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Self-incompatibility: A Mechanism For Pollination Control in Plants

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Abstract

Self-incompatibility is the mechanism in which the prevention of self fertilization and inbreeding occurs. The prevention of self fertilization occurs by inhibition of the pollen germination or the pollen tube growth when pollen from same/another flower of same plant falls on the stigmatic surface. Here the pollen grains fail to germinate on the stigma of the flower producing them. If some of the pollen grains do germinate, the failure of the pollen tube to enter the stigma occurs. Sometimes, pollen tube enters the style, but before the flower drops, their growth is too slow to effect fertilization and if the fertilization is effected, the degeneration of embryo occurs at early stage. Different types of self incompatibilities are heteromorphic type and other is homomorphic types. There are several mechanisms also on molecular basis for self incompatibility in different crops.

Keywords: Self incompatibility, fertilization, homomorphic types

Introduction:

In plant breeding, mode of pollination holds important role in determining the genetic constitution, ease in pollination control, nature of gene action and after release, stability of varieties. Various mechanisms are there that encourage the cross pollination and out of these self-incompatibility (SI) holds a great significance because of its utilization in hybrid seed production. Self-incompatibility (SI) is the mechanism involves the prevention of fusion of fertile (functional) male and female gametes after self pollination. Self-incompatibility (SI) is a mechanism in which self-recognition and then rejection occur. It is first reported by Koelreuter in the middle of eighteenth century. It leads to the prevention of inbreeding depression. Inbreeding depression is the loss of vigor as a result of inbreeding. In this article, we will discuss in brief about the different self-incompatibility classifications and its molecular models.

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Classification of self-incompatibility

Lewis (1954) gave the classical classification of self-incompatibility. He classified self-incompatibility (SI) into two main groups, i.e. homomorphic and heteromorphic system. The homomorphic system is sub classified again into gametophytic and sporophytic system of incompatibility.

Heteromorphic self-incompatibility:

In this, flowers of different incompatibility groups are different in morphology. The example for this system is in Primula having two different types of flowers namely pin and thrum. Long style and short stamens describes the pin type while short styles and long stamens describes the thrum flowers. This type of situation is termed as distyly. These both pin and thrum flowers are developed on different plants. Pin and thrum flowers have the only compatible mating. Single locus s governs this character. Thrum is produced by Ss, while pin flower is produced by ss. The pin flowers produce the pollen grains would be all s both in genotypes and in incompatibility reaction. On the other hand, the pollen grain produced by thrum flowers would be of genotypically two types i.e. S and s, but phenotypically all of them would be S.

Homomorphic self-incompatibility:

The morphology of the flower does not have a role with incompatibility reaction. The incompatibility reaction is controlled either by genotype of the pollen (gametophytic self-incompatibility) or by genotype of the plant on which it is produced i.e., sporophytic self-incompatibility.

Gametophytic self-incompatibility:

Pollen parent is having the genetic constitution (S1 S2) produce two gametes S1and S2 and two alleles are co-dominant in female parent and expressed of both will be there. Therefore, when pollen grains having S1 or S2 genetic constitution falls on a S1 S2 female plant, both will not germinate since there is co-dominance reaction in stigma. When it falls on the S1 S3 stigma of a female plant, S2 can only germinate and results in partial incompatibility and it is completely compatible occurs when falls on a S3 S4 female.

Sporophytic self-incompatibility:

In this, pollen parent with male gametes have both S1 and S2 developed from S1 S2 will behave as S1 and also in stigma as S1. Hence, a cross in between S1 S2 x S1S2 results in

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incompatibility and S1S2 x S1S3 results in incompatibility also while S1 S2 x S3 S4 results in compatibility.

Molecular models of self-incompatibility

Molecular model of self-incompatibility in Brassicaceae:

There are two genes namely, SP11/ SCR are present, SP11 acts as a male determinant and SRK acts as a female determinant. The promoter of incompatibility reaction is SLG. SRK acts in stigma i.e. in the plasma membrane of papilla cells while in the anther tapetum, expression of SP11 occur during pollen grain maturation. In a self-incompatibility (SI) reaction, when landing of pollen grain on stigma, SP11 will tend to bind with SRK and results in auto-phosphorylation and leads to pollen tube growth prevention. But in case of a compatible reaction, activation of SP11 does not occur and therefore, germination of pollen and fertilization takes place normally.

Molecular model of self-incompatibility in Solanaceae:

In case of Solanaceae family, the male determinant is SLF/ SFB and the female determinant is SRNase. When pollen grains falls on stigmatic surface, the production of SRNase occur and then enter into the stigmatic surface. They will lead to the degradation of the RNA which encodes the enzyme for pollen tube growth and result in pollen tube death. In case of incompatible reaction, production of RNase also occurs and it enters the stigmatic surface and it will lead to formation of complex with SLF. Therefore, there is no disturbance in RNA encoding enzyme for growth of pollen tube and pollen tube growth and fertilization occurs normally.

Molecular model of self-incompatibility in Papaveraceae:

In Papaveraceae family, identification of only female determinant is there which is called as S-protein. Male determinant on the other hand is unknown. Here, S protein will tend to bind with SBP (S-protein binding protein) and results in increasing the concentration of Ca++. This will start different reaction mainly actin depolymerisation which results in pollen tube death but in compatible reaction, S protein will not tend to bind with SBP. So, there is no fluctuation in Ca++ concentration and hence results in growth of pollen tube normally.

Conclusion:

Self-incompatibility (SI) is among the most important systems used by various flowering plants for the prevention of self-fertilization and hence, generation and

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maintenance of genetic diversity occur within a species. Moreover, there are two genes present in S-locus which control self-incompatibility. The natures of genes which are responsible for self-incompatibility are multi-allelic. For determination of self-incompatibility, there are different methods which vary with the type of self-incompatibility as well as the crop. Self-incompatibility will tend to prevent self-pollination effectively. Therefore, it has great effect on the breeding approaches and also on the objectives.