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ALL ABOUT ALMONDS

ALMOND BREEDING

BREEDING FOR SELF-FERTILITY IN ALMONDS

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- This example illustrates the importance of self-incompatibility and self-fertility in the breeding of a tree crop.

Introduction

Many commercial cultivars of almond (Prunus dulcis) are self-sterile (self- incompatible) (Figure 1a and 1b). When a self-sterile cultivar is grown in a commercial orchard, polleniser varieties must also be planted to ensure fruit set. Self-fertility would therefore be very useful for almond producers.

Self-fertility occurs in peach and could be introduced into almond by breeding, but many years of backcrossing would be needed to eliminate peach characters. Graselly and Olivier (1976) discovered that some Italian almond cultivars are naturally self-fertile. These cultivars can be used as sources of self-fertility in almond breeding.

Self-incompatibility and self-compatibility

In almond, self-incompatibility is under the genetic control of a gene on chromosome 6 (Ballester et al. 1997), with at least 40 alleles (S1 to S39, and Sf) which encode glycoproteins known as S-RNases. When expressed in the style of a flower, S-RNases recognise and degrade RNA from pollen tubes that have grown from pollen grain with matching S alleles. For example, an almond cultivar with the genotype S1S2 will express S1 and S2 S-RNases, which will stop the growth of S1 and S2 pollen tubes (Figure 2) but allow other pollen tubes (S3, S4, etc.) to continue growing (Figures 2 and 3).

This type of self-incompatibility, which occurs in the Rosaceae, Solanaceae and Gramineae families, is called gametophytic self-incompatibiltiy because it relies upon recognition of the haploid genotype of the male gametophyte (pollen).

Naturally self-fertile almond trees carry a dominant Sf (self-fertility) allele, which is thought to encode a non-functional S-RNase which does not recognise its own pollen and does not degrade the pollen tube.

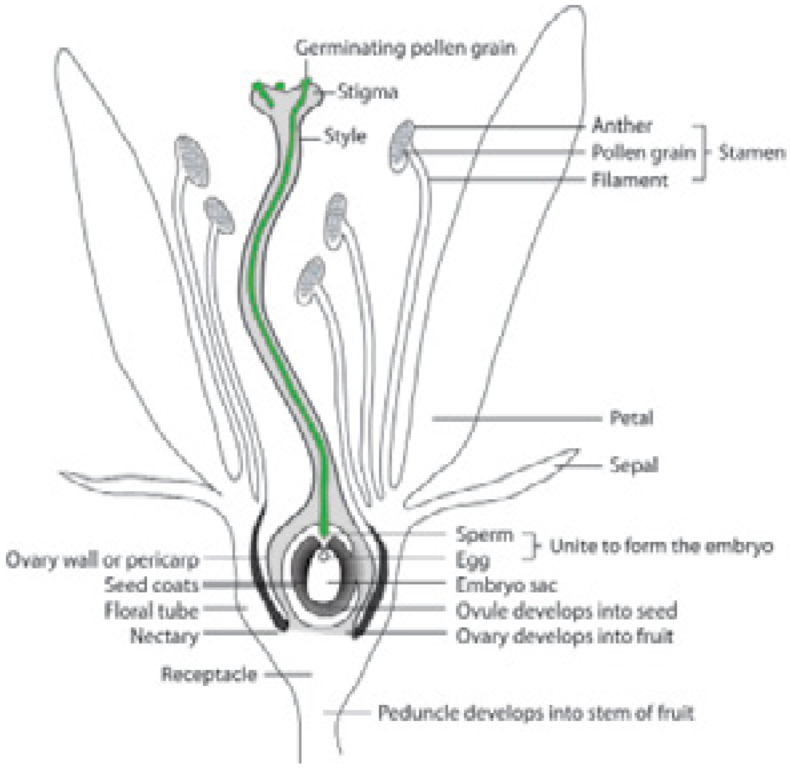

Figure 1a. Compatible pollen germinates and the pollen tube grows down to the ovule where fertilization occurs.

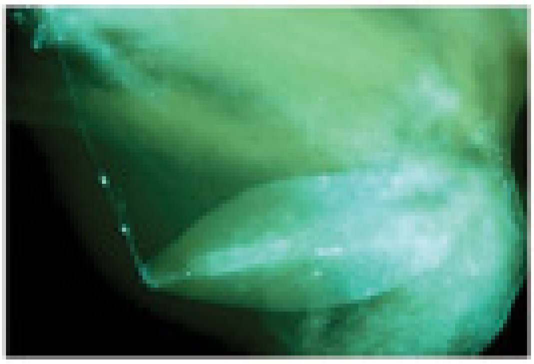

Figure 1b. Compatible pollen tube enters micropyle end of ovule.

