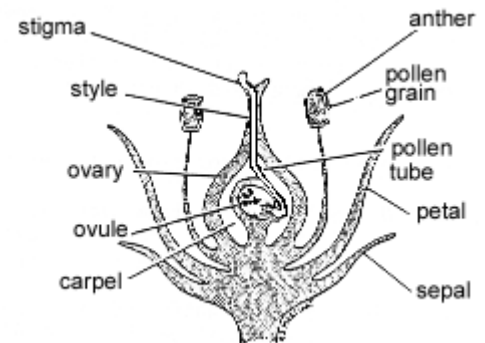


## Pollination

A flowering plant springs from a seed and grows. Given favorable conditions a bud develops and from it a showy flower emerges. Then pollination must occur. As the flower fades a fruit with seeds is produced. With seed dispersal one of nature's most fascinating and vital cycles, plant reproduction, has run its course.

There are about 250,000 species of flowering plants on earth that require pollination. Wind, gravity, water, birds, bats, and insects are the forces that accomplish pollination. Plants that produce a pollen that is light and easily blown about by wind are referred to as **wind-pollinated plants**. Pine trees and corn are two examples of wind-pollinated plants. A large number of plants produce pollen that is heavy and sticky and not blown easily from flower to flower. These require other agents, such as insects, to transfer pollen and are **insect pollinated plants**.



To produce a seed or fruit, pollen must move from the anther to a receptive stigma. This is **POLLINATION**. When the proper compatible pollen adheres to the stigma, it germinates and a pollen tube grows through the stigma and the style to the ovary. **FERTILIZATION** takes place in the ovary when the nucleus of the pollen or male germ cell unites with the nucleus of the ovule or female germ cell. Now a seed is produced.

**POLLINATION** – transfer of pollen from flower anther to stigma.

**SELF-POLLINATION** – pollen comes from same flower or same plant or from plants of identical genetic material. Flower must be SELF-FERTILE or SELF-COMPATIBLE.

**CROSS-POLLINATION** – pollen transferred from one flower to another. Flower must be CROSS-COMPATIBLE.

**FERTILIZATION** – union of male nucleus of pollen grain (passed through pollen tube) with female nucleus of ovule.

Cross pollinated flowers must have transfer of pollen from one flower to the next. Even self-pollinated plants may benefit from cross-pollination with hybrid vigor, or more rapid and complete growth. Male sterility has been found in many crops and plant breeders exploit this characteristic to develop hybrids which are then dependent on cross pollination.

Most flowers secrete **nectar**, a sugary, scented liquid to help attract insects to the flower. This is usually offered deep within the flower near the base where petals originate from around the ovary. In seeking nectar or gathering **pollen**, the insect accidentally brushes against anthers so that pollen grains are transferred to the stigma. Pollination is not a deliberate behavior but an accidental one performed by the insect as they collect food.

The honey bee is well adapted for **pollination**. Each colony contains thousands of individuals which are available to forage for the food (pollen and nectar) that's required to rear their replacements. Like other bees, their sense of smell, eyes, mouthparts, and numerous branched body hairs are ideally suited for finding food sources, sipping nectar, and collecting and distributing pollen. Honey bees visit a wide variety of flower types. In a single day, one bee makes 12 or more trips from the hive, visiting several thousand flowers. On each trip, it confines its visit to one plant species, collecting one kind of pollen. It has a complex communication system that enables the colony to find and collect food with maximum efficiency. These characteristics make honey bees most valuable agent for cross-pollinating crops.

## Crops Pollinated by Bees

Some of the crops that require, or at least benefit from, bee pollination are listed below. The list is grouped for convenience and is limited to plants that contribute to our food supply. Trees, shrubs, and plants useful for other purposes are not included. Crops marked with an asterisk are often grown on large acreage and the fields are stocked with honey bee colonies to provide adequate pollination for maximum yields and optimum quality.

### Forage and Legume Crops

\*Alfalfa; buckwheat; clover (alsike, berseem, crimson, Egyptian, \*Ladino, \*red, rose, strawberry, and white); \*crown vetch; sweet clover (\*Hubam, \*white, \*yellow); lespedeza (bush); \*trefoil; vetch (\*hairy and purple).

### Fruit Crops

\*Apple; apricot; \*avocado; berry (blackberry, \*blueberry, \*cranberry, gooseberry, raspberry, and \*strawberry); carambola; \*cherry; citrus (\*grapefruit, lemon, \*mandarin, nectarine, \*tangelo, and \*tangerine) \*kiwi, mango, passion fruit, \*peach; \*pear; persimmon, \*plum, and prune.

### Nut Crops

\*Almond, cashew, chestnut, coconut, and \*macadamia.

### Oilseed Crops

\*Cotton, flax, \*rape, \*safflower, soybeans, \*sunflower, tung.

### **Vegetable Seed Crops**

Asparagus, \*broccoli, \*brussel sprouts, \*carrots, \*cauliflower, celery, Chinese cabbage, collard, cucumber, dill, eggplant, garlic, kale, kohlrabi, leek, \*lima beans, mustard, \*onion, parsley, \*pepper, pumpkin, \*radish, rutabaga, \*squash, and \*turnip.

