Indian Journal of Agriculture and Allied Sciences
A Refereed Research Journal

ISSN 2395-1109
e-ISSN 2455-9709
Volume: 3, No.: 4, Year: 2017

www.ijaas.org.in
Received: 10.11.2017, Accepted: 20.12.2017
Publication Date: 31st December 2017

INSECT POLLINATORS; AGENTS FOR INCREASING CROP PRODUCTIVITY

Gouri Shankar Giri, M. Santhosh Kumar, Sunil Verma, Abhinav Kumar, Kalpana Bisht, Rupesh Gajbhiye and Ramesh Babu S.

Research scholar, Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi–221 005, Uttar Pradesh, E-mail: riinnku.24@gmail.com, Corresponding Author: Gouri Shankar Giri

Abstract: *Besides, making use of agronomic inputs and biotechnological approaches, the third way of increasing crop production and productivity is through management of pollination. It is an essential ecological services, provide by pollinators, helps in mitigating the problems of food production, nutritional security and biodiversity conservation. Pollinators, both biotic and abiotic, play an important role in sustaining the life in earth. Among various biotic polzlinators, which include living organism such as insects, birds, bats and others, insect pollinators play significant role in increasing food production through the process of their foraging. In the world of insects, different species of bees including honeybees, bumble-bees, stingless bees, and solitary bees are the most effective pollinators of crops. Over 25,000 species of bees are reported to pollinate over 70% of the world's cultivated crops. About 15% of the world's 100 principal crops are pollinated by manageable species of honeybees, bumble-bees, and solitary bees, while at least 80% are pollinated by other naturally occurring insect pollinators. They visit the flowers of the plants to obtain their food that is nectar and pollen and in return pollinate them. In addition to their role in pollination, provides various valuable products such as honey, bee wax, Propolis, venom etc., which play crucial role in improving nutritional status and livelihood of human beings. Besides bees, others are some species of butterflies, beetle, flies, play important role in pollination of some agriculturally important crops.*

Keywords: *Insect, Pollinator, Pollination, Crop productivity.*

Introduction: Human population continues to increase along with expectations for higher quality food and more resource-intensive production including animal agriculture and at the same time land for cultivation is decreasing day by day simultaneously. Now the major problem with us is how to increse food prodction in order to meet the incresing food demand for increasing global population. In order to feed the growing global population, now a day the most desired goal in agriculture is to get the maximum possible crop yields and better quality fruit and seeds under given inputs and ecological settings. There are two well-known methods for improving crop productivity. The first one is the use of good agronomic practices such as use of high yielding varieties, application of fertilizers and pesticides and others by which we can increase the food production. 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 [1].

The third and relatively less known method of improving crop productivity is through managing pollination of crops using friendly insects. The pollination process involves the transfer of pollen from the male part of the flower called 'anthers' to the female part called 'stigma' of the same flower (self-pollination) or another flower of the same or another plant of the same species (cross- pollination). Pollination is vital for completing the life cycle of plants and ensuring production of fruit and seed whether agricultural crops or natural vegetation or flora. This ecological process is an essential prerequisite for fertilization and fruit or seed set. If there is no pollination, there will be no fertilization, no fruits or seeds will be formed and

farmers will harvest no crop. Pollination is therefore the most crucial process in the life cycle of the plants and is essential for crop production and biodiversity conservation and helps enhance farm income and rural livelihoods [1].

The agents that help in pollination are known as pollinators. Pollinators play an important role in mitigating the problems of food security through the process of pollination, an important ecological services performed by them in the process of searching their food. They visit flowering plant in order to collect nectar and pollen, which in turn pollinate by them. Pollinators may be biotic or abiotic. Abiotic pollinators are responsible for 20% of the pollination occur worldwide and include wind (anemophilly) and water (hydrophilly) which constitute 19.6 % and 0.4 % of pollination respectively. Biotic pollinators constitute rest of the 80 % of pollination occur worldwide and includes living organisms such as insects, birds, bats etc. [2, 3]. Entomophily refers to cross pollination aided by insects

Pollination classes	**Type of insects**
• Melitophily	Bees
• Cantharophily	Beetles
• Myophily	Syrphid and Bombylid flies
• Sphigophily	Hawk moths
• Psychophily	Butterflies
• Phalaeophily	Small moths

