the blueberry, there is a great diversity of native bees that provide pollination services to blueberry farms. Observations performed in three small diversified farms with Bluecrop plantings in central Pennsylvania revealed that the smallest non-commercial planting had the greatest diversity of pollinators. While managed honey bee colonies were present at all sites, they were not commonly observed pollinating blueberries, compared to other wild bees such as bumble bees. For about every honey bee visiting blueberry flowers, we observed about 3 bumblebee queens (Figure 2). Mining bees in the genus *Andrena* were also a major group of wild bees observed at all sites (Figure 2). Both bumble bee queens and mining bees are active in the spring when blueberry flowers begin to bloom. At least 11 different species of Andrena have been observed pollinating blueberries in central Pennsylvania, often clinging to flowers during their visits.

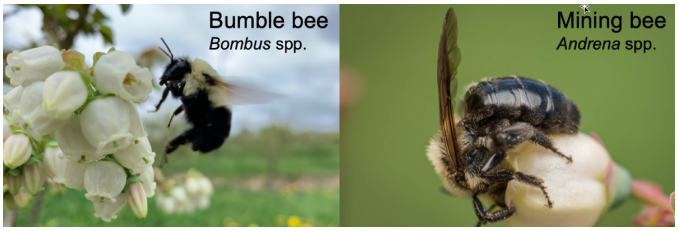

Figure 2. The common wild bees pollinating blueberry crops in central Pennsylvania. Both bumble bee queens (left) and mining bees (right) are active in early spring and are abundant pollinators of blueberries. Photos by Margarita López-Uribe and Nash Turley, Penn State.

Note that one of the most important pollinators of blueberries in the southeast region of the US is *Habropoda laboriosa*, commonly known as the Southeastern blueberry bee. While this bee has been recorded in Pennsylvania, it has not been observed in any of our study sites in central Pennsylvania. Table 1 shows a complete list of bee species that were observed pollinating highbush blueberry across three different sites recorded over two years.

Table 1. Common managed and wild bee pollinators of blueberry in central Pennsylvania

Common Name	Family	Genus	Species
Mining bees	Andrenidae	*Andrena*	*canadensis*
	Andrenidae	*Andrena*	*carlini*
	Andrenidae	*Andrena*	*carolina*
	Andrenidae	*Andrena*	*cressonii*
	Andrenidae	*Andrena*	*dunningi*
	Andrenidae	*Andrena*	*frigida*
	Andrenidae	*Andrena*	*imitatrix*
	Andrenidae	*Andrena*	*miserabilis*
	Andrenidae	*Andrena*	*nasonii*
	Andrenidae	*Andrena*	*perplexa*
	Andrenidae	*Andrena*	*pruni*
	Andrenidae	*Andrena*	*rugosa*
	Andrenidae	*Andrena*	*tridens*
	Andrenidae	*Andrena*	*vicina*
	Andrenidae	*Andrena*	*wilmattae*
Honey bee*	Apidae	*Apis*	*mellifera*
Bumble bees	Apidae	*Bombus*	*bimaculatus*
	Apidae	*Bombus*	*fernaldae*
	Apidae	*Bombus*	*griseocollis*
	Apidae	*Bombus*	*impatiens*
	Apidae	*Bombus*	*sandersoni*
Small carpenter bees	Apidae	*Ceratina*	*dupla*
	Apidae	*Ceratina*	*mikmaqi*
Cellophane bees	Colletidae	*Colletes*	*inaequalis*
	Colletidae	*Colletes*	*thoracicus*
Sweat bees	Halictidae	*Augochlorella*	*aurata*
	Halictidae	*Lasioglossum*	*pilosum*
Mason bees	Megachilidae	*Osmia*	*lignaria*
	Megachilidae	*Osmia*	*bucephala*
	Megachilidae	*Osmia*	*cornifrons*
Large carpenter bee	Apidae	*Xylocopa*	*virginica*

* Asterisk indicates managed bee species

Signs and Causes of Poor Pollination

Insufficient pollination may happen when there are too few pollinators to visit and pollinate every flower. In addition to the low abundance of pollinators, other causes of poor pollination include that the available bee species may be unable to perform sonication (e.g., honey bees) and/or the weather may be cold or windy and not conducive to bee foraging. Lack of sufficient bee-mediated pollination may result in blueberry bushes relying on self-pollination, which often develop into lower-weight fruit. To quantify crop pollen limitation, berry weights and numbers are compared between flowers that were hand-pollinated and flowers that received natural pollination (a.k.a. open pollination). In our study from sites in central Pennsylvania, we did not observe severe signs of pollination limitation.

