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## REVIEW ON HONEYBEE : MIRACLE AGENT OF POLLINATION

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### ABSTRACT

A wide range of insects are important contributors regarding crop pollination as not all crops can pollinate themselves. Pollination is very much essential in case of seed plants. Honeybees are also hence, one of the important insect factors which has a great role in pollination of different crops. When a worker honey bee visits a flowers to collect nectar, pollen often stick to her hairy body and when this same bee visit another flower of the same crop, some of the pollen gets transferred to the stigma of this flower thus gets pollinated. In this process the fragrance and the bright coloration of the flowers also play important role by attracting the honeybees. This review is therefore regarding the role of honeybees in the process of pollination of different crops.

**Keywords :** Honeybee, pollination, foraging, economical

### Introduction

Pollination is a most important ecosystem service provided by insects, resulting in sustainability and continuity of the ecosystem. The transfer of pollen from male to female sex organs is called pollination. Pollination is an important step in the reproduction of seed plants, the transfer of pollen grains (male gametes) to the plant carpel, the structure that contains the ovule (female gamete) (Sprengel, 1793). The availability of natural insect pollinators is decreasing rapidly due to the continuous use of pesticides and decline of necessary habitat (Richards, 2001). Many horticultural crops are dependent on insect pollination, and better pollination results in higher yields (McGregor, 1976; Free, 1993 and Klein *et al.*, 2007), more uniform ripening and improved plant vigor (Stoddard and Bond, 1987). A diverse array of insects like bees, butterflies, wasps, flies, beetles, and moths are responsible for providing this essential ecosystem service of crop pollination (Buchmann and Nabhan, 1996., Kevan, 1999). The principal flower-visiting insects are from the orders Hymenoptera and Diptera for the following reasons. Approximately 73% of the world's cultivated crops are dependent on pollination, of which 56.5% are pollinated by bees, 19% by flies, 6.5% by bats, 5% by wasps, 5% by beetles, 4% by birds, and 4% by butterflies and moths. Pollinators provide key of ecosystem services to both natural and agro-ecosystems. Positive relationships between the richness and abundance of floral resources and pollinator diversity and activity have been found at the landscape level (SteffanDewenter *et al.* 2002; Klein *et al.* 2003). Crops differ in their pollination requirements and hence their dependence on insect pollinators (Morse and Calderone, 2000). Honeybees are the principal species used for crop pollination worldwide (Free 1993). The true honeybees (Tribe *Apini*, genus *Apis*) consist of nine species i.e. *A. mellifera* Linnaeus, *A. cerana* Fabricus, *A. dorsata* Fabricus, *A. laboriosa* Smith,

*A. florea* Fabricus, *A. andreniformis* Smith, *A. koschevnikovi* Buttel-Reepen, *A. nigrocincta*, and *A. nuluensis*. Genus *Apis* primarily tropical was restricted to the Old World until *A. mellifera* was introduced worldwide. Both species, *A. cerana* and *A. mellifera* consist of medium -sized (10-11 mm) species with multiple combs in cavities, dances on vertical surfaces of combs in the dark (Michener, 2000). More than 100 agricultural crops in the United States are pollinated by bees. This means bees are important to produce nearly \$7 billion worth of agricultural crops produced annually in Arizona. Example of bee pollinated crops include Watermelon, Citrus and apple and many oil seed crops. Honeybees are the only ones that can be easily managed, moved around, and are known to exploit a wide variety of crop.

While a worker bee is in a flower gathering nectar, pollen from the anther often sticks to her hairy body. Because the bee generally visits a number of the same type of flower in a patch, she will rub some of the pollen into the stigma of another flower and complete pollination.

