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# HONEY BEES: A MODEL INSECT IN HORTICULTURAL CROP PRODUCTION

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**ABSTRACT**

**The focus of agriculture in India is slowly shifting from traditional system to high-value horticultural crops farming such as fruits and vegetables. The change of subsistence systems to commercial cultivation of horticultural crops possesses new challenges for improving crop productivity and quality. Amongst several factors attributing to low productivity, inadequate pollination is the most important. Pollination is a simple process involving transfer of pollen from anthers to the stigma of the same or different flower. Horticultural crops require adequate pollination for better fruit production. Most of the horticultural crops are cross pollinated and they need agent (honey bee) which could transfer pollen grain from one flower to another. Cross pollination of entomophilous crops by honeybees is considered as one of the effective and cheapest method for triggering the crop yield both qualitatively and quantitatively. It has been reported that there are more than 25000 described species of bees in the world and account for 65% pollination of various flowering crops. Primarily two honey bee species viz., *Apis cerana indica* and *Apis mellifera* have been successfully domesticated and practices for their management for pollination of crops have been standardized for many crops. Honey bee colony in the orchard must be ensured for better production.**

## Introduction

India is second largest producer of fruit (88.9 mt) and vegetable (162.89 mt) in the world followed by China. Most of the horticultural crops are cross pollinated. Cross-pollination helps at least 30 percent of the world's crops and 90 percent of our wild plants to thrive. It is estimated that about one third of all plants or plant products eaten by humans are directly or indirectly dependent on bee pollination. In India 50 million hectares of land is under bee dependent**.** The great value of bees as pollinators has been known for many years, but unfortunately, this knowledge is not widely appreciated and understood. In most of the crops, flowers have short life to perform pollination. If such a crop is not pollinated during that time, the flowers will fall and no seeds, berries or fruit will develop. There have to be sufficient numbers of bees in the field to perform pollination in cross pollinated crop. This is especially important in crops where the single flower may only be pollinated in a restricted time or in crops where the nectar production, or bee visits only take place during days where the temperature is at a certain level. In such a crop, the pollination in some years has to take place within three or four days. The flowers only produce some special smelling products attracting the bees when the ground temperature is above 15 $^{0}$C. When the temperature is lower, only a few bees are interested in visiting the flowers. If the farmer does not

provide honeybees or other bees for pollination, the whole harvest can fail. A honeybee can therefore visit 18-20 flowers in one minute. Lack of bees for pollination can cause losses to the farmer up to 75 percent of the crop. A single coffee flower is only open for three to four days when blooming. If a bee or another insect does not pollinate the flower during these days, it will wither, and no coffee bean will be produced. Bee visits plants for its food, nectar and pollen. This floral fidelity of bees is due to their preference for nectars having sugar contents and pollens with higher nutritive values. Honeybees are best known for the honey they produce. But the principal economic role of honeybees in nature is to pollinate hundreds and thousands of flowering plants and ensure seed set in quantity and quality. Both flowering plants and honeybees are interdependent for their biology and life cycle. Flowering plants offer nectar and pollen to honeybees and honeybees reciprocate their obligation by bringing about pollination, maintaining genetic diversity and continuation of the plant species.

Nearly 70 percent of the cultivated crops all over the world are cross-fertile and depend on insects like honeybees for pollination. Insects are the most commonly occurring pollinators of many agricultural and horticultural crops. Different kinds of insect pollinators such as bees, flies, beetles, butterflies, moths and wasps are important pollinators of many crops. Of all the pollinating insects, honeybees are considered as the most efficient and reliable crop pollinators. The beekeeping industry has rarely put itself forward as a Key Factor in agricultural production.

Many farmers all over the world do not recognize the need for bee pollination and consequently many bees are killed by careless use of pesticides.

The bee pollination in *Brassica* oilseed production creates a higher content of oil in the seed. Sufficient bees will also take care that all the plants in the field are pollinated in the same period, so the seeds ripen at the same time. This allows harvest of a uniform crop, with less green and unripe seeds among the ripe ones. That will give the farmer a higher price.

**Why honeybees often are the most important crop pollinators**

The effectiveness of honeybees is due to their great number, their social life and their ability to pollinate a broad variety of different flowers. A colony can consist of 20-80000 bees and they will normally be visiting flowers over a distance of two kilometers when they are collecting pollen and nectar. If nothing is to find in the neighborhood, they can fly even seven kilometers. A normal *Apis mellifera* honeybee colony will make up to four million flights a year, where about 100 flowers are visited in each flight. A well-pollinated crop produces well-shaped fruits, well-filled seed pods, a uniform seed set and tight clusters of fruits or seeds.

**Fig. 1. Honey bee pollinating litchi flower**

From research and experience, it is possible to recommend a certain number of bee colonies per hectare when growing a crop, but many other factors can influence.

