Pollination

Reviewed by Ben Phillips – Sept 2021

Pollination is the transfer of pollen from the male portions of the flower (stamens) to the female portions of the flower (pistils). This process is vital to the production of many vegetable crops, including cucumber, cantaloupe, pumpkin, squash, and watermelon. Some crops (such as tomato) are self-fertile, but wind or bees must vibrate the flowers to release pollen for fertilization.

Honey bees are often thought of as the most prevalent pollinator for vegetable crops, but studies show that many species of native bees — including bumble bees and squash bees — play a vital role in pollinating many vegetable crops. Tomato, for example, benefit from the “buzz pollination” that bumble bees can provide. Honey bees are unable to buzz pollinate, and therefore do not play a role in tomato pollination. The squash bee, a North American native, is an important pollinator of pumpkins and other squash crops. Native bees are often active earlier in the day and at cooler temperatures than honey bees.

To ensure pollination, many vegetable growers rent honey bee hives rather than manage their own hives. Since honey bee colonies are occasionally in short supply, growers should communicate frequently with their bee providers.

In addition to renting honey bee hives, growers can improve the pollination services of native and non-native bees by increasing on-farm habitats. The Xerces Society for Invertebrate Conservation (xerces.org) and Pollinator Partnership (pollinator.org) offer guides, plant lists, and other resources about building on-farm bee habitats.

At least 90 crops grown in the United States depend to some extent upon bees as pollinators, either for seed or fruit production. The exact number of honey bee hives needed to pollinate a crop depends on a number of factors, including the strength and condition of colonies, magnitude of the natural pollinator community, amount of wild flower material competing with the crop, attractiveness of the crop to bees, projected yield, and weather.

The following are guidelines for the number of hives to use when supplemental pollination is desired:

cantaloupe (2 to 3 colonies per acre)
cucumber (2 to 3 colonies per acre)
pumpkin (1 colony per acre)
squash (1 colony per acre)
watermelon (1 to 5 colonies per acre — the pollination requirements of seedless varieties are generally greater than seeded)

The following vegetables will set fruit without bees, but bee activity has been shown to increase yields:
eggplant **okra**
lima bean **pepper**

Honey bees do not assist in the pollination of the following crops, but will collect pollen and/or nectar from them:
pea **sweet corn**
snap bean **tomato**

Do not place hives in a field until the crop’s flowers are available to visit. If the hives are placed before the flowers are available, the bees will forage to surrounding areas and may not forage sufficiently in the crop that needs pollination. Bees forage best within about 100 yards of the colony. Therefore, if the field is large, the bees should be distributed in clusters around the field.

Bees also require a source of clean water. If not available nearby, set out a shallow container with fresh water.

Approximate Time from Pollination to Market Maturity Under Warm Growing Conditions

Vegetable	Days to Market Maturity
Bean	7-18
Cantaloupe	40-50
Corn, fresh market[1]	18-23
Corn, processing[1]	21-27
Cucumber, pickling (3/4 to 1-1/8 inch diameter)	4-5
Cucumber, slicing	15-18
Eggplant (2/3 maximum size)	25-40
Okra	4-6
Pepper, green stage (max size)	45-55
Pepper, red stage	60-70
Pumpkin, jack-o-lantern	60-90
Pumpkin, baking	65-75
Squash, summer, zucchini[2]	3-4
Squash, winter, butternut	60-70
Squash, winter, hubbard	80-90
Squash, winter, acorn	55-60
Tomato, mature green stage	34-45
Tomato, red ripe stage	45-60
Watermelon	40-50

[1]From 50% silking.
[2]For a weight of 0.25-0.5 lbs.

Bees and Pesticides

When foraging for pollen and nectar in flowering plants, honey bees, as well as bumble bees and native bees (solitary bees), may be exposed to a variety of different pesticides (insecticides and miticides) that can cause direct or indirect toxic effects. Direct toxicity occurs when honey bees are immediately killed after exposure to wet sprays or dried pesticide residues on leaves or flowers. Indirect toxicity is associated with sublethal effects on development, foraging behavior, immune system functionality, learning and memory retention, longevity, orientation, overwintering survival, and reproduction. In addition, indirect effects may be affiliated with social interactions as a result of honey bees sharing a contaminated food source.