Honeybee pollination is so important because pollination is needed for plants to reproduce, and so many plants depends on bees. When a bee collects nectar and pollen from the stamens the male reproductive organ of the flower sticks to the hairs of her body. When she visits the next flower, some of the pollen is rubbed off into the stigma, or tip of the pistil. The female reproductive organ of the flower. When this happens, fertilization is possible and a fruit, carrying seeds can develop. Plant rely on bees and other insects to reproduce and so they have adapted, over time, to become more attractive to them. A flower's scent can have appeal to bees, and its bright colors may lure the bees. Honeybees are considered as the most effective and ideal pollinators. Honeybees (*A. mellifera*) remain the most

economically valuable pollinators of crops worldwide (Watanabe, 1994). In the US alone, the marginal increase in value attributable to honeybees—that is, the value of increased yield and quality achieved through pollination by honeybees was \$14.6 billion in 2000 (Morse and Calderone, 2000). The aim of the current review is to describe effective use of honeybees, bumblebees, and other pollinators in agriculture. The honeybees are chief pollinators of guava, which contributes to 25.70 to 41.30 per cent cross pollination (McGregor, 2009). On the other hand, there has been an alarming decline in the populations of both native and honeybees with chemical intensive agriculture implicated as the major source of threats to pollinators. On the other hand, organic farming has been remarked as the best way to conserve pollination.

### Methodology

An extensive review was done to collect pertinent data with consultation of Journal articles, proceeding, annual reports and thesis work etc. covering mainly basic part directly or indirectly supporting to management, pertinent and relevant information with conclusive outline.

### Taxonomy

<b>Kingdom</b>	–	Animalia
<b>Phylum</b>	–	Arthropoda
<b>Class</b>	–	Insecta
<b>Order</b>	–	Hymenoptera
<b>Family</b>	–	Apidae
<b>Genus</b>	–	<i>Apis</i> .
<b>Species</b>	–	<i>Mellifera</i>

Honeybee with soft hairs, greyish thorax, and dark brown abdomen. Hairless hind legs that are bordered with hairs on both sides. Mouth parts are chewing and lapping type. Antenna is geniculate. Three pairs of leg with different functions. Foreleg is for antenna cleaning; mid leg is for storing wax and hind leg is for pollen collection.

Currently used scientific name was given to honeybee by Linnaeus in 1758. Therefore, the full scientific name of Italian honeybee is *Apis mellifera* Linnaeus 1758. The first part of the Latin name '*Apis*' is genus name and the second part '*mellifera*' is species name, often Linnaeus is abbreviated as 'L' and the date is omitted.

### Importance of honeybees as pollinators

Honeybee plays an important role for cross pollination. Pollination by honeybees is also important for monoecious and dioecious plant spp. Some plants will not produce fruit without honeybee pollination. Many agricultural crops such as *Aeschynomene americana* L, *Amonum xanthiodes* Wall, *Antigonon leptopus* Hook, and *Coccinia grandis* (L.) Voigt are pollinated by honeybees. Specialty of honeybee is, they actively seek out flowers with pollen and not for nectar, unlike other pollinators such as bats and hummingbirds that primarily visit flowers for nectar.

Now-a-days Tropical bee's interest has been increased. This is because honeybees originated in Tropical Africa and spread from South Africa to Northern Europe and East into India and China (Otis, 1991). The earliest known honeybee fossil (Genus *Apis*) was found in Europe dating back 35

million years. The honeybees of the genus *Apis* are the most studied because of their fascinating and complex life style, communication system (Nieh, 1998 and Roubik, 1995), pollination of agricultural crops and valuable hive products that they produce, such as honey, royal jelly, bee wax, bee pollen, propolis and bee venom. The floral fidelity of bees is due to the preference of nectars having sugar content and pollen with higher nutritive values. They increase the agricultural productivity and also maintain biodiversity by providing valuable pollination services. (McGregor, 1976 Partap and Verma, 1994). Beekeeping for pollination has been shown to increase the crop yield and quality and reduce the fruit dropping. It has been reported that pollination by honeybees increase the fruit juice and sugar content in citrus fruits and increase the oil content in rape seed, mustard and sunflower (Partap, 1992).

### Honeybee flora

Bee flora or Bee plants are those plants from which bee collect pollen and nectar. There are three types of bee flora: Plant that only supply nectar, plant that only supply pollen and the plants that provide both nectar and pollen (Allen *et al.*, 1998).