Major Insect Pollinators and their Contribution in Agricultural Production: Insect pollinators are of major importance in today agriculture. Among insects, bees, flies, beetles, butterflies, midges, moths, wasps, and weevils are important pollinators of many of the agricultural, horticultural crops, forage crops, ornamental plants, and wild plants. View that "perhaps one-third of our total diet is dependent, directly or indirectly, upon insect pollinated crops" [4]. In the world of insects, different species of bees including honeybees, bumble-bees, stingless bees, and solitary bees are the most effective pollinators of crops. Over 25,000 species of bees are reported to pollinate over 70% of the world's cultivated crops. About 15% of the world's 100 principal crops are pollinated by manageable species of honeybees, bumble-bees, and solitary bees, while at least 80% are pollinated by other naturally occurring insect pollinators [5].

Honey Bee as a Pollinator: Bees are industrious pollinators because they have co-evolved with flowering plants over millions of years. The bees need the flowers for food, while the flower needs the bee to reproduce. Bees pollinate a third of everything we eat and play a vital role in sustaining the planet's ecosystems [6]. Out of 400 different types of plants grown for human consumption about 84% of the crops depend on bees and other insects for pollination to increase their yields and quality [7]. As a result, annual global crop pollination by bees is estimated to be worth $170bn. Honey is one of several different products that can be harvested and others are beeswax, pollen, propolis, royal jelly and bee venom that are used in various ways [8]. Beekeeping can be an important sustainable and alternative source of income in rural areas, benefiting communities living in and around forests. Most importantly beekeeping can also be a practical tool for raising the awareness of these communities on the importance of forests management and for stimulating their conservation by improving their biodiversity [9].

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. Besides getting food for the bees as a result of their visit pollinate a number of crops. There are five important species of honey bee. These are

1. The rock bee, *Apis dorsata* (Apidae).
2. The Indian hive bee, *Apis cerana indica* (Apidae).
3. The little bee, *Apis florea* (Apidae).
4. The European or Italian bee, *Apis mellifera* (Apidae).
5. Dammer bee or stingless bee, *Melipona irridipennis* (Meliporidae).

Qualities of Honeybees which make them Good Pollinators

- Body covered with hairs and has structural adaptation for carrying nectar and pollen.
- Bees do not injure the plants
- Adult and larva feed on nectar and pollen which is available in plenty
- Considered as superior pollinators, since store pollen and nectar for future use
- No diapauses is observed and needs pollen throughout the year
- Body size and proboscis length is very much suitable for many crops
- Pollinate wide variety of crops
- Forage in extreme weather conditions also

Effect of Bee Pollination on Crop

- It increases yield in terms of seed yield and fruit yield in many crops
- It improves quality of fruits and seeds
- Bee pollination increases oil content of seeds in sunflower
- Bee pollination is a must in some self-incompatible crops for seed set

Crops Benefited by Bee Pollination

- Fruits and nuts : Almond, Apple, Apricot, Peach, Strawberry, Citrus and Litchi
- Vegetable and Vegetable seed crops: Cabbage, Cauliflower, Carrot, Coriander, Cucumber, Melon, Onion, Pumpkin, Radish and Turnip.
- Oil seed crops: Sunflower, Niger, Rape seed, Mustard, Safflower, Gingelly.
- Forage seed crops: Lucerne, Clover.

Following are the example of some crops that require honey bees for pollination in order to improve yield.

1. Sunflower: It is a cross-pollinated crop. The pollen of the plant cannot fertilize ovary of same plant. In order to fertilization and seed set the source of pollen should be come from different plant. Hence, honey bee acts as important agents for pollination in sunflower. In sunflower, yield increases even up to 60 per cent due to bee pollination. It improves quality and quantity of seeds. Oil content also increases by 6.5 per cent in seeds.

2. Cucurbitaceous Vegetables: Cucurbits are monoecious with staminate and pistillate flowers in same plant. Due to bee pollination fruit set increases up to 30 to 100 per cent.

3. Alfalfa or Lucerne: These plants have tubular flowers with 5 petals joined at base. They possess one large standard petal, 2 smaller petals on sides and 2 keel petals holding staminal column. When bee sits on a keel petal, stamina column strikes against standard petal resulting in shattering of pollen. This is called tripping. Seed set occurs only if bee sits to trips the flowers.

4. Coriander: In coriander yield increases up to 87 per cent due to pollination.

5. Cardamom: It is an important commercial crop depending on bees for pollination. Here yield increases up to 21 to 37 per cent.

