Invest in pollination for success with highbush blueberries

Rufus Isaacs, Sarah Ellis, Dylan Gaines, Mary Ann Rothenberger, Department of Entomology, Eric Hanson and Jim Hancock, Michigan State University, Department of Horticulture - May 8, 2016

For profitable yields, investing in pollination of highbush blueberries is crucial.

Photo 1. Comparison of highbush blueberry fruit set and yield when pollinators are excluded versus when they are allowed access to flowers. Slightly allowing bees to visit and pollinate flowers increased fruit set and yield dramatically.

Northern highbush blueberries (Vaccinium corymbosum) are common throughout the northern United States and Canada, and are native to eastern North America. They require pollination to ensure that flowers present at bloom turn into large, harvestable berries later in the season. Pollination is achieved by the movement of pollen by bees.

By planting pollinator friendly habitat, self-sterile cultivars, and managing honeybees to help ensure they receive the maximum return on their investments in land, bushes and other management inputs. Given the high per-acre input costs of blueberry production, spending money to ensure high levels of pollination makes sound business sense. Other things being equal, well-pollinated fields have larger berries, higher yields, and more even ripening than fields with sub-optimal pollination.

Across Michigan's blueberry industry, most pollination is by managed honey bees that are brought to fields in hives. Many of these colonies have been supplemented in earlier dates and they arrive back in Michigan as fruit crops start blooming in Southwest Michigan. Bumble bee colonies can also be purchased for placement in fields and there are several companies that rear and sell bees for pollination year round. Knowing which flowering pollinators into an integrated crop pollination strategy, the risk of poor pollination may be minimized.

Pollen is moved by bees

For pollination to occur, self-fertile or self-compatible blueberry pollen must be moved from the male part of flowers (anthers) to the female part (stigma) while the flowers are receptive. Bees are responsible for this movement of pollen, and pollination is dependent on bees being present in the blueberry field during bloom to deliver pollen. Each flower must be visited once by a bumble bee or more than once, or three times by honey bees to get enough pollen for a full berry. Not all berries will develop if only one pollen grain is left on the stigma. When bees are scarce, so there is a lot of work for them to do!

The pollen produced by blueberry flowers is relatively heavy and doesn't with the wind. It is held inside the flower by sticky pollen-like structures called anthers until bees visit. They may release the pollen by jogging the flower with their legs, or by vibrating the flower with their wings and buzzing (a behavior called sonication) and adapted to release the pollen using a vibration behavior known as "buzz pollination." When the bees shake the anthers, the pollen collects on their bodies. Bees groom pollen from their bodies and collect it into pollen baskets on their legs to feed their developing young, provide immunological protection, and, and chance at moving into a new decline and three days with. Flowers unlikely to turn into fruit after flow to as to use pollen. Cross-pollination pollen is deposited on the stigma, the pollen germinates and fertilizes the ovules that produce the tiny seeds. Fertilized seeds release hormones that stimulate berry growth, leading to larger berries.

Things to know before planting

Northern highbush blueberry bushes can produce berries even when there is no or limited pollen deposition by bees. This means that some proportion of the flowers can turn into berries, even if there are poor pollination conditions or few pollinators. However, the berries produced without pollination are smaller, softer, and ripen more unevenly than those produced with pollination. Since pollination increases the size and quality of the berries, and most of the berries produced are visited by bees during bloom to transfer sufficient pollen to the stigma while the flower is still viable so that fertilization can occur, growers want to attract pollinators and provide large numbers of bees (Photo 1, right). If designing a blueberry field of any appreciable size over a few acres, make sure there will be space for a beekeeper to drop hives on pallets near the field.

