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Role of Pollinizers for Optimizing Pollination Efficiency In Temperate Fruits Production

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Abstract

Fruit production is one of the most important diversification options for sustainable agriculture. Although India ranks second in fruit production at the global level but still the productivity per unit area is quite low compared to many developed countries. The causes of low productivity of temperate fruits are many and their magnitude varies from one location to another. Inadequate pollinators and fruit drop among various other factors are serious constraints and shall remain as one of the most critical and complex problem in fruit production. Pollination means transfer of viable pollen from mature anther to receptive stigma. Flowers are fully dependent on vector to move pollen. These vectors may be wind, water, birds, butterflies, bats and other animals that visit flowers. An abundance of pollinators sets a greater proportion of early flowers, results in an earlier and more uniform crop with higher quantity as well as quality of fruits. Failure or deficiency at any stage can result in crop reduction or total loss. The failure to set fruits may be attributed to unfruitfulness. This unfruitfulness is one of the serious problems of orcharding and its causes need to be understood properly for affecting control and obtaining acceptable production level. The causes to this problem are described under the following heads.

Keywords: Flowering Pollination, Pollen, Productivity, Temperate fruits,

EFFECT OF INADEQUATE POLLINATION

It is one of the major causes of reduced productivity. The transfer of pollen from the anther to the stigma of the same flower (autogamy) or from one flower to another on the same plant (Geitonogamy) constitutes the process of pollination. Any hindrance in the process of pollinators to fertilization will result in crop reduction on total loss due to failure of fruit set. This failure to set fruits may be due to unfruitfulness which is a serious problem in temperate fruits. It is, in cross pollinated crops that the phenomenon of pollination has serious implications especially due to monoecious, dioecious dichogamous nature of the plant necessitating cross pollination. However, fruit crops like apple, pears, cherries, almond etc. which have perfect flowers have cultivars which

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are self-incompatible and even cross incompatible. These all require cross-pollination for a normal fruit set. Among the major temperate fruits like apple and pear the most important cause of low productivity in India is often the lack of adequate and appropriate cross pollination. It has been observed that during certain years of general crops failure, there are some orchards which always carried full crop load only because of proper provision of cross pollination. The inclement weather conditions during such years of low productivity do not seem to affect such orchards. Most of the commercial cultivars of apple like Starking Delicious, Red Delicious and Rich-a-Red are self-incompatible as well as cross-incompatible with each other but will set a normal crop if crossed with pollinizing varieties like Golden Delicious, Red Gold, Tydeman's Early Worcester, Granny Smith, Winter Banana, Summer Queen etc. Flower structure peculiarities of some cultivars pose a serious problem in cross pollination. The upright position of stamens in delicious apple, combined with the spreading of petals permit the bees to extract nectar without touching the anthers.

CAUSES OF INADEQUATE POLLINATION:

The causes of inadequate pollination in temperate fruits may be due to the following reasons.

a) Insufficient proportion of pollinizer plants

It has been observed that most of the apple orchards do not have proper proportion of pollinizer as result of poor fruit set. The proportion of pollinizer should be around 15 per cent and upto 30 per cent under marginal areas.

b) Non synchronization of pollinizers

In certain years the flowerings of pollinizers do not coincide with the main variety and affects pollinators. It is therefore advisable to plant at least two pollinizing varieties which has similar flowering period for effective pollinators.

c) Alternate bearing behavior of pollinizers

Golden Delicious is an old and traditional variety used as a pollinizer in all the apple growing regions of the country. However, it has the tendency to bear in alternate years thus necessitating the provision for additional pollinizer or regulation of flowering through fruit thinning.

d) Faulty placement of pollinizer in the field

Placement of pollinizer is an important step in fruit production of temperate fruits. The number and placement of pollinizers required for best pollination is largely determined by the foraging habit of bees. It has been reported that about 80 per cent bees tend to work down tree rows whereas, 16 per cent work across the rows and many work on 2 or 3 adjacent trees in a single foraging trip. It is therefore desirable to provide a source of pollen grain within each rows in more dense plantings. The pollinizer trees should be distributed so as to cover the maximum trees

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of the main variety in the orchard. Several planting plans are in use for apple which provides 11, 15, 20 and 33 per cent pollinizers. Having every other tree in each row a pollinizer tree, it ensures maximum pollination but this plan is practical if there is a market value of pollinizer variety (e.g. Gale Gala and Redlum Gala can be considered as commercial varieties in context to India because of Red colour and sweet fruits).

