Scientific Innovation Magazine
ISSN : 2584-1157

Pollinators and Their Role in Okra Yield Enhancement

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Abstract

Okra (Abelmoschus esculentus) is an important vegetable crop cultivated worldwide and pollinators have an important role in creating yield and quality of this crop. However, most Okra flowers are self-pollinating but insect pollinators contribute greatly to increased fruit set, improved seed quality and higher productivity of these different pollinators, bees—especially honeybees (Apis spp.) and bumblebees (Bombus spp.)—are the most efficient of which, then come butterflies, hoverflies and beetles. These insects help in efficient transfer of pollen, so leading to good fruit development and thereby exalting the market value of the produce. Several factors influence the presence and activity of pollinators in okra fields such as habitat availability, pesticide use, climate variability and farming practices. Okra yield has negatively been affected by the widespread use of chemical pesticides and habitat destruction which has resulted to a decrease in the pollinator populations. In order to combat these challenges, pollinator friendly agricultural practices including but not limited to IPM, companion planting, and conservation of natural habitats have been proposed. As a second feature, organic farming and cultivation of floral diversity are agroecological strategies that can favor the abundance and effectiveness of pollinators in okra fields. Available studies suggest that tops bearing open field pollinators bear much higher fruit set and better seed viability than when relying on open or induced self-pollination. Pollination enhancement techniques like keeping bee colonies around okra fields and encouraging natural pollinator habitat adoption have been found increasing crop

productivity but there is lack of logistics in the farm for such activities. It is therefore vital to understand the role of pollinators in the cultivation of okra so as to come up with sustainable agricultural practices for food security that preserve the ecological balance. Okra yield enhancement through pollinators: Discloses the need for pollinators in augmenting okra yield; Looks into factors affecting pollination efficiency, and; Discusses sustainable measures towards pollinator conservation to boost crop productivity.

Introduction

A crucial process of plant reproduction which directly affects agricultural productivity is pollination. A widely cultivated vegetable with nutritional and economic significance, okra (Abelmoschus esculentus) is positively influenced by insect-mediated pollination. Okra flowers are primarily self pollinating, but research has confirmed that insect pollinators both increase fruit set and improve both seed viability, as well as total crop yield. The quantity of produce is improved by the pollination, it also affects fruit quality, which is the key factor for sustainable okra cultivation.

Okra is a poor self pollinator, however bees (particularly honey bees Apis spp. and bumble bees Bombus spp.) are the best pollinators of okra. Pollen transfer is also accomplished by other pollinators (butterflies, hoverflies and beetles). More efficient fertilization ensues as a result of the activity of these pollinators and reflects in larger and more uniform fruits with better market value. But pollinator populations are pushed by a number of threats, including habitat loss, overuse of pesticides, and climate change. Pollinator decline results in fewer but more diverse pollinator species and less abundance of pollinators, which present challenges to the agricultural productivity, and thus, the adoption of pollinator-friendly farming practices is needed. To improve pollination in okra farming, the conservation of natural pollinators, reduction of pesticide application and encouragement of agroecological techniques, including companion planting and organic farming should be practiced. Fields with actively pollinating insects have

produced greatly higher yields than those having no pollinating insects at all. Hence, in order to assure sustainable agriculture in the long run, it's important to comprehend the influence of pollinators in okra output and implement strategies toward pollinator population maintenance.

Floral Biology of Okra

A member of the Malvaceae family, okra (Abelmoschus esculentus); its floral characteristics are distinct and highly important for its reproductive success and yield. In view of this, it was considered important to understand its floral biology in order to optimize pollination strategies and result in enhanced fruit production.

1. Flower Structure and Morphology

Okra plants produce big, conspicuous, hermaphrodite flowers which are usually pale yellow with a dark purple or maroon center. The species has five broad petals that are spread out from a central column of fused stamens surrounding the pistil; they have five green sepals forming a calyx. The flowers are born solitarily and in the leaf axils all along the stem.

The reproductive structures include:

• **Androecium (Male Reproductive Organ):** A numerous stamens that are grouped in a column which have anthers that produce pollens.

Gynoecium (Female Reproductive Organ): A single pistil with a five lobed stigma and a long style ending on the ovary.

They have Nectar Glands at the base of the petals that produce nectar in order to attract pollinators.