For some cultivars, it is not sufficient just to get high rates of pollen transfer from bees because the type of pollen can be important. Some blueberry cultivars benefit from the transfer of cross-compatible pollen, meaning that the field should be designed to have a combination of cultivars that bloom around the same time and that are compatible. For pollination systems that require cross-pollination for full yields, this can provide a 10-20 percent increase in yield from the improved fruit set and berry size. Table 1 provides a guide to cultivars and their level of dependence on this cross pollination for full yields. However, some popular northern highbush blueberry cultivars are self-fruitful, meaning they can be fertilized by pollen from the same cultivar (high group in the table), and this is one reason why solid blocks of cultivars can be a good option for growers who are managing honeybees for pollination, meaning that a benefit can be gained by interspersing another cultivar for many commercial settings growers might consider the increased complications in management outweigh the benefit.

Table 1. Variation among highbush blueberry cultivars in the need for a pollinating cultivar to provide cross-compatible pollen during bloom

Dependence on a pollinating cultivar	Cultivar
Low: no pollinator needed	Duke, Draper, Bluetay, Nelson and Rubel
Intermediate: pollinator beneficial	Bluecrop, Legacy, Jersey, Liberty, Elliott and Aurora
High: pollinator needed	Brigitta, Spartan, Chippewa, Polaris and Toro

In a third group, cross-pollination is needed, and this is achieved by bees moving pollen between cultivars as they fly from row to row. In this situation, planting fields with alternating blocks of co-blooming and compatible cultivars promotes cross-pollination. While pollination between different cultivars is preferred for the best for pollination, it would also cause difficulties with harvesting and spraying. Alternating blocks of up to eight rows allows pollen exchange to occur easier to manage. Alternating blocks of larger sizes will result in too few exchanges between cultivars that need cross-pollination. Before purchasing blueberry plants, check with your nursery to determine the need for planting bushes with pollinator cultivars.

Using honey bees for blueberry pollination

Wait until bloom has started to bring in bees

Flowers of blueberry are primarily more attractive to honey bees than other flowers due to the relatively low nectar amount. Because of this, honey bees will forage on other crops that are in the crop but started to bloom so that bees forage more on blueberry than other flowers (Photo 2). If brought in too early, bees may have to forage elsewhere, reducing their pollination, spending more time and energy to find food, and increasing their chance of being lost. Bees live only three days with. Placement near to the blueberry field can also help to keep them focused on the crop. Still, some cultivars, notably Jersey, have low attractiveness, and bees may still fly over this cultivar to reach other

Photo 2. A honey bee attending nectar from a blueberry flower. This is the workhorse of blueberry pollination, and is the most important pollinator of highbush blueberry. Bumble bees are actually considered more efficient pollinators to around, there are enough bees for sufficient transfer of pollen between flowers. Photo credit: Jason Gibbs, msu

Renting healthy colonies

If you are renting hives from bees, you should expect to receive healthy and vigorous bees. A healthy colony contains around 30,000 worker honey bees and will have six frames of brood. Having weak hives will affect the pollination of the fields receiving them. It is worth taking time to ensure you have strong hives. If you suspect weak colonies, talk to your beekeeper about getting additional hives or replacing them. One strong hive of 30,000 bees can pollinate 2 acres of blueberries, but weak hives will not be able to pollinate as much and will need more bees to do so. Flowers must be pollinated by bees in the morning when they are most attractive to bees. Pollination agreement that lays out the grower's expectations. This can include the strength of the colonies and how quickly the colonies will be placed out of the field after bloom. Example pollination contracts are available online.

Honey bee stocking densities

There have been many changes in blueberry production and in bees over the past few decades, and yet many people still seem to be using stocking density recommendations in 1992. We consider those to be outdated. Bees are still important, bloom density, such as in a field affected by frost or when it is still establishing, and these can also be used in small areas. However, the number of bees needed for pollination is dependent on many factors. Generally, it helps have a high honey density as some of the newer cultivars and intensive production systems provide or if field sizes are large without enough bees to flowers which have relatively low attractiveness.

The last few decades have also seen the loss of feral honey bee colonies due to the parasitic Varroa mites, so those colonies are no longer available for pollination. Managed honey bee colonies, which are fed and protected from pests and dependent than ever on managed bees, so it is important to stock fields with sufficient bees to supply enough visits to flowers which have relatively low attractiveness. Table 2 provides a guide to stocking rates.