6. Gingelly: Another oilseed crop where bee pollination causes 25 per cent increase in yield.

7. Apple: In apple seed set occurs only if it is pollinated by bees. Fruit is formed only around the seeds. If improper seed set occurs fruit shape is lopsided resulting in decreased market value.

Percent Increase in Yield due to Bee Pollination

Mustard - 43%
Sunflower - 32 - 48%
Cotton - 17 - 19%
Lucerne - 112%
Onion - 93%
Apple - 44%
Cardamom - 21-37%

Bumble Bee as a Pollinators: Natural pollination using bumblebees (*Bombus impatiens*) is an effective way of increasing profits and reducing labor costs. Bumblebees can increase crop production through more efficient pollination. Many crops are well suited to natural pollination with bumblebees, including cucumbers, peppers, tomatoes, vegetables, seed crops, strawberries, blueberries, cane berries, melons, and squash. Bumble bees are considered as more efficient in pollination as compared to honey bee because of the following reason.

- Bumblebees are active at temperatures near 40°F (5°C), honeybees become active at temperatures near 60-65°F (15-18°C).
- Bumblebees are active on cloudy, foggy, and rainy days. Honeybees are less active at low light levels.
- Bumblebees will fly in winds of up to 40mph (64km/hr).
- Bumblebees pollinate flowers through a method called “buzz pollination”, a rapid vibrating motion which releases large amounts of pollen onto the bee. In most situations, “buzz pollination” will allow a bumblebee to pollinate a flower in a single visit. A honeybee typically needs to visit a flower between 7-10 times before it is fully pollinated.
- Bumblebees lack the sophisticated communication system of honeybees, and are less likely to leave your crop for more attractive flowers.
- Unlike honeybees, bumblebees are attracted to flowers with narrow corolla tubes, such as blueberries and cranberries.
- Bumblebees are much more efficient pollinators than honeybees. They mainly forage for pollen rather than nectar, and transfer more pollen to the pistils with each visit.
- Bumblebees promote higher rates of cross-pollination, as they forage between plants more randomly than honeybees.
- Bumblebees visit many more blooms per minute than honeybees.

- Bumblebees work earlier in the morning and later into the evening hours.
- Bumblebees work better in tunnels, as they have a better sense of direction.
- Bumblebees are safer for us and our employees. Bumblebees are non-swarming and much less aggressive than honeybees.
- Bumblebees can be used in conjunction with honeybees to enhance pollination.

Hoverflies as a Pollinator, *Syrphus* sp. (Syrphidae:Diptera): Hoverflies, sometimes called flower flies, or syrphid flies, make up the insect family Syrphidae. They are often seen hovering or nectaring at flowers and the adults of many species feed mainly on nectar and pollen, while the larvae (maggots) eat a wide range of foods. Hoverflies are important pollinators of flowering plants in a variety of ecosystems worldwide (Larson et al, 2001). Syrphid flies are frequent flower visitors to a wide range of wild plants, as well as agricultural crops, and are often considered the second-most important group of pollinators after wild bees. Although hoverflies are often considered mainly nonselective pollinators, some hoverflies species are highly selective and carry pollen from one plant species for e.g. *Cheilosia albitarsis* is thought to only visit *Ranunculus repens* (Haslett, 1989).

Carpenter Bee as a Pollinator, *Xylocopa* sp. (Xylocopinae:Anthophoridae): Carpenter bees are robust dark bluish bees with hairy body and are important pollinators in native plant communities, gardens, and in some crops. As they visit flowers and feed on nectar, they pick up and transfer pollen. Insect pollinators such as honey bees contribute a value of around $29 billion to our agricultural industry with about 15 percent of this value coming from native bees like the carpenter bees (Long, 2012).

Fig Wasp as a Pollinator, *Blastophaga psenes* (Agaonitae:Hymenoptera): Fig is pollinated by fig wasp only. There is no other mode of pollination. Figs and fig wasps have a special relationship that is essential to their mutual survival. The fig provides a home for the wasp and the wasp provides the pollen that the fruit needs to ripen. There are two types of fig capri fig and symrna fig.

(i) Capri Fig: It is a wild type of fig and is not edible. It has both male and female flowers and is produced pollen in plenty amount. It is the natural host of fig wasp.

(ii) Smyrna Fig: It is the cultivated type of fig and is edible. It has only female flowers and do not produce pollen, hence require pollen from male flower which is providing by fig wasp. It is not the natural host of fig wasp.