Some plants provide resin, but these are less common. The forager's bee visits on different plant spp. To collect nectar and pollen (McGregor, 1976) including agricultural crops and native plants. The honeybees that derived from different spp. are such good native plants floral pollinators because they have morphological structures that facilitate pollen attachment, transfer, and deposition. The plant that produces nectar and pollen in higher amount in one geographic region may not yield the same amount of nectar and pollen in another region (Erdtman, 1996). Floral nectar provides energy or flight activity and other activity in the colony. Honeybees also converted the nectar into honey and store it in the honey storage area of comb. Pollen provides lipids, minerals and vitamins (Gary, 1975). Pollen from different plant spp. differs in nutritive value and attractiveness to honeybees (Barker, 1971).

### Honeybee foraging behavior

Forager bees prefer the nectar of one flower spp. Nectaries can be located in various areas of flower and some spp. have extra floral nectaries that may be visited by bees. The sugar concentration in the nectar of a given plant spp. Depend upon its location, time of day and its genotype. If nectar with high sugar concentration is available, a forager of *Apis mellifera* can carry as much as 70-80mg of nectar per load (Akranakul, 1976 and Partap, 1997). A single forager bee will visit different flowers in the morning and, if there is sufficient attraction, she will make visit to that type of flower for most of the day. After returning the hive, the foragers transfer the nectar to one or more house bees, which then dehydrate the nectar and convert into honey. They use the enzyme invertase, which split sucrose in the nectar and hold the droplet in their mouthparts (Partap, 1992 and Partap, 1997). By collecting nectar and pollen, foragers also collect plant gum and water (Fanesi *et al.*, 2009; Bankova *et al.*, 1983).

Propolis is a resinous hive product collected from various plant material by honeybee workers. In some countries, especially in Eastern Europe, Propolis has been used in folk medicine for centuries. Its chemical composition

includes flavonoids, aromatic acids, esters, ketones, fatty acid, terpenes, polysaccharides, and several other compounds (Marcucci, 1995, Bankova *et al.*, 1983).

#### There are more than 30 species of plants visited by honeybees that are:

Sl. No.	Common name	Botanical name	Flowering period	Bee food value
<b>Fruit plants</b>				
1.	Orange	<i>Citrus reticulata</i> Blanco	March to may	N2
2.	Apple	<i>Pyrus malus</i> L.	April to may	N2,P2
3.	Naspati	<i>Pyrus communis</i> L.	March to April	N1,P1
4.	Almond	<i>Prunus dulcicis</i> (Miller)	Feb. to March	N2,P2
5.	Peach	<i>Prunus persica</i> LL.	March to April	N2,P2
6.	Guava	<i>Psidium guajava</i> L.	March to April	P1
7.	Mango	<i>Mangifera indica</i> L.	Feb. to April	N3
8.	Mulberry	<i>Morus serrate</i> Roxb.	March to May	N1, P2
<b>Vegetables</b>				
1.	Radish	<i>Raphanus sativus</i> L.	Feb. to April	N1, P1
2.	Pumpkin	<i>Cucurbita maxima</i> (Duch)	July to August	N1
3.	Onion	<i>Allium cepa</i> L.	April to June	N2
<b>Oilseed crops</b>				
1.	Coriander	<i>Coriandrum sativum</i> L.	Jan. to March	N1, P1
2.	Mustard	<i>Brassica campestris</i> var.toria	December to Feb.	N1, P1
3.	Sunflower	<i>Helianthus annus</i> Lin.	May to June	N1, P1

#### Factor affecting honeybee population

The population of honeybee is declining day by day. The US has experienced combined colony losses far greater than the level considered normal by beekeepers. The continued collapse of honeybee population may threaten the success of pollination services by honeybee. There is not due to single factor (Oldroyd, 2007). It also involves Global warming, honeybee pest and diseases, pesticide, and colony collapse disorder.

#### Global warming

Global warming and climate change may affect the relationship between plants and their pollinator honeybees foraging in extreme whether condition, however the level of pollination decline, due to habitat destruction, extensive use of pesticide, pathogen, parasite and changing environmental condition.