A final point to make here is that if the weather is hot during bloom and flowers open quickly, this increases the chance that bees will not get visited before they lose viability. Higher stocking densities can counteract this potential binding factor.

Research and experience in blueberries has shown variation across northern highbush cultivars in their needs for bee pollination (Table 2) due to the variation in attractiveness of different cultivars and their degree of self-compatibility. The table below shows a range of stocking densities from the lower rates recommended two decades ago to the updated rates based on the current pollination requirements of northern highbush blueberry cultivars. Use the lower end of the ranges for modern fields. This shows five hives per acre for Jersey and Earlibluetw, but some growers are using up to eight colonies per acre to ensure good pollination if spring weather is cool and there are only a few good days for honey bee activity. These bees will bloom for two to three weeks. Supplemental bee pollination insurance to make sure that whatever the spring brings there will be the best chance of good pollination.

Table 2. Recommended stocking density of honey bees for highbush blueberry cultivars. Use the lower rates of need for honey bees, and within each group on the lower end of the range for modern fields. Use higher bee rates for use in young, frost-damaged, or fields in high rates for use in mature, healthy, or large fields.

Cultivar	Honey bees hives per acre	
	Low rate	High rate
Rubel, Rancocas	0.5	1
Weymouth, Bluetta, Bluecrop	1	2
Bluecrop	1.5	3
Elliot, Coville, Berkeley, Stanley	2	4
Jersey, Earlibluetw	2.5	5

Adapted from Pritts & Hancock, 1992

A rule of thumb is that you'd need four to eight honey bees per bush in the warmest part of the day during bloom to get bee pollination to fill out the berries. Although this study was done in Michigan, the pollination need was not sufficient; in well-pollinated fields, the contiles fall off when they are still bright white. Check your fields this season and if need be, contact your local beekeeper to see if additional hives can be placed in blueberry fields next year.

Hive placement

If possible, place the colonies in sheltered locations with the entrances facing east or south. This will encourage earlier activity as the bee warms in the morning sun. Hives should be spread out around the farm to maximize floral visitation with a maximum hive of 300 yards between hives. Placement in an open area is slightly away from the edge of the fields also reduces the risk of pesticide drifting onto colonies being disturbed by a tractor.

Using bumble bee colonies

Bumble bees are very efficient at pollinating blueberries with activity at lower temperatures than honey bees, faster visits to flowers, and higher rates of pollen transfer per flower visit. A single visit of a bumble bee to a blueberry flower can deposit enough pollen for full pollination, whereas three visits are needed by honey bees.

The common Eastern bumble bee, Bombus impatiens (Photo 3), has been reared for use as a crop pollinator. These insects are available commercially and can be shipped directly to the farm in eastern United States and Canada. Koppert is one supplier based in Michigan that provides the bees in Quads, each containing four colonies however pollination is expensive per unit. Our evaluations of the bees suggest a commercial Quad, many fields found they provided comparable yield and fruit set to honey bees when tested in small fields at a rate of one Quad per acre.

Wild bee pollinators

While ants, butterflies and honey flies will visit blueberry flowers to gather nectar, bees are the most effective at pollination. Over 150 wild bee species have been found in Michigan blueberry fields, and about 10 of these were sufficiently abundant during bloom and carried enough pollen to be considered valuable crop pollinators. These bees include a diverse assortment of 300 species from March to mid-June. Pollination period and in farms where there are some undisturbed areas for nesting (Photos 4-5), and farms can be managed to enhance their abundance.