**Table 1. Honeybee colony in Horticultural crops:**

| Crops | Bee colonies per hectare |
|---|---|
| Apple | 4 |
| Alfalfa | 8 |
| Apricot | 2 |
| Asparagus | 4 |
| Avocado | 5 |
| Bean (Lima) | 9 |
| Blackberry | 7 |
| Blueberry | 8 |
| Cabbage | 5 |
| Carrot seed | 8 |
| Citrus | 2 |
| Cucumber | 7 |
| Mango | 15 |
| Mandarin | 4 |
| Eggplant | 3 |
| Melon | 7 |
| Kiwifruit | 8 |
| Peach and nectarine | 2 |
| Pear | 4 |
| Strawberry | 8 |
| Watermelon | 5 |
| Pumpkin, squash, gourd | 4 |

**Table 2. The role of honeybees in the pollination of stone fruits**

| Fruit | Variety | Condition | Fruit set (per cent) | Yield/tree (kg) |
|---|---|---|---|---|
| Apricot | Trevatt | Open<br>Enclosed | 19<br>11 | 99<br>67 |
| Cherry | Moss Early | Open<br>Enclosed | 36<br>2 | 35<br>2 |
| Peach | Golden Queen | Open<br>Enclosed | 26<br>22 | 216<br>155 |
| Peach | Crawford | Open<br>Enclosed | 28<br>10 | 47<br>18 |
| Plum | Satsuma | Open<br>Enclosed | 6<br>2 | 38<br>15 |

**Effect of pollination in improving quality and production of horticultural crop**

Bee pollination not only results in a higher number of fruits, berries or seeds, it may also give a better quality of produce, and the efficient pollination of flowers may also serve to protect the crops against pests. The better weight due to sufficient pollination arises from the development of all seeds in a fruit.

For example, an apple can only develop all the seeds if it has been pollinated by several bees and fully fertilized. It is possible for an apple flower to develop about ten seeds. If all the seeds do not develop, the fruit itself does not develop a side where the seeds are not developing. This results in poorly shaped apple of low weight. Similarly in strawberries 21 visits of bees are necessary for fully development of fruits. A single strawberry can have 400-500 seeds sitting on the surface of one berry. A sufficient number of bees for pollination can also protect the crop against serious pest attacks. If flowers are open and not pollinated due to lack of bees, pollination can take many days. In that time the flower is attacked by different pests eating the pollen, sucking the sap, laying eggs in the flower, or spoiling it in other ways. . If there are sufficient bees in the field, the flowers will only have to be open for a short time, and the different pests will not have so much time for their destruction. In that way, adequate numbers of bees ensure rapid and efficient pollination and protect crops against pests.

Many horticultural crops are actually self-sterile and require cross-pollination to produce seeds and fruit, not only self-sterile varieties benefit from cross-pollination, but self-fertile varieties also produce more and better quality seeds and fruits if they are cross-pollinated. There are two well-known methods for improving crop productivity. The first method is making use of agricultural inputs such as the use of quality seeds or planting material and good cultural practices like timely irrigation, organic and inorganic fertilizers and chemical pesticides to increase yield. The second method includes the use of biotechnological techniques, such as manipulating rate of photosynthesis and biological nitrogen fixation, etc. These conventional techniques ensure healthy growth of crop plants, but work up to a limit. At some stage crop productivity becomes stagnant or declines with additional inputs for the known agronomic potentials of crop will have been harnessed. A range of studies have shown that pollination makes a very significant contribution to the agricultural production of a broad range of crops, in particular fruits, vegetables, fibre crops and nuts.

Pollination by honey bee increases fruit set, enhances fruit quality and reduces fruit drop in apple, peach, plum, citrus, kiwifruit and strawberry. Bee pollination did not only increase the fruit set but also reduced fruit drop in apple, peach, plum and citrus. Reports have also indicated an increase in fruit juice and sugar content in citrus fruits. In strawberry, bee pollination reduces the percentage of misshapen fruits. It has been estimated that the benefit of using honeybees for enhancing crop yields through cross-pollination is much higher than their role as producers of honey and beeswax.

A range of studies have shown that pollination makes a very significant contribution to the agricultural production of a broad range of crops, in particular fruits, vegetables, fibre crops and nuts. Dependency of some horticultural crops on insects for pollination is given in Table 3.

