Review Article

Foraging Behavior and Pollination Ecology of Bumble Bee and Honey Bee in Pakistan; A Review

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Abstract | Bumblebee and honey bees are supreme affectionate social insects of agricultural crops. Both genus *Apis* and *Bombus* are used for the pollination of vegetables, fruits and crops commercially. Honey bee can dispense 80% in insect pollination and considered as a best pollinator towards crop pollination, Bumblebee are more efficient and competent pollinator due to their buzzing behavior, efficiency to forage at low temperature, vibration to burst the pollen sac, high speed to flower visitation at low temperature and solitary colony structure. In northern areas of Pakistan bumblebees are natural pollinators. The various products of honey bee especially honey, royal jelly and bee venom used for the treatment of various diseases like cardiac diseases, hypertension and many others problems. These are the main source of income for entomologist and agriculture graduates. There are several factors (habitat loss, landscape degradation, overuse of agrochemical, exotic species and pathogens) involved in the declining of pollinators, a big loss for the economy of Pakistan. The aim of this review paper was to check the importance of honey bee and bumblebee as chief pollinator of agriculture crops. This review indicates how declining factors are alarming for the bumblebee and honeybee.

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1. Introduction

Pollination is most effective ecosystem services for the biodiversity of plants on earth. Pollination permits the reproduction of plants, provides fruit, seeds and the leaves that consumed by human throughout the globe (Hein, 2009; Eeraerts *et al.*, 2020b). There is various source of pollination like insects, wind, air, rain, human, animals and birds (Delaplane *et al.*, 2013).

1.1 Importance of pollinators

Pollinators are key components of the global biodiversity. Pollinators belong from diverse insect orders like Diptera, Hymenoptera, Lepidoptera and Coleoptera. These can deliver a key ecosystem service of pollination, vital for the maintenance of agricultural crops and wild plant communities (Noriega *et al.*, 2018). Insect pollinators are playing an indispensable role in the pollination of food crops (Akhtar *et al.*, 2018). More than 80 percent of overall pollination activity is achieved by insects. The yields of some fruits, seeds and nut crops can also decrease by over 90% (Abrol *et al.*, 2019) in the absence of pollinators.

1.2 Importance of family Apidae in pollination services of food plants

Non-bee insects have been shown to be important

pollinators, but bee pollinators are more concern (Decourtye *et al*., 2019). The family Apidae is include bumblebees, solitary bees, stingless bees and honey bees. More than 25,000 bee species belonging to more than 4,000 genera from order Hymenoptera are pollinators of important wild and cultivated crops. Many researchers have reported that75% of main agricultural crops rely on insect pollinators for fruit set and seed development (Sgolastra *et al*., 2018).

1.3 Significance of honey bee and bumblebee as pollinators

Bumblebee and honeybee are used for pollination of natural vegetation and agricultural crops commercially. Both bees can provide maximum pollination services with high economic returns (Quigley *et al*., 2019; Nayak *et al*., 2020). Honeybee species can also play parallel role in the cross-pollination of economic crops and medicinal plants (Ahmad *et al*., 2017). Approximately 250 identified species in a single genus *Bombus* meaning 'booming' has been recognized internationally, and *Bombus* species worth 14 billion euro production of the globe. In Pakistan 61 key pollinate plants (26 fruits, 19 vegetables, 7 oilseeds, 4 grain legumes, 2 aromatic and 3 nut shrub plants) are relying on bees pollination and the production value of pollination dependent crops equates to US$ 1590 million (Irshad and Stephen, 2013).

Stephen and Irshad (2012) describe the importance of specific crop pollination in the presence of honeybee hives that is the production of mustard crops increased by 30%, production of sarsoon and toria increased by 47%, cucumber and cauliflower up to 28-32.5% and 23% respectively, clover yield increased 100 %, yield of Sunflower and radish has risen to 18.7 and 22 percent respectively and the onions seed set increased 62-93 percent in several districts of Pakistan. Number of pods, grains, seed weight and yield of various crops such as onion, sunflower and canola can increase due to insect pollination especially bee (Suhail *et al*., 2001; Munawar *et al*., 2009; Oz *et al*., 2009; Stephen and Irshad, 2012).

In Pakistan, few honeybee and bumblebee species are artificially reared under control condition due to their economic importance. European honey bee *Apis mellifera* and European Bumblebee *Bombus terrestris* are reared by many researchers due to adaptation of artificial environment (Prof. Dr. Christoph Künast (E-Sycon). Bee's pollination can assist the farmers in crop production and also aid in ecosystem worldwide. Farmers in Pakistan buy bee hives at rent for the pollination of field crops.

1.4 Comparison of pollination efficiency of honey bee and bumblebee

Honey bee is considered as the most contributing towards the crop pollination, but bumblebees are more efficient, competent pollinators because of their buzzing behavior, efficiency to forage at every climatic condition, vibration to burst the pollen sacs, sunlight, high flower visitation speed, High speed of pollination and solitary colony structure. Bumblebee is much more productive than honeybees due to their longer tongue and faster pace of foraging. Both these are suitable for both open field conditions and enclosed and protected farming systems like variety of greenhouse crops (Li *et al*., 2008; Xie *et al*., 2016; Eeraerts *et al*., 2020a).

In northern areas of Pakistan bumblebees are natural pollinators particularly in the high altitude regions of Himalaya. Apart from that, Inherent bumblebee population rely on plants species structure, flowering composition and abundance in a specific region (Sheikh *et al*., 2015).