Photos 4-5. Many wild bee species nesting in dead stems in the crop is not in bloom and areas of undisturbed soil for nesting. Left, a miner bee gathering pollen from an early spring flower. Right, a sweat bee searching for a place to lay eggs. Photo credit: Jason Gibbs, msu

Wild bees fall into several major categories, including bumble bees, miner bees, sweat bees, mason bees and carpenter bees. Bumble bees and some sweat bees form social colonies later in the summer, but in spring during blueberry bloom, most are solitary and females emerge from their nests to forage on pollen and nectar and lay eggs. Nest sites vary by species. Many of these bees are abundant during the spring, and some species, such as Andrena carolina, are specialists on blueberry.

Wild bees nest in different areas in and around blueberry fields. Miner bees and most sweat bees make underground nests. A female bee leaves this nest to forage for pollen and nectar and lays her eggs in a separate nest. Mason bees Pollen and nectar is collected and shaped into a ball placed in each cell. A single egg is laid on each pollen ball that provides food for the developing larva. Carpenter bees excavate tunnels in dead wood, and bumble bees nest in blueberry bushes in the wood-line strip. Thick layers of mulch can prevent ground nesting bees from digging burrows.

Some bees are active in the early morning and evening, but others are active throughout the day. Blueberry bushes are in small blueberry fields surrounded by natural habitat, wild bees can provide the majority of pollination. However, as blueberry fields get larger and more isolated, honeybees and bees such as carpenter bees, some sweat bees and mason bees, prefer to nest in large, dead wood or pre-existing cavities. Brambles, logs and tree stumps in adjacent habitat and fence rows can be useful nesting sites for these bees.

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Pest management during pollination

Most insecticides have some level of toxicity to bees, as there are restrictions on their use during bloom. Not spraying while honey bees are in the field is the most effective way to avoid any risk of poisoning, so monitoring for pest problems carefully before and during bloom can help minimize the need for pest control at this time of the year. Insecticides with short residual activity, such as Sevin, are generally less toxic than those with longer residual bees. If a pesticide application is necessary during bloom, the compounds that are least toxic to bees should be used with careful observation of the pollinator restrictions on the label. Two insecticides that can be applied during bloom for control of moth larvae in blueberries are products containing diacrito thuringiensis (Bt), such as Dipel and Javelin, and the insect growth regulators Intrepid and Rimon.

The U.S. Environmental Protection Agency (EPA) has developed new pesticide labeling guidelines for certain insecticides that kill other insects than honey bees and are toxic to them. This information is gradually being added to the labels of some insecticides, including neonicotinoids and the new product Exirel. Since these pesticides have never been sprayed in Michigan blueberry fields, the impact on bees is not clear at this time, but it provides more information. EPA's infographic can be downloaded here: The New EPA Bee Advisory Box.

If spraying during the bloom period, one of the most important things growers can do to minimize effects on bees is to apply when the bees are not foraging. Late evening is the best time to apply sprays during bloom because the compounds have time to be absorbed and for the residues to dry before bees are active the following morning. Dust formulations must be avoided because particles can be picked up easily by the bees' hairy bodies.

Recent research has also found that certain fungicides have effects on bees, harming their gut microbes and making them more susceptible to parasite infections. This can in turn result in reduced colony health and increased mortality. Follow the same basic principles for spraying only when necessary and when bees are not foraging to reduce the potential for harming bees during bloom.

More information and a list of pesticides with their toxicity to bees is available from a recently-updated MSU Extension bulletin, "Minimizing pesticide risk to honey bees in fruit crops" (E3249). This document contains a list of insecticides and fungicides ranked by their relative risk to bees and plenty of other good information on how to minimize bee poisoning.

Summary

Blueberries are a seasonal component of growing blueberries. To attain high levels of fruit set with large, evenly-ripening berries requires bees to deposit enough pollen on stigmas during bloom. This can be done by honey bees, other managed bees and wild bees. As with pest management, reliance on one strategy may not be the most sustainable approach, so diversifying pollination sources can spread risk to ensure consistent pollination and profitable yields every year.

Whichever bees are visiting flowers during bloom, ensuring the health and safety of these insects is an important part of maintaining good pollination. Follow label restrictions and practice good pollinator stewardship so they can continue to provide services for years to come. Thank you for your attention!

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