**Advantages of bee pollination**

Honey bees are the most efficient pollinators of several agricultural, horticultural, silvicultural, fodder and wild plants. As a result of cross pollination by bees, somatic,

reproductive and adaptive heterosis occurs in plant progeny. The following qualitative and quantitative changes in plants:

- Stimulate germination of pollen on stigma,
- Increase viability of seeds, embryos and plants,
- More nutritive and aromatic fruits,
- Stimulate faster growth of plants,
- Increases number and sizes of seeds and yield of crops,
- Increases nectar production in the nectaries,
- Increases fruit set and reduces fruit drop,
- Enhances resistance to diseases and other adverse climatic conditions,
- Increases the oil content in oil seed crop.

**Table 3. Dependence of some crops on insects for pollination is as under**

| **Fruits** | **Percent Dependence** | **Vegetables** | **Percent Dependence** |
|---|---|---|---|
| Grape fruit | 80 | Pumpkin | 90 |
| Lemon | 20 | Water Melon | 70 |
| Lime | 30 | Vegetable Seed | 100 |
| Strawberry | 40 | | |

**Table 4. Horticultural crops pollinated by honey bee**

| | |
|---|---|
| Okra | *Abelmoschus esculentus* |
| Kiwifruit | *Actinidia deliciosa* |
| Potato | *Solanum tuberosum* |
| Onion | *Allium cepa* |
| Cashew | *Anacardium occidentale* |
| Celery | *Apium graveolens* |
| Carambola | *Averrhoa carambola* |
| Beet | *Beta vulgaris* |
| Mustard | *Brassica alba* |
| Rapeseed | *Brassica napus* |
| Broccoli | *Brassica oleracea* italica |
| Coriander | *Coriandrum sativum* |
| Melon | *Cucumis melo* |
| Cucumber | *Cucumis sativus* |
| Pumpkin | *Cucurbita* spp. |
| Guar bean | *Cyamopsis tetragonoloba* |
| Quince | *Cydonia oblonga* |
| Lemon | *Citrus limon* |
| Carrot | *Daucus carota* |
| Hyacinth bean | *Dolichos spp.* |
| Longan | *Dimocarpus longan* |
| Persimmon | *Diospyros kaki* |
| Durian | *Durio zibethinus* |
| Cardamom | *Elettaria cardamomum* |
| Loquat | *Eriobotrya japonica* |
| Fennel | *Foeniculum vulgare* |
| Strawberry | *Fragaria* spp. |
| Sunflower | *Helianthus annuus* |
| Litchi | *Litchi chinensis* |
| Macadamia | *Macadamia ternifolia* |
| Barbados cherry | *Malpighia glabra* |
| Apple | *Malus domestica* |
| Mango | *Mangifera indica* |
| Alfalfa | *Medicago sativa* |
| Rambutan | *Nephelium lappaceum* |
| Cauliflower | *Brassica oleracea* botrytis |
| Cabbage | *Brassica oleracea* capitata |
| Brussels sprouts | *Brassica oleracea* gemmifera |
| Turnip | *Brassica rapa* |
| Chilli | *Capsicum annuum* |
| Papaya | *Carica papaya* |
| Chestnut | *Castanea sativa* |
| Watermelon | *Citrullus lanatus* |
| Avocado | *Persea americana* |
| Lima bean | *Phaseolus spp.* |
| Allspice | *Pimenta dioica* |
| Apricot | *Prunus armeniaca* |
| Sweet Cherry | *Prunus avium* spp. |
| Sour cherry | *Prunus cerasus* |
| Plum | *Prunus domestica* |
| Almond | *Prunus amygdalu* |
| Peach | *Prunus persica* |
| Guava | *Psidium guajava* |
| Pomegranate | *Punica granatum* |
| Pear | *Pyrus communis* |
| Black currant | *Ribes nigrum*, |
| Rose | *Rosa spp.* |
| Raspberry | *Rubus idaeus* |
| Blackberry | *Rubus fruticosus* |
| Hog plum | *Spondias spp.* |
| Tamarind | *Tamarindus indica* |

| | |
|---|---|
| Blueberry | *Vaccinium* spp. |
| Broad bean | *Vicia faba* |
| Cowpea | *Vigna unguiculata* |
| Grape | *Vitis* spp. |
| Jujube | *Zizyphus jujuba* |

**Conclusion**

The declining horticultural productivity can be attributed to a number of factors, but pollination plays a crucial role. One can go for use of improved agricultural technologies, such as the use of quality seed, high yielding varieties, good agronomic practices like timely irrigation and fertilizers, but without pollination, neither fruit nor seed will be formed. Pollinator scarcity is the main factor responsible for inadequate pollination and production. This can be overcome by conserving manageable species of honey bees' colonies. Promoting use of beekeeping for pollination of horticultural crops will be of benefit to both the beekeeper and to the farmer. Honey bees do not only ensure quality production but also produces honey, wax etc. addition profit to the growers. Many growers are not aware of how significant the contribution of native pollinators is to the production of their crops and farm profitability.

**How to cite this article?**

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