1.5 Insects pollinated crops relay on bumblebee and honey bee pollination in Pakistan

The major source of floral plants for the bumblebee are; mary thistle, globe thistle, lesser knapweed ,wild daisy bellis, centaurea blue, sunflower, blue thistle, saw-wort, zinnia, daisy, brachychiton, dicliptera, baikhar, sichuan gold, chrysanthemum, yellow bells, cucumber, musk melon, tori , field bindweed , pink morning glory, rock rose ,persimmon, kachnar, amaltas, lupin flower, black locust, clover , gladiolus , sage ,dead-nettle white pudina ,okra ,hollyhock ,rose of sharon, sleeping beauty ,fox glove pink ,apple ,butter cup ,tomato ,brinjal , lantana and banafsha (Sheikh *et al*., 2017).

In Pakistan major crops are alfalfa, clover, almond, melon, soybean, sunflower, cucumber, mustard, apricot, cherry, peach, citrus, pear, persimmon, loquat, shain, kalongi, prune, apple, mosquite, sheesham, plum, ber, cantaloupe, okra, rape seed, carrot, onion, avocado, kiwi, acacia, cranberry blueberry in different ecological areas are most likely to require honeybee pollination (Rashid, 2019).

1.6 Factors involved in the declining of pollinators

The various factors are involved in the pollinator

declining but majors are (1) habitat loss, (2) landscape degradation, (3) overuse of agrochemicals, (4) climate change (Le Conte and Navajas, 2008), (5) air pollution (Le Conte and Navajas, 2008), (6) insect predation (Le Conte and Navajas, 2008), (7) exotic species, (8) exposure to pesticides (Le Conte and Navajas, 2008), and pathogens (Le Conte and Navajas, 2008; López-Uribe *et al.*, 2020).

1.7 Impact of rising global population on pollinators

The rising global human population is reinforcing the need for commercial crops cultivated under intensive cultivation crops such as tomatoes, peppers, cucumbers, strawberries etc. in plastic tunnels hydroponics farms, which stresses the use of such crops pollinators. These pollinators aid to improve the production of fruit, weight, size and other chemical characteristics in order to achieve cost-effective production (Hristov *et al.*, 2020).

1.8 Influence of pesticides on honey bee and honey production

Anthropogenic impacts can cause unprecedented rates of declines in wild pollinators (Ghazoul, 2005). Consequently, improper use of pesticides can caused harmful impact on the pollinators. Extensive use of pesticides leads to depletion of the population of honey bees and also to a decline in the pollination process. The poisonous chemicals are transmitted through the pollen and nectar in the honey bee hive which can kill the entire colony of honey bees (Chmiel *et al.*, 2020).

1.9 Effect of invasive species on insect pollinator

Invasive species are great challenge for the growth and survival of indigenous plants. These exotic species also attract pollinators for pollination services because of their eye-catching flowers so majority of native species are deprived from pollinators in the presence of alien species (Muñoz and Cavieres, 2008). (Cook *et al.*, 2007) predicted the impact of invasive species on ecosystem services that is the key step for the management of these alien species. They developed the bio economical model that warrant the impact of these exotic species before it arrival.

They anticipated the invasion of Varroa bee mite (*Varroa destructor*) and the negative impact it would have on pollination by reducing honey bee populations, resulting in a loss of pollination services, reduced crop yields and additional cost of production (Sajid *et al.*, 2020).

1.10 Effect of deforestation/habitat losses on insect pollinator

The clearing and splitting of natural forests worldwide is more prevalent as demand for agricultural productivity is high so require more agricultural land area, especially in tropical countries Where much of the world's biodiversity is found (Ngai *et al.*, 2008).

1.11 Impact of pollinator losses in the economy of Pakistan

In Pakistan the output of a certain crop has fallen to about 33.4% owing to the lack of pollination (Aslam *et al.*, 2004) and there will be three main categories of plants affected by decline in pollination, primarily growing the production of fruit and vegetables with estimated losses of EUR 50 billion per crop and EUR 39 billion of edible seed crops losses (Gallai *et al.*, 2009).

Pollinator populations in the Himalayas area of Pakistan are decreasing because farmers and the government are unaware of pollination advantages. In the Azad Kashmir mountain area of Pakistan, apple yield decreases every year because pollinators are absent and farmers substitute apple trees with agricultural crops (Uma and Tej, 2002). Loquat production in Peshawar decreased 64.4% due to lack of honey bee and apple yield are also decreased (Uma *et al.*, 2012).

Conclusions and Recommendations

In this review, we highlighted the importance of social bees i.e., honeybee and bumblebee as an important pollinator for the pollination of important field crops. From the comparison of both genus, we concluded that bumblebees are more competitive than honey bee because of their various characteristics. Since pollinators are crucial in food production, reductions in pollination services may create scenarios for shortages or low food diversity.

The introduction of pollinators-friendly practices such as minimizing the use of synthetic inputs or preserving and sustaining semi-natural ecosystems on farms and landscapes would have two benefits to encourage the conservation of biodiversity and to increase productivity and profitability for local farmers. Under optimum pollination conditions, there ought to as many pollinators as mandatory to meet the many and diverse pollination services required by both farmers 'crops and the natural world.

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Novelty Statement

The review study was conducted as chief pollinators honey bee and bumble bee are declining due to multiple factors habitat loss, overuse of agrochemicals, climate change and others. The main aim of this review is to adopt the pollinators friendly practices like less use of pesticides, encourage farmers to relay on natural enemies for the destruction of pests.

Author's Contribution

ZS wrote the manuscript and MR improved the article.

Conflict of interest

The authors have declared no conflict of interest.

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