### **Vegetable Crops**

Beans, \*cucurbits (cantaloupe, cucumbers, muckmelon, pumpkin, squash and watermelon), eggplant, lima beans, and peppers.

## **Providing Honey Bee Colonies for Pollination**

Providing honey bee colonies to pollinate crops is by far the easiest and most reliable service in planned pollination. There are over 3.5 million acres of crops in the United States that depend upon honey bees for pollination. It is important for beekeepers to provide strong colonies to the grower who rents bee hives. **Strong colonies** not only supply more field bees, but the bees continue to forage when a weak colony will not. Strong colonies need proportionally fewer bees to perform hive duties and thus they have more field bees.

When renting colonies for pollination it is desirable for beekeepers to have a **written agreement** with growers. The contract should cover: (1) number and strength of colonies to be used; (2) plan of colony distribution in the field; (3) time of delivery and removal; (4) the beekeeper's right of entry to service the colonies; and (5) the degree of protection from pesticides; (6) plan of payment of the rental fee; (7) penalties for poor quality or service by the beekeeper or breach of promise by the grower; and (8) rewards or bonuses for exceeding the minimum in quality service, protection, or time of financial settlement.

## **Resources on Pollination**

There are numerous printed and visual sources of information on pollination. Selections from each are appended to this material. CAPA (Canadian Association of Professional Apiculturists) has published an informative 34 page guide: **MANAGING BEES FOR CROP POLLINATION**. This leaflet includes a listing of crops, their pollinator requirements, and number of honey bee colonies required. Penn State publishes a 7 page Extension Bulletin **HIVES FOR HIRE** and offer a sample pollinator contract. From Georgia the 31 page Extension Bulletin **BEE POLLINATION OF GEORGIA CROP PLANTS** includes very good basic information about honey bees and the different pollinators. Important honey bee pollination crops (such as cucumber and watermelon) have a summary of their pollination requirements that includes a table of published recommendations on the numbers of bee colonies suggested for adequate pollination. An 8 page Tennessee Extension bulletin **MAKING A POLLINATION CONTRACT** includes basic information on honey bee pollination and a sample pollinator contract.

Regional publications cover specific recommendations for common crops that rely on honey bee pollination. NRAES-55 (Northeast Regional Agricultural Experiment Station) **HIGHBUSH BLUEBERRY PRODUCTION GUIDE** includes a section on Blueberry pollination along with

basic flowering information for this hard-to-pollinate New England Crop. NRAES-75 **MID-ATLANTIC ORCHARD MONITORING GUIDE** covers fruit pollination in a similar fashion. **MID-ATLANTIC COMMERCIAL VEGETABLE PRODUCTION RECOMMENDATIONS** summarizes basic information on pollination requirements for vegetables in the EAS region.

There are [several excellent video \(VHS\) tapes](#) available on pollination and a couple of slide sets (with scripts) also useful. The list below summarizes these resources

.The Story of Pollination	23	1983	National Geographic Society
A growers guide to colony evaluation for pollination	30	1995	USDA (A.I. Root Co.)
The Flower & the Hive	12	1960	Internat Film Bur (Canada)
Sexual encounters of the floral kind	58	1986	Insight Media, NYC
Plant Reproduction	30	1997	Insight Media, NYC
Flowers: Structure & Function	10	1950's	Coronet, Northbrook, IL
Poll of Alfalfa by honey bees	28	1960's	Hercules Powder Company
Pollination: The Insect Connection	14		Films for Humanities/Sciences, Princeton, NJ

Beekeeping Education Service has slide sets on Pollination (20 slides). The Honey Bee and Pollination (81 slides) and Pollination Ecology (20 slides) for purchase as well as related slide sets on plants and bee management.

The most useful technical sources of information on pollination of crops are the Academic Press book by John Free and the USDA publication prepared 20 years ago by McGregor. The latter is being updated by pollination experts and will be available on disc and perhaps internet as sections are revised from the USDA Bee Lab in Tucson, AZ. THE UN has a new FAO Bulletin that summarizes our knowledge of tropical crop pollination.

Free, J.B. 1993. Insect Pollination of Crops. 2<sup>nd</sup> Edition, Academic Press, NY. 684 pp.

McGregor, S.E. 1976. Insect Pollination of Cultivated Crop Plants. USDA AGRIC. Handbook 496. 411 pp. (Available on Tucson Bee Lab or A.I. Root, Co. web pages.)

Roubik, D. editor 1995. Pollination of Cultivated Plants in the Tropics. FAO Agric. Serv. Bull. 118. 198 pp.

Buchmann, S.L. and G.P. Nabhan. 1996. The Forgotten Pollinators. Island Press, Washington, D.C.

Johansen, C. and D. Mayer. 1990. Pollinator Protection: A Bee and Pesticide Handbook. Wicwas Press, Cheshire, CT. 212 pp.

Extension leaflets on Pollination are also available from other regions of the U.S. (Florida, California, Illinois) and from the commercial companies A.I. Root and Dadant and Sons. The

USDA has two publications that are no longer available for distribution but may still be available from State Cooperative offices or in libraries.

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