The number of berries from the open-pollinated flowers was not different from those in the hand-pollinated flowers. However, at one site, we found a 17% decrease in the average weight of berries in the open compared to the hand-pollinated flowers. Reductions in berry weight are one sign of pollen limitation, so our results suggest there is potential to maximize pollination at these sites in central Pennsylvania. Other signs of poor pollination in blueberry crops include: later ripening berries, decreased berry size, and reduced number of viable seeds in each berry (Benjamin and Winfree, 2014).

Supporting More and Healthier Bee Pollinators

Several studies and our own observations indicate that higher pollinator abundance is correlated with increased berry weight. This highlights the importance of enhancing wild pollinators to increase crop yields. Therefore, growers in Pennsylvania should be aware of the critical importance of wild bees for the production of blueberries. In order to reach maximum crop yield, growers should follow best practices to support and enhance a diverse array of wild pollinators. Some of these recommendations include:

1. Do not apply insecticides during bloom. If fungicide applications are necessary during bloom, choose effective products with the lowest toxicity ratings possible, as indicated on the pesticide label.

2. Keep in mind that flowering weeds around crops can become important routes of pesticide exposure for bees. Therefore, it is recommended to remove blooming weeds such as dandelion or white clover before pesticide sprays rather than afterward.

3. Help maintain nesting habitat for wild bees by preserving natural forest habitat surrounding the blueberry field. Maintaining nesting habitat may also include refraining from tilling the soil surrounding the blueberry field if possible. Soil disturbance from tilling disrupts the habitat for many ground-nesting bees.

4. While it is common practice to supplement pollination with commercial honey bee colonies, growers can also consider purchasing commercial bumble bees to maximize pollination. However, introducing managed bees for pollination can facilitate the transmission of pathogens from managed to wild bees. Therefore, it is recommended to limit the introduction of managed pollinators when possible. Some additional management practices that can be considered to decrease pathogen transmission include: renting honey bee colonies that have low levels of varroa mites and placing managed colonies in the center of the plantations where wild bee abundance is lower than at the edge of the fields.

5. Consider integrating other plants or crops near blueberry fields that bloom both before and after blueberries in order to provide wild bees with sustained resources throughout their active season and incentivize them to maintain nests nearby. To help support early-emerging bees like mining bees try planting native spring-flowering trees like willow, red maple, serviceberry, cherry, and redbud. Native perennial wildflowers such as milkweeds, black-eyed Susan, mountain mint, Joe Pye weed, coneflower, sunflowers, and beebalm will help support bumble bees and a wide variety of other pollinators.

Summary

It is clear that adequate pollination is necessary for achieving maximum yield from blueberry crops. While signs of pollination limitation appear to be weak at farms in Pennsylvania, growers should be aware of this possibility and are encouraged to implement recommendations to sustain and enhance wild pollinators in their farms. If signs of pollen limitation are present, such as low fruit set, smaller than average berries, and late-ripening berries, growers should consider changing management practices. Actions such as enhancing habitat to encourage wild bees near the farms or supplementing farms with managed pollinators can promote blueberry pollination.

References

Benjamin, F. E., Winfree, R. (2014). Lack of pollinators limits fruit production in commercial blueberry (*Vaccinium corymbosum*). *Environmental Entomology*, 43(6), 1574-1583.

Courcelles, D. M. M., Button, L., Elle, E. (2013). Bee visit rates vary with floral morphology among highbush blueberry cultivars (*Vaccinium corymbosum* L.). *Journal of Applied Entomology*, 137(9), 693-701.

Gibbs, J., Elle, E., Bobiwash, K., Haapalainen, T., Isaacs, R. (2016). Contrasting pollinators and pollination in native and non-native regions of highbush blueberry production. *PloS one*, 11(7), e0158937.

Javorek, S. K., Mackenzie, K. E., Vander Kloet, S. P. (2002). Comparative pollination effectiveness among bees (*Hymenoptera: Apoidea*) on lowbush blueberry (Ericaceae *: Vaccinium angustifolium*). *Annals of the Entomological Society of America*, 95(3), 345-351.

Nicholson, C. C., Ricketts, T. H. (2019). Wild pollinators improve production, uniformity, and timing of blueberry crops. *Agriculture, Ecosystems and Environment*, 272: 29-37.

Reilly, J. R, Artz, D. R., Biddinger, D., Bobiwash, K., Boyle, N.K., Brittain, C., Brokaw, J., Campbell, J.W., Daniels J., Elle, E., Ellis, J. D. (2020) Crop production in the USA is frequently limited by a lack of pollinators. *Proceedings of the Royal Society B*, 287(1931):20200922.

Kilpatrick, S.K., Gibbs, J., Mikulas, M.M., Spichiger, S.E., Ostiguy, N., Biddinger, D.J. and López-Uribe, M.M. (2020) An updated checklist of the bees (Hymenoptera, Apoidea, Anthophila) of Pennsylvania, United States of America. *Journal of Hymenoptera Research*, 77:1.

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