To protect bees, farmers should avoid using pesticide and other chemicals. Beekeeper should be encouraged to use native plant species instead of exotics. They should also increase the diversity of bee flora in order to increase foraging and crop yields. By having several plant species flowering at once, and a sequence of plants flowering through spring, summer and fall, it is possible to support a range of honeybee spp. that pollinate throughout the season.

#### Pest and diseases

There are many pest and disease affecting honeybees. Among them, Varroa mites and Nosemosis are of most common to honeybee researcher and beekeepers (Fries, 2010 and Genersch, 2010). The mites are external parasite that attach themselves and feed on the developing pupae inside the colony, once the adult honeybee emerge, mature Varroa will spread to other bees. Parasitized bees that emerge develop with reduce fitness including reduced lifespan (DeJong and DeJong, 1983) and possesses deformed wings.

While preventing this mite acaricides have been used to eliminate the parasite, making their colonies susceptible to future infection (AFSSA, 2009).

*Nosema* primarily affects the digestive system of adult honeybees, resulting in malnutrition, and ultimately, host death (Malone *et al.*, 1995). It also disturbs the hypo pharyngeal gland of the host. Colonies that are known to be strong by beekeeper may experience a sudden collapse of the colony due to the inability of the queen to replace the loss of infected bees (Higes *et al.*, 2008).

#### Pesticides and chemical spraying

Pesticides are substances used to eliminate unwanted pests. Unfortunately, honeybees are insects that are greatly affected by insecticides. There are several ways honeybees can be killed by insecticides. One is direct contact of insecticides on the bee while it is foraging in the field. The bees immediately die and does not return to the hives. The main symptom of honeybee pesticide kill is large number of dead bees in front of hives. After a honeybee pesticide loss, the colony may suffer additionally from brood diseases and chilled brood. Another symptom is sudden loss of colony filled force. Exposure to pesticides may make them more susceptible to other diseases, such as *Nosema* (Alaux *et al.*, 2010).

Bee poisoned with a pesticide will contaminate nectar and pollen back at the hive, especially when bee farmers use the wrong conditions or formulations. Moreover, application of sub lethal doses of parathion causes mistakes in communicating time sense, distance and direction of feeding sites (Johanson, 1997). Imidacloprid decrease foraging rates (Young *et al.*, 2008). Thiacloprid is toxic to honeybees.

#### Colony collapse disorder (CCD)

Colony collapse is a disorder is a syndrome that is characterized by sudden loss of adult bees from the hive. Many possible explanations for CCD have been proposed, but no one primary cause has been found. The no. of managed honey bee colonies has dropped caused by combinations of many factors such as pathogens, pests, diseases, pesticides and genetically modified plants.

## Challenges of honeybee pollination

As we all know that population of honeybee is declining day by day due to application of pesticides, climate change and deforestation. Due to pesticide application problem, poor seed set of onion, the death of honeybees in the hives and abandoning of bee keeping. There are different pesticides' used by crop growers which can poison the honeybees and influence the bee health. The major pesticides are Malathion 50%, Dimethoate 40%, Diazinon 60% EC. Due to misapplication of these chemicals, honeybee mortality and causing reduction of honeybee colonies, which ultimately results in a reduction of bee products and crop yield. On the other hand, lack of awareness about the value of crop pollination is another key factor for honeybee decline.

## Conclusion

Pollination is an ecosystem services and honeybee are a valuable pollinator. It has a great adapted capacity, as it is found almost everywhere in diverse climatic condition. Honeybee pollination improves the yield of various oilseed crop, vegetables crop and fruit crop. However, use of pesticides application affect the integration of bee keeping and crops. The application of pesticides during the flowering period of target crops should be avoided and ensures the protection of honeybee health. Farmers should use ecofriendly pesticides or organic pesticides derived from plant extract and IPM practice should be promoted for control of pest in their agriculture field. However, low level understanding of the value of pollination is affecting the yield of agricultural crops. Therefore a lot has to be done on the contribution of honeybee and other insect pollinators in boosting crop yield and to solve the challenges they are facing. Awareness creation should be given to the society about the value of crop pollination and protection of honeybees and other insect pollinators from pesticide poisoning.

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