Euphytica 31 (1982) 405–408

A MECHANISM FOR INHIBITING CROSS-FERTILIZATION IN PIGEONPEA (*CAJANUS CAJAN* (L.) MILLSP.)

D. E. BYTH, K. B. SAXENA[1] and E. S. WALLIS

Department of Agriculture, University of Queensland, St. Lucia 4067, Brisbane, Australia

Received 13 October 1981

INDEX WORDS

Cajanus cajan, pigeonpea, cross-fertilization, outcrossing, cleistogamy, modified flower, pure seed production.

SUMMARY

Natural out-crossing imposes considerable costs and inefficiencies in breeding, evaluation and commercialization of pigeonpea (*Cajanus cajan* (L.) MILLSP.). This note reports identification of a modification of floral morphology which inhibits cross-fertilization. Floral morphology and possible mechanisms of action of this character are discussed.

Pigeonpea (*Cajanus cajan* (L.) MILLSP.) is generally considered as a self-pollinated crop. However, considerable natural out-crossing, mainly by bees, occurs (PATHAK, 1970; ARIYANAYAGAM, 1976; GREEN et al., 1979; ONIM, 1981) and has exceeded 40 per cent in some circumstances. As a result controlled production of self-pollinated seed is necessary; by bagging for genetic testing and maintanance, and by isolation for large scale increases. Natural out-crossing thus imposes considerable costs and inefficiencies in breeding, evaluation and commercialization of this crop.

In this note, we report the identification of a modification of floral morphology (Fig. 1) which influences the incidence of cross-pollination in pigeonpea. The character was observed in cv. Royes and several other accessions at the University of Queensland, Brisbane, Australia. A modified flower of cv. Royes and a normal flower of cv. Prabhat are diagramatically compared in Fig. 2. In the normal flower the margins of standard are slightly convolute and open with only slight pressure. In contrast, the standard margins of the modified flower are strongly convolute. This expression is highly variable among genotypes and to a lesser extent within plants of a line. In some lines, the margins overlap in opposite directions at the proximal and distal regions of the calyx, and appear to act in a manner analogous to a 'zipper'.

The modified 'wrapped' flower character appears to inhibit cross-fertilization in two ways. Firstly, opening of the petals is delayed until after anthesis has occurred; secondly, although honey bees and native bees actively work wrapped flowers, they are presumably unable to do so sufficiently early in floral development to cause significant outcrossing. Other insect vectors not present at this site may work such flowers

[1] On leave from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India.

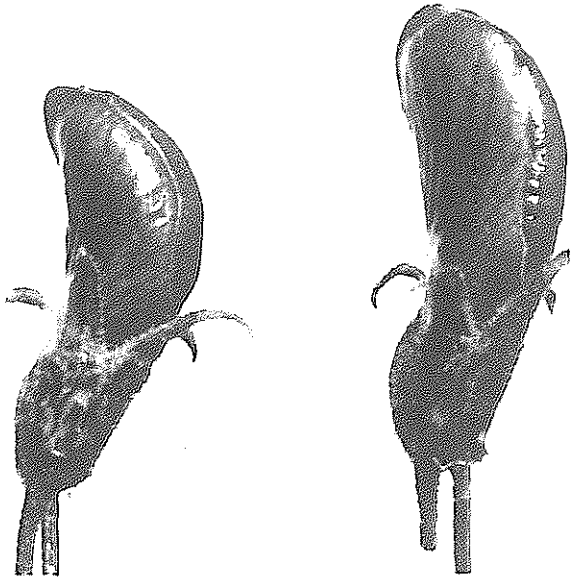

Fig. 1. Wrapped flower of pigeonpea, C322.

prior to anthesis. However, in the absence of conclusive evidence of this, we consider that wrapped flowers inhibit cross-fertilization in pigeonpea.