2. Flowering and Pollination Mechanism

Blooming of okra flowers is diurnal; they open in the early morning and are receptive for only a few hours. Moreover, they exist in close proximity to the anthers and stigma such that they undergo self-pollination. Cross pollination by insects may lead to increased fruit set, better seed quality, and increased genetic diversity, however. The transfer of pollen from the anthers to the stigma accomplishes the pollination. Wind, gravity, or bees, butterflies, and beetles help this process along. Nectar attracts pollinators and these animals apparently transfer pollen inadvertently as they forage for it. However studies have shown that insect pollination is better at fertilization leading to a heavier fruit weight and seed viability.

3. Fruit and Seed Development

If the pollination is successful, the fertilized ovary becomes a long, ribbed, green capsule full of many seeds. It takes about 5-7 days for the fruit to mature, and the fruit should be harvested in time in order to ensure market quality. Such flowers are commonly unfertilized and wither without flowering into pods.

4. Factors Influencing Pollination Efficiency

Pollination success of okra is influenced by several factors.

• Environmental Conditions: Temperature, humidity, and wind influence pollen viability and pollinator activity. Also, the presence of pollinators is important: more (and different) pollinators mean more efficient transfer of pollen.

• Excessive pesticide use can deter pollinators and inhibit fertilizing the flower.

Key Pollinators of Okra

Okra (Abelmoschus esculentus) is susceptible to variation in yield and quality and requires pollination for the improvement in yield and quality. While okra is mostly a self pollinating

plant, insect pollinators contribute to a better fruit set, a viable seed, and also in general to a bigger crop. When okra flowers are visited by different insect species, in search of nectar and pollen, effective pollen transfer is established. Okra is basically pollinated by the bees, butterflies, hoverflies and the beetles.

1. Bees (Hymenoptera: Apidae)

Okra is the crop for which bees are the most efficient pollinators as their foraging, body, structure and thus the high frequency of flower visits increased the percentage of fruit set.

• **Okra's (Hibiscus esculentus) primary pollinators include honeybees (Apis spp):** in particular Apis mellifera and Apis cerana. They act as nectar and pollen collectors by transferring pollen grains from flower to flower, and thus increasing fertilization.

Bumblebees (Bombus spp.): Bumblebees are better pollinators as their body size is larger than that of honey bees, and they are effective in vibrating flowers and dislodging pollen.

• **Stingless Bees (Trigona spp.):** These social small bees also contribute to pollination mainly in the tropical regions.

2. Butterflies and Moths (Lepidoptera)

Various butterfly species (eg, the common tiger Danaus genutia and the cabbage white Pieris spp.) visit flowers of okra for nectar, or to lay eggs for the next generation. With a long proboscis, they can insert themselves deep into flower and in the process, they transfer pollen. Nocturnal moths have only a minor role in okra pollination by occasional contact of anthers and stigma.

3. Hoverflies (Diptera: Syrphidae)

Hoverflies are bees look alike and secondarily serve as pollinators. Okra flowers are visited by okra beetle for nectar and for pollen transfer, but its contribution is less important than for bees.

4. Beetles (Coleoptera)

Okra pollination is partly assisted by some beetles including the pollen beetle (Meligethes spp.). For instance, despite they are not specialized pollinators, their movement inside flowers goes into service of pollen transfer.

5. Wind and Abiotic Pollination

Although storm wind has a slight effect on pollination of okra, compared to an insect mediated one it is of little consequence.

Impact of Pollinators on Okra Yield

Okra (Abelmoschus esculentus) yield is more enhanced by the presence of pollinators that result into better fruit set, higher seed viability and increased cropping of the crop. Although okra is basically self-pollinating, cross pollination mediated by insects substantially affects fruit quality and quantity. Pollinators increase pollen transfer efficiency and fertilization, which in turn means higher economic for the farmers.

1. Increased Fruit Set and Productivity

Studies have shown that percentage of fruit set in fields with an active pollinator is higher than in fields without. Bees, in particular, are even better fertilizers by efficiently transferring pollen between flowers, propelling chances of fruit formation. In okra large scale cultivation, it is important especially, since to ensure commercial viability, the optimal fruit set is required.

2. Improvement in Fruit Size and Weight

The development of larger and heavier okra pods is due to pollinator-mediated fertilization. This is probably due to the fact that insect pollinated flowers produce well developed, elongated and uniform fruits than flowers that only goes with self-pollination. Cross pollination has been found to produce fruits on okra plants that are 30 percent heavier than plants that pollinate themselves, thereby increasing both marketability and consumer preference.

3. Enhanced Seed Viability and Germination

Good seed quality is provided by pollinators through the process of cross-pollination, which keeps the genes diverse. In insect pollinated okra flowers, the seeds have higher germination rates, better vigour and have the potential to be stored better than in self-fruit flowers. This is quite beneficial for seed producers who wish to keep up a planting material of high quality to come.

