SELF INCOMPATIBILITY

[Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination.]

Sexual incompatibility

If a pistil, carrying functional female gametes, fails to set seeds after pollination with viable and fertile pollens, the two are called incompatible. This phenomenon is called as **sexual incompatibility**.

Inter-specific Incompatibility Between individuals of **different species**

Intra-specific Incompatibility Between individuals of the **same species**

Self-incompatibility is a condition where pollen is not able to fertilize the same flower or other flowers on the same plant due to inhibition of the growth of the pollen tube in the stigma and style, thereby preventing delivery of male gametes to the ovules. The absence of fusion of male and female gamete leads to no seed formation in these plants.

Self-incompatibility systems may be classified into two basic types:

heteromorphic and homomorphic.

1. Heteromorphic incompatibility.

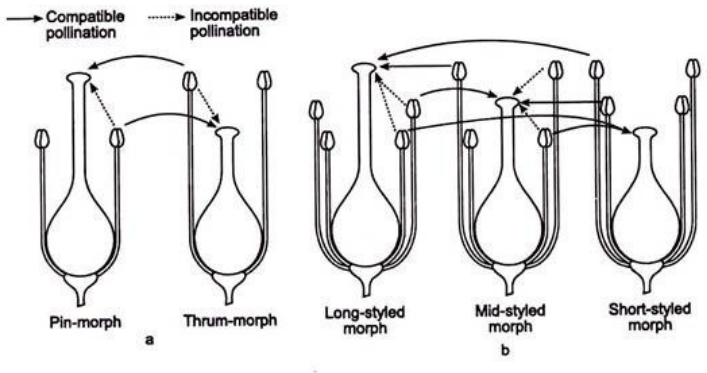

Fig.6.9 : Heteromorphic Incompatibility. a–Dimorphic system; b–Trimorphic system (diagrammatic, *after* Shivanna, 1982).

This is caused by differences in the lengths of stamens and style (called heterostyly). In Heteromorphic System, flowers of different incompatibility groups have

different morphology. For example, relative length of styles and stamens in the flowers of the same species, e.g. Distyly (Primula species) and Tristyly (Oenothera) has been reported as Heteromorphic Systems. In one flower type called the pin, the styles are long while the anthers are short. In the other flower type, thrum, the reverse is true (e.g., in Primula). The pin trait is conditioned by the genotype ss while thrum is conditioned by the genotype Ss. A cross of pin (ss) × pin (ss) as well as thrum (Ss) × thrum (Ss) are incompatible. However, pin (ss) × thrum (Ss) or vice versa, is compatible. The condition described is distyly because of the two different types of style length of the flowers. In Lythrum three different relative positions occur (called tristyly).

2. Homomorphic

In the Homomorphic System, incompatibility is not associated with morphological differences among flowers. The incompatibility reaction of pollen may be controlled by:

1. The genotype of the sporophyte (the plant on which it is produced) → Sporophytic control

2. The own genotype of male gamete/pollen grain → Gametophytic control.

In Homomorphic flowers, all flowers have exactly the same structure. Avoidance of self-fertilization depends on genetic/biochemical mechanisms. There are two quite different types of self-incompatibility- **Sporophytic self-incompatibility (SSI)** and **Gametophytic self-incompatibility (GSI)**.

Gametophytic self-incompatibility (GSI)

- In this type of incompatibility, pollen is binucleate and pollen behaviour is determined by the S allele present in each pollen and stigma is wet type.
- It means the incompatibility reaction of pollen is determined by its own genotypes, and not by the genotype of the plant on which it is produced.

- Generally, incompatibility reaction is determined by a single gene having multiple alleles. Sometimes, polyploidy may lead to the loss of incompatibility due to a competition between the two S alleles present in diploid pollen.
- Important examples are pineapple, loquat, apple, pear, plum, cherry, almond, apricot, some citrus and members of Solanaceae family.

Sporophytic self-incompatibility (SSI)

- The incompatibility reaction of pollen is governed by the genotype of plant on which the pollen is produced and not by the genotype of the pollen.
- It means the incompatibility is imposed by the maternal genotype, due to that all the pollen grains from a given plant behave similarly.
- Incompatibility occurs at the stigmatic surface resulting in the inhibition of pollen germination. Pollens are trinucleate and the stigmatic surface is dry e.g. *Mangifera indica*.

How to overcome self-incompatibility

There are many methods to overcome self-incompatibility

Bud pollination:

It is the most successful method to overcome self-incompatibility.

Irradiation:

X-ray irradiation of flower buds at pollen mother cell stage helps to overcome self-incompatibility. Actually, irradiation damages the physiological mechanism of self-incompatibility in the style.

Surgical method:

Removal of stigmatic surface /whole or part of the stigma or style to remove self-incompatibility.

High temperature:

Around 60°C temperature is needed to remove self-incompatibility.

In Vitro pollination:

This method is caused by removing the stigmatic, stylar and ovary wall tissues are directly dusted with pollen grains and then cultured in a suitable nutrient medium that supported both the germination of pollen and the development of fertilized ovules.

Mixed pollination:

This is achieved by pollinating the stigma with a mixture of chemically or irradiated treated compatible pollen, and live incompatible pollen. So, recognition pollen may also supply growth substances to cause germination of incompatible pollen and this process helps to remove self-incompatibility.

Application of chemicals:

Treatment of pistil with different chemicals including growth hormone have been recorded to be effective in overcoming self-incompatibility the treatment of *Brassica oleracea* stigma with hexane before pollination was found to be effective in fruit set.

Grafting:

Grafting of a branch onto another branch of the same plant or of another plant is reported to reduce the degree of self-incompatibility in Trifolium pratense.

Stub-pollination:

In some plants incompability may be restricted to the stigma or the style is too long and the pollen tube could not reach the ovary. In this case, removal of stigma and part of style before pollination may prove helpful in. overcoming incompatibility.

Significance of Self-Incompatibility:

Self-incompatibility is by far the most efficient outbreeding mechanism. It has been envisaged as one of the main causes for the rapid evolution of angiosperms. In many crop plants the major limitation to exploit hybrid vigour is the lack of male sterile line, and the absence of suitable chemicals to induce effective male sterility without affecting the female fertility.

Thus, here self-incompatibility can be used effectively in producing hybrid seeds, without undergoing emasculation, nuclear or cytoplasmic sterility or restoring to gametocides. Thus it is very essential to select strictly self- incompatible lines, which will not demonstrate pseudo-compatibility under reasonably varied environmental conditions.

Besides its importance in breeding programmes, it sometimes becomes essential to overcome self-incompatibility. These include production of pure lines of the selected parents in the plant breeding programmes; maintaining hybrid characters in species which are difficult to propagate vegetatively or susceptible to viral infection; in fruit orchards self-incompatible is a rule, however, it becomes necessary to include varieties that with cross-compatible, because lack of proper weather conditions for the activity of pollinating insects may drastically reduce yield.

References

- www.biologydiscussion.com
- Takayama, S., and Isogai, A. (2005). Self-incompatibility in plants. *Annu. Rev. Plant Biol.* 56: 467–489.

[The information, including the figures, are collected from the above references and will be used solely for academic purpose.]