Biscuit Cake Chocolate & Confectionery Association

BCCCA/The University of Reading

The Genetic and Physiological Basis of Self-Incompatibility in Cocoa

Investigating this complex pollination system to find ways to accelerate cocoa breeding

Many traditional cocoa varieties, such as Amelonado and Catongo, are self-compatible and will set fruit when pollinated with their own pollen or indeed pollen from closely related trees. However, many cocoa genotypes are self-incompatible and these cannot set fruit when pollinated with their own pollen or with that from certain other (generally closely related) individuals. Many of the Upper Amazon genotypes, notable for their disease resistance characteristics, are self-incompatible and care has to be taken to ensure that these are planted alongside cross-compatible types in the field to ensure that pollination problems do not lead to poor yields.

Furthermore, effective use of self-incompatible types as part of a breeding effort requires a working knowledge of their cross-compatibility. This is of great importance for many breeding applications including:

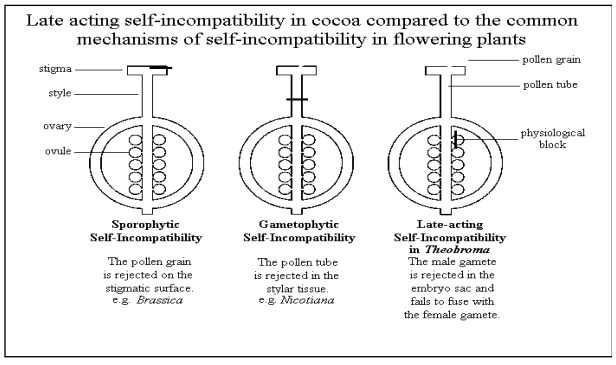
- Selection of cross-compatible parents for the production of F1 hybrids
- Production of fully inter-compatible varietal mixes to ensure on-farm biodiversity
- Generation of homozygous breeding lines

There are a large number of cross-compatibility groupings and the status of any pair of genotypes can only be determined empirically by hand-pollination. Test pollinations have to be repeated several times since the incompatibility reaction itself is subject to environmental influences and breaks down under certain (only partly characterised) conditions. The aim of this research was to develop a deeper understanding of the incompatibility system in cocoa with a view to providing the plant breeder with the information and tools needed to manipulate the system and accelerate the breeding process.

Mechanisms promoting self-incompatibility have evolved to favour outcrossing and are common in the plant kingdom. The system in cocoa is unique in a number of ways and has remained enigmatic. This research, using a combination of pollination experiments, gene homologue searches, confocal microscopy, fluorescent staining and hormone application techniques, has provided an insight in to this complex process.

It appears that incompatible pollen is not recognised at the stigmatic surface, as it is in the *Brassica* family, and the germinated pollen tube is not rejected before it reaches the ovule, as it is in the *Nicotiana* family. In cocoa, the recognition reaction seems to take place in the embryo sac since the pollen germ cell is delivered more slowly to the egg nucleus following pollination with incompatible pollen than with compatible pollen. This reaction may be effected through changes to the nuclear membranes and/or disruption to the cell division processes, thus preventing fertilisation from taking place. Experiments with auxin suggest that this plant hormone has an important role in preventing compatibly pollinated flowers from abscising though high levels of artificially applied auxin do not lead to fertilisation of incompatible types.

Future research may help to elucidate the mechanisms involved and give rise to techniques to manipulate the incompatibility system to the breeders' and, most importantly, farmers' advantage.



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Publications:

Ford, C. S. (2004). Investigations into the genetic and physiological basis of self- incompatibility in cocoa (Theobroma cacao L.). University of Reading.

Ford, C. S., & Wilkinson, M. J. (2012). Confocal observations of late-acting self-incompatibility in Theobroma cacao L. *Sexual Plant Reproduction*, *25*(3), 169–183. https://doi.org/10.1007/s00497-012-0188-1

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