In general, early morning or late evening applications of pesticides pose less of a hazard because this is when most bees are less active. However, this depends on temperature, as bumble bees are active at lower temperatures (40°F) whereas honey bees are active when temperatures are >50°F.

Do not apply pesticides to flowering plants or weeds. Systemic insecticides, applied as either drenches or granules, to the soil or growing medium, are less harmful to bees than foliar applications. The pesticide formulation can influence bee toxicity. For example, emulsifiable concentrates (EC) and water-soluble (WS) formulations are typically less harmful to bees than wettable powder (WP) formulations.

It is important to note that some fungicides can enhance the toxicity of certain insecticides to honey bees when mixed together. This enhanced toxicity is referred to as synergism, which means that the combined toxicity is greater than the sum of the toxicity of each pesticide applied separately. The ergosterol or sterol biosynthesis inhibiting (EBI) class of fungicides have been shown to increase the toxicity of certain insecticides in various chemical classes, including: organophosphates, pyrethroids, and neonicotinoids to honey bees. For instance, the toxicity of pyrethroid insecticides to honey bees is enhanced over a thousand fold when mixed with ergosterol biosynthesis inhibitors. In addition, mixing some neonicotinoid insecticides with certain fungicides can enhance toxicity to honey bees as much as a thousandfold.

In addition to fungicides, insect growth regulators, which are insecticides that disrupt insect growth and development, and eventually lead to death, are known to be harmful to honey bees. The three categories of insect growth regulators — chitin synthesis inhibitors, juvenile hormone mimics, and ecdysone receptor antagonists/ agonists —have been reported to be directly and/or indirectly harmful to honey bees; especially the larvae (brood).

The Fungicide Table and Insecticide Table contains Bee Precaution information based on the toxicity of oral exposure to honey bees, honey bee brood, and other bees. It is important to read the pesticide label carefully to determine the potential level of toxicity to all bee types (honey bees, bumble bees, and native bees). Furthermore, you can incorporate into pollination contracts a list of pesticides, application methods, and timing of applications that are mutually agreeable to both growers/producers and beekeepers. These tables utilize the University of California IPM *Bee precaution pesticide ratings*; a systematic review of toxicity data for most crop management chemistries found at www2.ipm.ucanr.edu/beeprecaution.

State laws may require that applicators notify beekeepers 24 hours before applying a pesticide that is directly or indirectly harmful to honey bees when; 1) the treated crop is in flower (blooming), and 2) the field is greater than a half-acre and within a half-a-mile from a registered apiary. It is important to contact your state department of agriculture to determine if there are laws or regulations that protect other pollinators (bumble bees and native bees).

For more information on bees and pesticides, refer to the extension publication, *Pesticides and Bees* (Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF3428. Kansas State University; Manhattan, KS. 8 pgs, bookstore.ksre.ksu.edu).

Organic Vegetable Production

Reviewed by Liz Maynard – Aug 2021

Organic vegetable farming is a production system that relies on biological processes and natural materials to manage soil fertility and pest populations, and to promote healthy crop growth. The federal Organic Foods Production Act regulates the use of the term “organic” to describe an agricultural product in the marketplace. Vegetables sold as “organic” must be grown and handled according to the National Organic Rule and any applicable state regulations. The National Organic Rule prohibits the use of most synthetic chemicals (fertilizers, pesticides, etc.), and requires farmers to write and follow organic production plans, as well as keep farm and field records. Fields used to grow organic crops may not have had any prohibited material applied to them in the previous three years. In addition, USDA-accredited organic certification agents must inspect and certify all operations with more than $5,000 in gross annual sales of products labeled “organic.”

Growers interested in transitioning to organic production should educate themselves about practices used in their area and plan carefully. Experience suggests that it can take a number of years for pest populations and soil nutrient cycles to adjust enough for successful organic production.

This guide includes recommendations for some inputs that are permitted in organic production, but also for many that are not. The note ‘OMRI-listed’ indicates pesticides that have been listed by the Organic Materials Review Institute (OMRI) as approved for use in organic production in the U.S. Growers should always check with their organic certification agents before using any product to make sure it meets their certifier’s criteria.

Other organic production resources include:
eOrganic, the Organic Agriculture Community of the Extension Foundation eorganic.org

Organic Vegetable Gardening Techniques (University of Missouri Extension Guide G6220) provides an introduction