Orchard Pollination

Pollination is the sexual portion of a tree's life cycle and involves the integration of several biological and physical factors, including cultivar compatibility, synchronous blooming, insects, and proper weather conditions. If any one of these components is missing or limiting, crop yield and quality can be affected.

Pollinators are important for all tree fruit crops, whether cultivars are self-fertile or self-sterile. Bees are the most important group of pollinators of tree fruits. Honey bees are the most widely used bee for pollination because they are easy to manage and can be moved. However, several species of mason bees *(Osmia sp.)* are also managed for tree fruit pollination, and more than 80 species of wild bees frequent tree fruit orchards and contribute significantly to pollination.

The nearer the pollinizer to the producing tree, the better distribution by the bees of pollen to all blossoms. Crabapples are often used as pollinizers.

All apple cultivars require cross-pollination with a pollinizer (not to be confused with a pollinator, which is a bee) to ensure commercial quality fruit and yields. Varieties differ in their self-fruitfulness. For example, Golden Delicious is considered partially self-fruitful, while Red Delicious is not. Regardless of the degree of self-fruitfulness, provide cross-pollination in every planting. With respect to cross-pollination, all red sports and spur types are considered the same as the parent variety. For example, Yorking is not a pollinizer for York Imperial. Closely related varieties may not pollinate one another—for example, McIntosh, and Early McIntosh. Triploid varieties do not pollinate any varieties. Otherwise, all varieties with satisfactory pollen are pollinizers of one another if the bloom periods overlap. It is advisable to have three pollinizer varieties in all Stayman and Winesap blocks.

Cold periods during flowering can reduce pollination and subsequent fruit set. Pollen may fail to germinate when temperatures are below 41°F, and pollen tube growth is extremely slow below 51°F. Therefore, in some situations, temperatures could be warm enough for bees to fly (65°F for the honey bee, 5 to 10 degrees cooler for bumble bees and solitary bees), but if the weather turns cold, the pollen tubes may not grow fast enough before the embryo sac deteriorates.

Effective pollination period (EPP)

The effective pollination period (EPP) is the difference between the period of time for pollen tube growth and that of ovule longevity. The longer the effective pollination period, the greater the likelihood of adequate fertilization and seed development. Pollination must occur within 2 to 4 days after the flowers open; otherwise, the embryo sac will degenerate before fertilization can occur. Studies have shown that this period can vary depending on cultivar. The growth of the pollen tube and eventual fertilization of the embryo is largely dependent on temperature and its relationship to the effective pollination period.

The EPP was introduced in the mid-1960s as a way of establishing the time frame between when a flower is pollinated and when the embryo becomes unreceptive. After pollination it takes a certain time for the pollen tube to reach the embryo sac. Once a flower opens, the embryo has only a limited time when it is receptive. If the pollen tube does not reach the embryo before it degenerates, then the flower will not set. The length of the EPP will vary by flower position within the cluster and by certain cultural practices. In general, the EPP can be as short as 3 days and as long as 12 days; Delicious has one of the shortest EPPs. Williams and Wilson developed a temperature response index to allow the estimation of the time required for a pollen tube to

grow to the embryo (see below). The index is based on the daily mean temperature over a period of days. When the index reaches or exceeds 100 percent, the pollen tube should have reached the embryo and fertilized the egg. As an example, suppose the average mean temperature over the past five days had been 50, 54, 50, 52, and 59 degrees. Pollen tube growth would be expected to be 14 + 20 + 14 + 17 +50 = 115 percent, meaning pollen tube growth would have taken slightly less than 5 days.

Mean daily temp (°F)	41	43	45	46	48	50	52	54	55	57	59
Pollen tube growth index (%)	8	9	10	11	12	14	17	20	25	35	50

Effective Pollination Period Index

Five conditions are necessary for satisfactory cross-pollination:

- Pollinizer and main variety bloom periods must overlap.
- The pollinizer variety must have viable diploid pollen.
- The pollinizer variety must be located near the producing tree.
- Bees and other insects must be present in the orchard and be active at bloom.
- Weed blossoms, such as dandelions, mustard, and wild radish, should not be present in quantity since they attract bees away from fruit tree blossoms.

Certain varieties have a biennial bearing tendency. During the “off” year of the pollinizer, the adjacent variety, although an annual bearer, will tend to become biennial because of the lack of cross-pollination. Summer applications of NAA or ethephon can help to promote return bloom. This is discussed later in the plant growth regulator section of this chapter. This is not as serious when one of the two is relatively self-fruitful; however, the problem must be considered along with all the other factors that affect pollination. A pollinizer is the source of pollen necessary to set fruit. A pollinizer might be another tree with compatible pollen or a bouquet of flowering branches placed in the orchard, whereas a pollinator transfers pollen from tree to tree. The most important pollinators are bees, but some types of flies such as syrphids, some beetles, and some types of thrips may also assist but to much lesser degrees.