The standard plan of planting every third tree in every third row, a pollinizer is effective because every tree is adjacent to a pollinizer in a diagonal planting. The flowers on the side of the trees adjacent to pollinizer usually set more fruit than those on the opposite sides. The planting plan for pollinizers is as under:

O	O	O	O
O	X	O	X
O	O	O	O
O	X	O	X
O	O	O	O
O	X	O	X
O	O	O	O
O	X	O	X
O	O	O	O
O	X	O	X

25% pollinizer
(Every second plant in second row is a pollinizer)

O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X
O	X	O	O	X

33% pollinizers
(Every third row is a pollinizer variety)

e) Lack of pollinators due to inclement weather conditions

Inclement weather conditions adversely affect the pollinators in a particular locality. Several pollinators have been reported to visit apple flowers including bumble bees. Most surveys have shown that honey bees form a high percentage (88%) of insects visiting apple flowers. Once, the bumble bees were considered to be efficient pollinators because of their large hairy bodies and their ability to work at lower temperature. Their number has drastically reduced due to indiscriminate use of pesticides and loss of appropriate nesting habitat.

Honey bees foraging is affected by weather condition. The foraging activity increases with increase in temperature upto 38°C. The optimum temperature being around 19°C. Their activity

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is restricted during insufficient light even if temperature is favourable. On any cloudy day the bees prefer to stay near the hive.

f) Biotic and Abiotic factors

Various biotic and abiotic factors are responsible for pollination and fertilization. Temperature, rainfall and wind are the major factors which favour or prevent pollination and fruit setting. Temperature above 32ºC is deleterious to pollination because of desiccation of stigmatic surface. Warm temperature above 20ºC during bloom is important for bee activity and their activity is affected below 10ºC. Pollen of most deciduous fruits like plum, cherry, apple and pear germinates freely at temperature of 10ºC and is inhibited below 5ºC. Rain at blossoming is recognized as one of the most important factors limiting the set of fruit. Rain, cold and wind that usually accompany it at flowering cause the loss of more fruit than any other climatal agencies.

i. The damage is done in several ways. The most obvious injury is the washing of the pollen from the anther.
ii. The secretion on the stigmas also is often washed away or becomes so diluted that the pollen does not germinate.

Wind: The average fruit grower regards wind as one of the most important agents in the transfer of pollen from stamen to stigma. Many plants such as walnuts, pecans, hazels, pistachio etc. are wind pollinated and a reasonable amount of wind at blossoming is a distinct aid in securing a good set of fruit. However, majority of the deciduous fruits are insect pollinated since bees and other pollen carrying insects work most effectively in a still atmosphere and in a strong wind may refuse to work.

Characteristics Pollinizers in commercial fruit production

Since most of the commercial cultivars of apple are self unfruitful adequate number of pollinizing cultivars must be planted in the orchard. A pollinizing variety should have the following characters.

1. An abundance of viable pollen
2. Pollen needs to be in harmony with the primary cultivar.
3. Flowering need to coincide with the primary cultivar's blooming period and also consistent and abundant carrier
4. The blooming season of the profuse flowering should coincide with the main cultivar's flowering period.
5. Need to conceive at the same age as the primary cultivar
6. Must be devoid of illness, vermin, and insects.
7. Well-suited to the agro-climatic zone, where the principal cultivar thrives.