In fig wasp, males are wingless and present in capri fig whereas females are winged. Female wasp lays eggs in capri fig, larvae develops in galls in the base of the flowers. Male mates with female even when the female is inside gall. Mated female wasp emerges out of flower (capri fig) with lot of pollen dusted around its body. The female fig wasp enters smyrna fig with lot of pollen and deposits it on the stigma But it cannot oviposit in the ovary of symrna fig which is deep seated It again moves to capri fig for egg laying. In this process smyrna fig is pollinated caprifig will be planted next to smyrna fig to aid in pollination.

Oil Palm Pollinating Weevil as a Pollinator, Elacidobins kamerunicus (Curculionidae: Coleoptera): Oil palm, *Elaies guineensis* is one of the most extensively cultivated plantation crops in many parts of the world. Its flowers are monoecious and contain both female and male flowers on one tree. Flowers of different sex bloom at different times and get pollinated all year round. Fully developed flowers emit strong anised smell, which is actually volatile organic compounds (VOCs) odour called estragole. *Elaedobius kamerunicus*, the oil palm pollinator, is a tiny weevil belonging to the order Coleoptera in the family Curculionidae, is identified as the most efficient insect pollinator of oil palm. The weevil prefers the inflorescence of oil palm for oviposition, indicating its close relationship with this species. The introduction of weevils into oil palm plantations increased fruit set and dramatically raised the yield of oil palm. The introduction of EK in Malaysia in 1981 increased pollination and fruit production from 20% to 30%. The specificity of the pollinator and lack of predators led to a great success for the palm oil industry, saving tens of million pounds on hand pollination. More or less it aid in increasing oil palm bunch weight by 35% and oil content by 20% [10].

Other Pollinators: Butterflies (*Deilaphila* spp.) and moths (*Acherontia* spp.) Ants, flies, stingless bees, beetles etc. play important role in pollination of many agricultural crops and helps in increasing the food production both in terms of quality and quantity.

Conclusion: In the era of 20th century, how to mitigate the problem of food demand in order to feed growing global population is the major problem with all of us. Pollinators are important agent in mitigating the above problems because

of they provide an important ecological service which we called pollination. One-third of everything we eat is comes from pollination. Besides, pollination of important food crop they play crucial role in biodiversity conservation and maintenance of ecological balance. Hence it is important to conserve them by making use of practices that are favourable for them. If there is no pollinators, there will be no pollination, which leads to ultimate death of entire living world.

References

1. Partap, U., & Partap, T. (1997). Managed Crop Pollination: The Missing Dimension of Mountain Agricultural Productivity. Mountain Farming Systems' Discussion Paper Series No. MFS 97/1. Kathmandu, ICIMOD.
2. Proctor, M. Yeo, P. Lack, A. (1996). The natural history of pollination. Timber Press, Portland.
3. Buchmann, S.E., Nabhan, G.P. (1996). The Forgotten Pollinators. Island Press, Washington, DC, USA, 292
4. McGregor, S. E. (1976). Insect Pollinations of Cultivated Crop Plants. US Department of Agriculture, Agriculture Handbook (p.496).
5. Nabhan, G. P. and Buchmann, S. L. (1997). Services provided by pollinators. Pages 133–150 in G. Daily, editor. Nature's services. Island Press, Washington, D.C.
6. Bradbear, Nicola. (2009). "The Value of Bees for Crop Pollination." Bees and Their Role in Forest Livelihoods. Food and Agriculture Organization, Web. 27 Aug. 2015
7. Berenbaum, H. (2007). Emotion-focused and problem-focused coping: A comparision of potentially adaptive strategies. *Cognition and Emotion*, 21(1): 95–118.
8. Global Development Solutions, L.L.C. (2009). Integrated Value Chain Analysis for Honey and Beeswax Production in Ethiopia and Prospects for Exports. The Netherlands Development Organization (SNV)
9. Yetimwork Gebremeskel Gebru, Awet Estifanos Gebre and Gebremedhn Beyene. (2016). Review on the role of honeybee in climate change mitigation and poverty alleviation. Livestock Research for Rural Development 28 (3).
10. Adaigbe, V.C., Odebiyi, J.A., Omoloye, A.A., Aisagbonhi, C.I., Iyare. (2011). *Journal of Horticulture and Forestry*. **3**, 163-166.