Most West Indian accessions, and some Indian accessions, in the Australian collection exhibit the wrapped flower character. We have recovered this character in phenological classes ranging from photoperiod insensitive to late maturing (maturity group 0-VII, GREEN et al., 1979) types. In all cases studied here, the wrapped flower is associated with large flower size, large pods with six or more locules and large seed. This is probably a genetic association. Thus the variable frequency of the wrapped flower

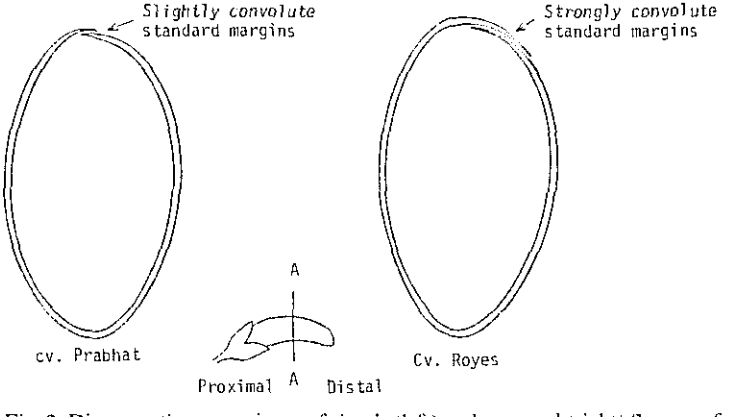

Fig. 2. Diagramatic comparisons of simple (left) and wrapped (right) flowers of pigeonpea.

character in pigeonpea internationally may reflect a correlated response to local selection for particular seed size and pod characteristics.

Unlike most Indian accessions introduced to Australia, West Indian accessions have been quite homogeneous within lines, both for original seed from the West Indies and for the seed subsequently produced by open pollination. This infers a low incidence of cross-pollination. Although ABRAMS (1975) reported an average of only 6% natural outcrossing in Puerto Rico, ARIYANAYAGAM (1976) reported 26.4% out-crossing in Trinidad. This high degree of out-crossing was attributed to the presence of a large number of pollinators, particularly the 'South American Black Bee' which forces entry into the flower before it opens and probably causes out-crossing (Ariyanayagam, pers. comm.). This insect species is not present at the Queensland University Farm. At this site, less than 2% out-crossed individuals are recovered in open-pollinated progenies of cv. Royes, which was selected from West Indian material (WALLIS et al., 1979) and has wrapped flowers. Male sterile plants with wrapped flowers set extremely few pods under open pollination. Conversely, open-pollination of small seeded, normal flowered, fertile lines results in up to 30% out-crossing and male sterile, normal flowered plants have essentially normal pod set. These results indicate that, at this site, cross-fertilization of pigeonpea is a common occurrence but is virtually prevented by the floral modification, even in the presence of large populations of honey bee (*Apis mellifera*).

Segregation in an F_2 population of cross QPL-1 × Royes indicated that the wrapped flower condition was controlled by two dominant genes. Genetic studies are continuing.

It is emphasized that considerable study of the wrapped flower character is necessary to confirm its effects on the mating system in other environments, its usefulness in breeding and seed production, its inheritance and any character associations. However, it is one of the potential methods of modifying the mating system of pigeonpea to allow the use of simpler and more rigorous breeding methods and efficient pure seed production.

ACKNOWLEDGEMENTS

This work was supported by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Dr K. B. saxena was supported by an Australian Commonwealth Special Research Grant.

REFERENCES

ABRAMS, R., 1975. Status of research on pigeonpea in Puerto Rico. Proceedings of the Int. Workshop on Grain Legumes, ICRISAT, Hyderabad, India: 141–147.

ARIYANAYAGAM, R. P., 1976. Out-crossing and isolation in pigeonpea. Tropical Grain Legume Bulletin 5: 236–240.

GREEN, J. M., D. SHARMA, K. B. SAXENA, L. J. REDDY & S. C. GUPTA, 1979. Pigeonpea breeding at ICRISAT. Paper presented to Regional Workshop on Tropical Grain Legumes, Univ. of West Indies, St. Augustine, Trinidad, 18–22 June, 1979.

KHAN, T. N., 1973. A new approach to the breeding of pigeonpea (*Cajanus cajan* (L.) MILLSP.). Formation of composites. Euphytica 22: 273–277.

ONIM, J. F. M., 1981. Pigeonpea improvement research in Kenya. In: Proceedings of the International

Workshop on Pigeonpeas, ICRISAT 15–19 December 1980, Patarcheru, A.P., India. Vol. 1: 427–436.
PATHAK, G. N., 1970. Red Gram. In: Pulse crops of India: pp. 15–33.
WALLIS, E. S., P. C. WHITEMAN & D. E. BYTH, 1979. Pigeonpea... A new crop for Queensland. Queensland Agricultural Journal 105 (6): 487–492.