4. Role in Sustainable Crop Production

The presence of pollinators in the okra fields promotes the farming as a sustainable practice by subduing the need of artificial pollination. Natural pollination by insects is more cost effective and eco-friendly compared to the manual pollination which is labour intensive and time consuming.

5. Comparative Studies on Pollinator Influence

Open-pollinated, pollinator excluded, and hand pollinated okra plants have been field trial compared, and, as expected, open pollinated plants (those visited by pollinators) have:

• Higher fruit set (by 20-40%)

• Improved pod length and diameter

• Greater seed count per pod

Factors Affecting Pollinator Activity in Okra Fields

Various environmental, ecological as well as human induced factors influence pollinator activity in the okra (Abelmoschus esculentus) fields. Pollination is effective only if the quantity and types of pollinators are adequate, and these are determined by climatic conditions, farming practices and biotic availability of habitat. The main functions of pollination and factors affecting the efficiency of this process of okra seeds setting (pollination) are discussed in this paper.

1. Climatic and Environmental Factors

• Temperature: Bees in particular are very sensitive to temperature change. For 25–35°C, pollinators are most active within this temperature range but extreme heat or cold will reduce pollinator movement.

• High humidity levels are not efficient for pollination as pollen viability gets affected. On the other hand, very low humidity can result in pollen desiccation and hinder pollinators' ability to collect and pass on the pollen.

• Wind Speed/Rainfall: These have a disfavourable effect on pollinator activity because they make it difficult for the insects to fly and visit flowers. Pollen may also be washed away under wet conditions, decreasing its fertilization success.

2. Floral Characteristics of Okra

• Quality and Quantity of Nectar: Okra flowers are good nectar producers and the quality and quantity of their nectar influences the extent to which pollinators are attracted to them. Increased pollinator visits occur when there is higher nectar secretion.

• A floret is quite weak and opens for a short time during the morning. For this pollination to be effective, pollinators need to be active during this window.

3. Agricultural Practices and Land Use

• Pesticide and Chemical Use: Excess use of insecticides and pesticides may be bad for the pollinators as it would harm their population and activity rate in okra fields.

• Large scale monoculture leaves few foraging options for the pollinators, it reduces floral diversity. Flowering cover crops can be planted or floral diversity can be maintained to attract pollinators.

• Soil and nutrient management: Poorly fertile soil decreases plant health, thereby, decreasing nectar production that pollinators visit. Floral rewards for pollinators are improved by proper fertilization.

4. Habitat Destruction and Fragmentation

• Loss of pollinator habitats due to deforestation and urbanization can result into the decrease of nesting and foraging site for pollinators.

• These pollinators also require a lack of shelter such as hedgerows, undisturbed soil patches, or artificial bee hotels to thrive.

Conclusion

Okra (Abelmoschus esculentus) production achieves higher productivity and sustainability because of pollinators. Okra can reproduce by itself but insect pollinators enhance the fruit production while improving seed preservation and raising total productivity together with fruit quality. The primary okra pollinators belong to the species Apis spp. and Bombus spp. among

the bee population whereas butterflies together with hoverflies and beetles help with pollination. The pollinators create effective fertilization by which the plants produce larger fruits that become more uniform and valuable in the market. Scientific studies show that when insects do the pollination of okra plants result in more fruits per plant and larger heavier fruit and better seed germination outcomes. The absence of pollinators leads fields to produce fewer marketable fruits while maintaining poor fruit quality. The economic gain farmers and biodiversity along with ecological stability result from successful pollination methods. The activity of pollinators in okra fields depends on a combination of environmental conditions along with features of the flowers and farming methods as well as available natural habitat space. Pollinator behavior gets affected by temperature and humidity levels and wind speed conditions but excessive pesticide application together with habitat destruction pose ongoing threats to pollinator populations. The integration of sustainable farming methods including chemical reduction efforts and the implementation of various flowering vegetation along with nesting provisions helps preserve sustainable pollinator populations. A sustainable okra cultivation depends on integrating pollinator-friendly techniques due to their essential role in production longevity. The government should stimulate farmers to adopt ecological farming methods including organic cultivation and agroforestry for improving pollinator health. The government through its extension service needs to launch public awareness campaigns about pollinator preservation and establish programs to encourage farmers using pollinator-friendly agricultural practices. The production of high-quality and abundant okra yields entirely depends on the essential role of pollinators. Food security depends heavily on environmental health alongside sustainable practices that protect pollinators and their habitats for sustainable farming and benefit both agriculture and ecosystems.

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