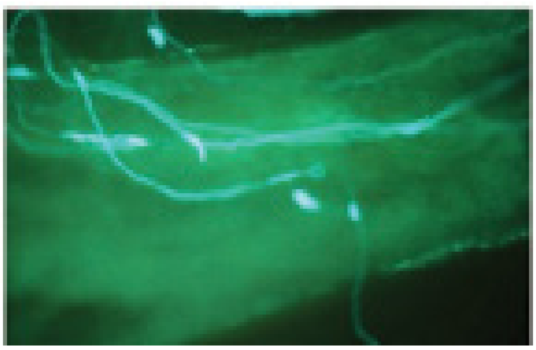

Figure 2. Pollen tubes arrested in the top one-third of the style due to S-allele incompatibility.

Self-incompatibility and self-compatibility in almond breeding

With knowledge about the S genotypes of trees, almond breeders can predict which crosses will be possible and what S genotypes can be expected among the progeny (Table 1).

The Australian Almond Breeding Program has used molecular markers based on PCR primers designed from the sequences of the introns of the S-alleles (Channuntapipat et al. 2003; Ortega et al. 2005) to identify the S-alleles of Australian cultivars. These markers have been used to confirm genotypes of imported parental cultivars and to test selected progeny. For a breeder, knowledge of which incompatibility group a tree belongs to is important. For example when pollen from an S1Sf tree is applied to the stigmas of an S1S2 tree the breeder can expect that all S1 pollen tubes will be degraded and that all progeny will be S1Sf or S2Sf and will be self-fertile.

The Australian Almond Breeding Program has used selected clones from France and Spain as sources of self-fertility. When these parents self-fertile cultivars have been released to the Australian industry: Carina, Capella, Mira and Vela. (genotypes SfS1, SfS2, SfS3, SfS8 and SfS9) are crossed with self-incompatible cultivars such as Nonpareil (an important cultivar in Australia, genotype S7S8) some progeny are self-fertile and others are self-incompatible. From these crosses, four new self-fertile cultivars have been released to the Australian industry: Carina, Capella, Mira and Vela.

Conclusion

Most almond clones will not set fruit unless pollinated by trees of different incompatibility genotypes. Accurate identification of S genotypes is useful in designing crosses and selecting progeny in breeding programs and for choosing compatible combinations for use in commercial orchards. Discovery of a naturally occurring allele for self-fertility made it possible to develop self-fertile cultivars of almond.

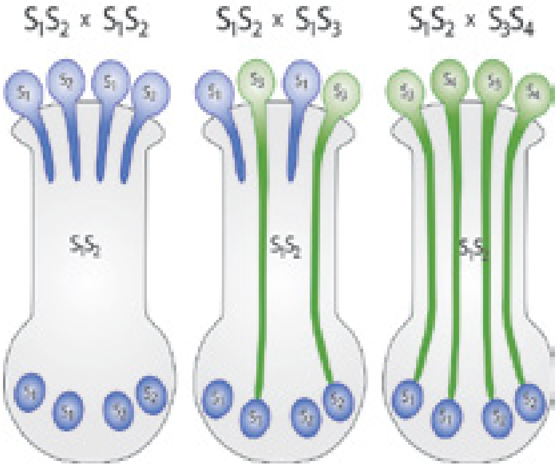

Figure 3. Gametophytic self-incompatibility system. Germination of pollen grains, which carry one of the same S-alleles as the pistil, is inhibited in the upper style.

Table 1. Expected genotypes and self-fertility status of progeny from various crosses.

Female parent	Male parent	Compatible	Progeny	Self-fertile progeny
S1S2	S1S2	No		
S1S2	S1S3	Yes	S1S2, S1S3	No
S1S2	S3S4	Yes	S1S3, S1S4, S2S3, S2S4	No
S1S2	S1Sf	Yes	S1Sf, S2Sf	100%
S1S2	S3Sf	Yes	S1S3, S2S3, S1Sf, S2Sf	50%

References

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OTHER RESOURCES

Australian Almond Breeding Program
https://bit.ly/3pxvwq6

PROJECT CODE

AL12015: Australian Almond Breeding Program

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MORE INFORMATION

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