Trees that provide sufficient compatible pollen for the main cultivar(s) in the block are necessary for pollination. A desirable arrangement is a pollinizer located not more than 100 feet from the variety to be pollinated. In larger blocks, plant two rows of pollinizer (starting on the windward side of the block), four rows of main variety, two rows of another pollinizer, four rows of the main variety, then two rows of the first pollinizer, etc., and repeat the arrangement across the block. We recommend that no fewer than three pollen-compatible varieties be planted in an orchard. Thus, for example, if you are planting a Delicious block, select two additional suitable pollinizer varieties to plant. Where additional pollen is needed, graft a pollinizer branch into each tree. Select main variety and pollinizer trees with overlapping annual bloom times. Large bouquets of pollinizer branches placed in drums of water near main variety trees may be used when no other pollinizers are available. The nearer the pollinizer to the producing tree, the better distribution by the bees of pollen to all blossoms.

All fruit species require pollination to set fruit. Some species are self-fruitful and do not require more than one cultivar per block. Peaches, nectarines, tart cherries, most apricots, and some European plums are self-fruitful, and a solid block of one cultivar may be planted. Apples, pears, and sweet cherries require mixed plantings of different cultivars for adequate cross-pollination. The percentage of flowers that need to be set varies greatly between fruit crops. For crops like cherries, yield is the most important factor in a commercial crop, so 20 to 60 percent of sweet cherry and 20 to 75 percent of sour cherry blossoms need to be set for a commercial crop. For other fruit crops where size is more important commercially or to prevent biennial cropping, the percentage of flowers that need to be pollinated is much lower: apple, 2 to 8 percent; pear, 3 to 11 percent; peach, 15 to 20 percent; apricot, 20 to 25 percent; and plum, 3 to 20 percent. This is the reason for hand-thinning many crops like peaches later in the season or for chemical thinning apples since under normal conditions these crops will tend to set too many fruit that, if left to mature, will be too small commercially.

Improving pollination can lead to increased production owing to larger and better-shaped fruit and/or a greater number of fruit per tree. Research in Massachusetts has shown that fruit size and calcium content are directly related to the number of seeds per fruit, with the number of seeds being dependent on good pollination. The more pollinizer trees in a planting, the better the potential for

cross-pollination. However, using rows of apple pollinizers means the loss of some efficiency in orchard operations. Having two or more cultivars in an orchard may pose problems in spray-to-harvest limitations and cultural practices, and it may confuse pickers, resulting in bins of mixed cultivars. There also may be an inefficient use of land owing to differences in growth habits. These disadvantages, however, are far outweighed by the greater yields associated with pollinizer use.

Pollinizer placement

The placement of pollinizers is important. Ideally, every tree in an orchard should be located as close to a pollinizer tree as possible. However, efficient orchard production practices do not include scattering pollinizers of commercial cultivars throughout a block. (An exception is the use of ornamental crabapples.) The preferred arrangement of pollinizers is in solid rows. One scheme is to alternate two rows of pollinizers between four rows of the major cultivar. An exception is planting cultivars, such as Delicious, that have a tendency to be less fruitful. In these instances, and when it is desirable to maximize pollination, a pollinizer row should be set every third row.

Supplemental pollination practices

Even with an adequate allowance for pollinizers, it may sometimes be necessary to provide for additional pollen when weather conditions do not favor cross-pollination. Using hive inserts with commercially obtained pollen is a common practice that can increase pollen sources. Inserts are specially constructed to fit in the entrance of hives and are filled on a frequent basis with pollen. The inserts are constructed so that bees are forced to track across the pollen and carry it to the flowers as they forage. A second method of increasing pollen is to cut bouquets of flowering branches from trees elsewhere in the orchard and place them in large containers of water within the tree rows. Bouquets should be checked daily and replenished as needed. A third method is to graft selected limbs with a compatible pollinizer branch. The disadvantage of this method is the necessity to clearly mark the limb to prevent it from being pruned out in the winter and prevent harvest crews from mixing the fruit in bins. All these methods should be viewed as supplemental means of increasing pollination. The best pollination method is to have an adequate number of pollinizer cultivars and strong, healthy honey bee colonies.

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Contact Information

Robert Crassweller
Professor of Tree Fruit
rmc7@psu.edu
814-863-6163