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Role of pollination and pollinators in vegetable production

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Abstract
Pollination plays a crucial role in crop production. It is a typical process whereby pollen is transported from anther to stigma of a flower. As a consequence fruit develops and a seed born. Pollinator is a biotic agent which transfers pollens from male to female part. 75% of the total cultivated plants grown around the world are pollinated by biotic agents. Only bees, bats and birds affect 35% of the crop production worldwide. Among them fruits and vegetables are the most benefitted items. But now-a-days the pollinator population is decreasing at a faster rate. If such scenario continues, then much of the food we eat today would not be available in the future. Therefore, is it necessary to understand and to conserve the pollinator population and their habitat to establish a healthy ecosystem.

Keywords: pollination, pollinators, vegetable crops

Introduction
Sexual reproduction is an indispensible physiological function in the whole life span of a flowering plant. It is unimaginable to think of the whole diversity without sexual reproduction. Pollination being an initial process of the sexual reproduction, it is the basis of fertilization. A flowering plant springs from a seed and grows. Given favorable conditions a bud develops and from it, a showy flower emerges. Then pollination must occur. As the flower fades a fruit with seeds is produced. With seed dispersal one of nature's most fascinating and vital cycles, plant reproduction, has run its course. It is estimated that more than 1,300 types of plants are cultivated around the world for food, beverages, medicines, condiments, spices and even fabric. Out of these, almost 75% are pollinated by animals. In fact, pollinators such as bees, birds and bats affect 35 percent of the world's crop production which increased outputs of 87 of the leading food crops worldwide and obviously within these, fruits and vegetables are the most benefited items. But now due to alteration in their food and nesting habits, habitat loss, over use of chemical pesticides, climate change, over collecting and human activity, the population of the pollinators is decreasing at an alarming rate. Therefore, conservation of pollinators and their habitat is vitally important for a sustainable agriculture.

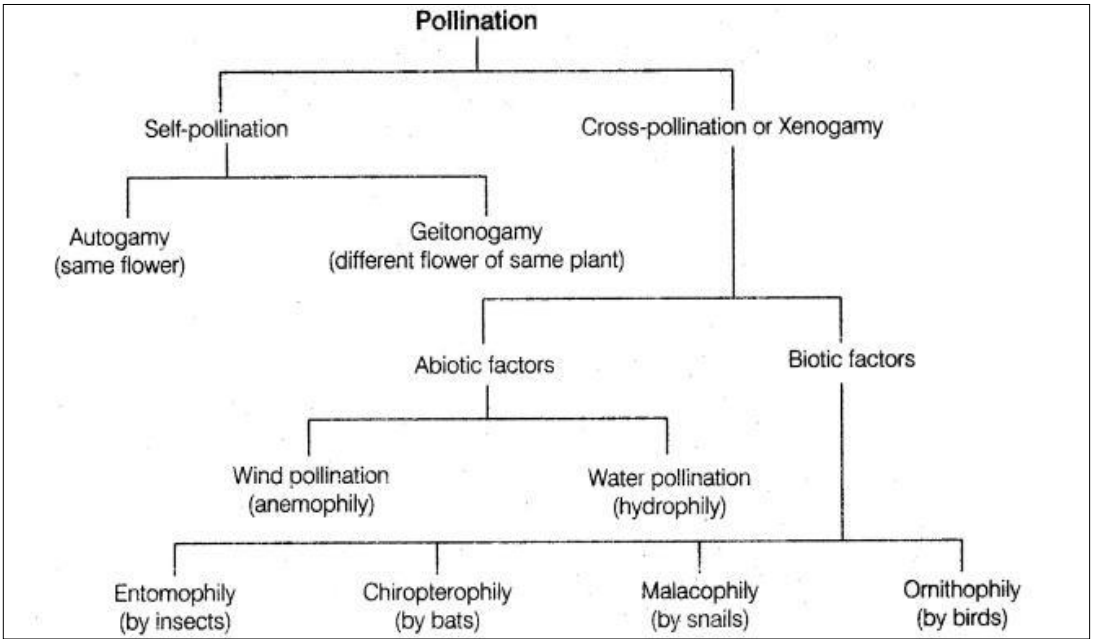
What is pollination?
Pollination is defined as the transfer of pollen grains from the anther (male structure) to the pistil (female structure) of the same plant species. Pollen can be transferred within an individual flower or between separate flowers. Successful pollination results in the production of viable seeds and a fruit to protect them.

Significance of pollination
Mode of pollination plays important role in plant breeding. It has a great impact on genetic constitution, genetic purity, transfer of gene and adaptation.

Classification of pollination
Self-pollination: pollen comes from same flower or same plant or from plants of identical genetic material. Flower must be self-fertile or self-compatible.
Ex:- Solanaceous vegetables- tomato, chilli, okra, leguminous vegetables like garden pea, beans, lettuce etc.

Cross-pollination: Pollen transferred from one flower to another. Flower must be cross-compatible.

Ex:- Members of Brassicaceae family like cabbage, cauliflower, radish, Cucurbits like melons and squashes, bulb crops like onion, garlic, tuber crops like yam etc.



Pollination

Mechanism of self pollination

- Cleistogamy: Cleistogamy is a condition when the pollination occurs in the closed flowers or when the flower never opens even after pollination. Ex:- cow pea, lettuce. (Lal *et al.*,2017)
- Chasmogamy: Chasmogamy is a condition where flower opens only after pollination. Ex-tomato
- Position of anthers in relation to stigma. Ex- tomato, brinjal
- Masking effect of other floral organ. Ex- pea and beans.