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POLLINATION STATUS IN FRUIT PLANTS:

Almond: Most of the commercial cultivars of almond are self-unfruitful and many even cross unfruitful e.g. Non-Pareil, Texas (Mission) 1xL, Drake, California paper shell, Ne Plus ultra etc. All these varieties are required to be planted in combination of 3-4 all to ensure cross pollination. However, some hard-shelled varieties like Tuono, Ferragnes, Laurrane etc. are self-fruitful. Unlike apple, peach, plums and apricot over setting in almond is not an undesirable feature.

Avocado: Although it is a subtropical fruit but can be grown successfully under the mid hill conditions of Himachal Pradesh. The unique flowering behaviour of avocado promotes cross pollination and is desirable to plant 2-3 varieties with similar flowering period.

Cherry: Almost all varieties of sweet cherries are self-incompatible and many others are cross incompatible too. These fall in 8 or more cross incompatible groups and varieties within each group are cross incompatible. A number of self-fruitful cultivars have been developed through breeding. These include Stella, Compact Stella Lapins etc.

Hazelnut: Pollination in hazelnut is a bit complicated one. Although it is a monoecious tree but the flowering does not coincide with the dehiscence of anthers. It is therefore advisable to plant at least two different varieties which are known to pollinate each other. Our experience with the crop is that the catkins do not actually dehisce rather get shrivelled due to low temperature prevailing during December-January which is the time for flowering. The female flowers with thread like red stigmas remain un-pollinated as pollen is not available due to shrinkage of the catkins.

Kiwi fruit: It is a dioecious plant and requires provision of a male plant in the ratio of 1:9. Although being a dioecious crop, number of staminate vines has been observed to bear fruit on one or more canes. Such canes arise usually from adventitious bud mutations in internodal regions. Flowers on these canes are identical to the staminate flowers, except that one or more fertile carpals are present in the ovary with functional stigma-style. Fruit that develops from mutant flowers rarely weigh more than 40 g at harvest and are usually pointed in shape. No cultivar has yet been developed from these hermaphrodite flowers/ vines.

Pecan: It is also a monoecious tree and requires a pollinizing variety for commercial production.

Walnut: Monoecious tree and requires planting of 2-3 varieties in a block for effective pollination.

Pear: Like apple, adequate pollination is necessary to obtain good yield. Williams and Conference are good pollinizers for many cultivars. Therefore, it is suggested to plant two or more varieties which have overlapping flowering period. The commercial cultivars like Bartlett,

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Red Bartlett, Max Red Bartlett, Starkrimson and William's Bon Chretien fall under the category of mid-season varieties and have similar flowering period.

Pistachio: A dioecious plant suitable for dry temperature regions. The most common planting combination is of kerman (Female) with peters (Male) in the ratio of 9:1.

Temporary aids to pollination

1. **Top working of pollinizers:** Almost all the pollinizing varieties used for top working overgrow and exhaust the main variety but a newly released bud sport of Red Gold under the name Satai Gold is an excellent substitute because of its uniform growth, longer duration of flowering and good pollen viability. (vars used for top working are Red Gold, Golden Spur, Golden Delicious etc.). Besides, crab apples like Snow Draft, Manchurian, and Golden Hornet are good pollinizers. Red Flesh is very early bloom.

2. **Bouquets:** Flowering branches of the pollinizer variety are placed in bottles with water and hung throughout the orchard. The bouquets should consist of large branches with dehiscing and unopened flowers.

3. **Pollen Dispenser:** A semi artificial method of cross pollination involves pollen dispenser designed to force honey bees to pass through prepared pollen as they leave the hive (Townsend 1958). The pollen is collected by picking blossoms at ballon stage. These can also be put in small trays at the entrance of the beehive. The pollen gets stuck to one legs of the bees leaving the colony and thus helps in the transfer of pollen to the other cultivars.

Conclusions: Use of good pollinizer at a proper proportion aid production of good quality and high yield. Pollination is also one of the factors limiting crop productivity. Problems related to pollination need attention in the early stages for better production and quality. The preferable solution to this problem is to promote planting of appropriate ratio of pollinizer varieties and honey bees for pollination.

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