Mechanisms of cross pollination

Sl. No	Mechanism		Examples of vegetables
1	Dicliny or Unisexuality.	Monoecy Dioecy	Annual cucurbits, Cassava Spinach, Perennial Cucurbits, Asparagus
2	Dichogamy	Protoandry Protogyny	Onion Cauliflower
3	Self incompatibility	Sporophytic Gametophytic	Brassicas Radish
4	Male sterility	Cytoplasmic genetic	Onion
5	Heterostyly	-	Brinjal
6	Combination	Protogyny and SI	cauliflower

Role of pollination in vegetable production

Breaks incompatibity

- Incompatibility breaker. Helps to break the incompatibility in plants with male sterility or self incompatibility.
- Stimulate germination of pollen on stigmas of flowers.
- Increase fruit set and reduces fruit drop.
- Production of Hybrids**.**

Yield and quality

- Increases the seed yield in plants.
- Increase in fruit yield.
- Quality enhancement.

Income generation and livelihood

- Serves as a source of income generation.
- Maintains ecosystem diversity.

Pollination Increasing the Fruit Yield: (Das *et al*., 2017)

Vegetable	Increase in fruit yield
Cabbage	9-135
Carrot	22-100
Onion	100-300
Radish	354-987
Turnip	100-125
Brinjal	25-150

Problems of poor pollination

Sl. No.	Crop	Pollination problem
1	Cucumber	Mis-shaped fruit, poor seed set
2	muskmelon	Crinkled fruit
3	Brinjal	Flower drop
4	Chilli	Flower and fruit drop
5	Pumpkin and other cucurbits	Reduction in yield

Pollinator

A pollinator is the biotic agent, animals or vector which moves pollen from the anthers of a flower to the stigma of another or same flower to accomplish fertilization. Das *et al*., (2017).

Types of pollinator

Biotic pollinator: insect, bat, snail
Abiotic pollinator: wind, water

List of insect Pollinators in different vegetables:- Das *et al*., (2017)

Crops	Insect pollinators
Tomato	Honey bees, Wild bees, bumble bees (*Examalopsis glubosa*), wild solitary bees (*Anthophora urbana*)
Water Melon	Honey bee, wildbees (*Peponapsis* spp. and *Zenoglossa* spp), cucumber beetles (*Diabrotica* spp.), scarab beetles, meloid beetles, flies and moths.
Pumpkin and Squash	Honey bees.
Brinjal	Bumble bees, carpenter bees and honey bees.
Cole Crops	Honey Bee, Wild Bee and Flies
Okra	Honey Bees and Bumble Bees
Cow Pea, Beans	Bumble Bees
Beans	Bumble Bee
Onion	Flies and Honey Bee
Carrot & Radish	Honey Bee, Flies and Bees
	Honey bees, Wild bees, bumble bees (*Examalopsis glubosa*), wild solitary bees (*Anthophora urbana*)

Declining pollinator population

In recent years there is a world-wide decline in pollinator population and Diversity.

Factors responsible for decline of pollinators

a) Land use Change

This decline could be the decline in the habitat with the accompanying decrease in their food (nectar and pollen) supply as a result of decline in pristine areas, land use changes, increase in monoculture-dominated agriculture, and negative impacts of modern agricultural interventions, e.g. use of chemical fertilizers and pesticides. Earlier, farmers used to grow a variety of crops, which bloomed during different months of the year and provided food and shelter for a number of natural insect pollinators and hence the pollination problem never existed.

b) Increase in insecticide and pesticides

The insecticides have contributed to the extermination of both the diversity and abundance of pollinating insects. Example:- *Varroa destructor*, Asian hornet

c) Climate change

Changes in climate might also be affecting insect numbers. Studies conducted at International Centre for Integrated Mountain Development show a decline in the indigenous bee populations in their natural habitat. The main reasons for this appear to be habitat change, which is reducing the availability of forage and nesting places; ongoing expansion of monoculture, which is reducing the diversity of forage resources; extensive use of pesticides; competition from the exotic *A. mellifera*; insufficient focus and capacity of national institutions; and changing economic and social landscape. The loss of indigenous bees has adversely affected the livelihoods of poor mountain communities who used to earn money from beekeeping and honey hunting, and it also poses a serious threat to agricultural production and maintenance of biodiversity in many parts of the region. The decline in pollinator population and diversity presents a serious threat to agricultural production, and conservation and maintenance of biodiversity in many parts of the world. In this regard, the decline in natural insect pollinators can be considered as decreasing crop yields and quality despite necessary agronomic inputs.

d) Protection of Pollinators

- Read and follow labels before using the insectides and pesticides.
- Avoid Seeds Treated with Neonicotinoids.
- Avoid Treatment in the areas where pollinators visit frequently and at active foraging hour.

Strategy to increase pollination

- An adequate population of bees should be maintained to insure pollination.
- Conservation and management of the pollinators through commercial bee keeping.
- Proper selection of insecticides for treating other pests is important to minimize adverse effects on the pollinators.
- Enhancement of skill through training and extension.
- Creation of Awareness of commercial bee keeping.

Conclusion

Pollination is an important ecological survival function. It is essential for reproducing and producing enough seeds for dispersal and propagation. Pollinators are the agents of pollination. Decline in the population of pollinator poses a threat to global agriculture. Much of the food we eat would not exist without pollinators. Therefore, it is utmost essential to take a positive step towards pollinator conservation.

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