A New Source of Genetic Male Sterility in Pigeonpea

E.S. Wallis, K.B. Saxena, and D.E. Byth*

Abstract

The identification of a new source of genetic male sterility in pigeonpea is reported. This source differs from that reported by Reddy et al. (1977), and cytological examination indicates that the abnormal anther development involves degeneration of the pollen mother cells at the young tetrad stage. This form of male sterility has been recovered in phenological classes ranging from 52 to 80 days to flower for December sowings at 27°S. The character is being maintained in ten phenological groups. This new source of genetic male sterility will widen the genetic base for hybrid production in pigeonpea.

Several forms and sources of genetic male sterility in pigeonpea were identified by Reddy et al. (1977). The most interesting of these forms was characterized by translucent anthers caused by nonseparation of tetrads associated with a persistent tapetum (Reddy et al. 1978). Varietal hybrids between this material and elite male parents of various maturities have exhibited up to a 30% increase in yield over the pollen parent (Green et al. 1979). Hybrid seed can be produced by cross-pollination, using bees as the vector. However, crossing blocks would require isolation, and manual identification and removal of fertile plants within sterile rows is necessary. There are prospects for commercial use of hybrid cultivars, but the labor-intensiveness of seed production may restrict this to countries with low labor costs. Procedures for more efficient hybrid seed production were discussed briefly by Byth et al. (these Proceedings).

Identification of a New Source of Male Sterility

Cultivar Royes (formerly designated UQ-50) has recently been released in Australia for mechanized production of dry seed in frost free areas of the tropics and subtropics (Wallis et al. 1979). It was derived from a West Indian accession (Q-8189) identified as "*Cajanus cajan* O.P. dwarf (4)." It is a botanically determinate cluster type of medium-late maturity, with red flowers, large pods, and large white seed. During prerelease testing

*University of Queensland, St. Lucia, Brisbane, Australia.

in 1976, it was grown at Tamworth (31 ^{o}S) by J. Holland, New South Wales Department of Agriculture. He identified an off-type plant that was earlier flowering than cv Royes (approximately 80 days) and had yellow flowers, but was otherwise very similar to cv Royes in habit. Open-pollinated seed from that plant was designated B15B. The plant was also crossed to a line of photoperiod-insensitive pigeonpea. Single-plant progenies of B15B and the cross were evaluated at Tamworth and Redland Bay for three generations.

At Redland Bay in 1980, it was noted that some plants within the B15B progeny produced very few pods and flowered over a prolonged period. Anthers of these plants were brown, shrivelled, nondehiscent and arrow-shaped, and contained no pollen grains (Dundas et al. 1980). In contrast, all other plants in the B15B had normal pod set, and normal anther development and behavior. Subsequently, over 100 male-sterile plants were identified in the progenies of the B15B x photoinsensitive line. This confirmed that this male-sterile character arose initially in cv Royes, and the original off-type plant used for hybridization in 1976 presumably was heterozygous for the gene(s) determining male sterility.

Characteristics of This Source

We have now recovered male-sterile plants in B15B and its progenies at several locations. The abnormalities of the anthers described above were common to all sites, and pod set on such plants was universally low. This indicates that this form of male sterility is stable in expression across a number of environments in subtropical Australia and in Fiji.

Cytological examination of microsporogenesis in male-sterile plants from Redland Bay indicates that the abnormal anther development involves degeneration of the pollen mother cells at the young tetrad stage (Dundas et al. 1980). This differs from the translucent anther type of male sterility in pigeonpea described by Reddy et al. (1977, 1978). Anther wall development was also different between these two forms.

Preliminary evidence suggests that the new form of male sterility is controlled by a single recessive. Detailed study of the inheritance is continuing.

It is significant that this male sterility arose in cv Royes. This cultivar has a modified floral structure involving overlap of the lobes of the standard petal. Byth et al. (these Proceedings) considered that this "wrapped flower" character effectively enforces self-pollination, probably by mechanical exclusion of bees until after anthesis. The presence of wrapped flowers in cv Royes and B15B allowed easy recognition of male sterility, owing to extremely low pod set on sterile plants. Since the insensitive parent used in crosses to B15B has simple flowers, progenies of this cross segregated for both wrapped/simple flowers and male fertility/sterility. Pod set on sterile/wrapped plants was invariably poor, but was virtually normal on sterile/simple plants. This confirms the effectiveness of wrapped flowers in enforcing selfing (Byth et al. these Proceedings). They also suggested the use of wrapped flowers to establish self-pollinated breeding methods, and of wrapped/simple flowers and fertility/sterility to allow recurrent selection in pigeonpeas.

Significance of this Source

This form of male sterility has been recovered in a range of phenological classes and is being maintained in ten genetic backgrounds ranging from 52 to 80 days to flower for December sowings at 27°S in Australia (Table 1). Plants flowering in less than 60 days from sowing are regarded as photoinsensitive (Wallis et al. 1980). This range of backgrounds will allow the production of hybrids ranging from insensitive to medium-late flowering types.

All of the steriles being maintained are botanically determinate cluster types. In fertile sibs, seed size ranges from 7 to 11 g/100 seeds, and both white and brown seeds have been identified in these backgrounds (Table 1). The potential for seeds per pod is moderate to high in all cases. These seed and pod characteristics are important with respect to the use of these male steriles in breeding. Single-cross hybrids that are large podded, with large white seed, can be produced by the appropriate choice of the male parent.

This new form of male sterility is a useful addition to that of MS3A/4A in that it avoids canalization of breeding on one genetic source of sterility. Further, the genetic backgrounds of the B15B and MS3A/4A sources differ significantly in origin, growth habit, phenology, and seed and pod characteristics. This allows establishment of a broader genetic base for hybrid cultivars.

Table 1. Some characteristics of new genetic male-sterile lines of pigeonpea being maintained at the University of Queensland, Australia.

Identification	Source	Days to flower	Height (cm)	Seed color	Maximum seed/pod
QMS[a]-1	B15B	80	140	White	6
QMS-2	B15B	70	150	Brown	5
QMS-3	Q7701[b]	62	125	White	4
QMS-4	Q7701	62	120	Brown	5
QMS-5	Q7701	66	105	White	5
QMS-6	Q7701	60	100	White	5
QMS-7	Q7701	56	125	White	6
QMS-8	Q7701	59	155	White	5
QMS-9	Q7701	52	90	White	4
QMS-10	Q7701	52	100	White/Brown	5
Standards					
Insensitive		55	75	Brown	4
Royes		110	160	White	6
B15B		80	140	White	5

a. QMS = Queensland Male Sterile
b. Q7701 = B15B x Photoinsensitive line

We are maintaining this character in the nominated backgrounds, and will distribute them on request as soon as possible. Detailed study of the genetic relationship between the B15B and MS3A sources is in progress. We are also evaluating the relative combining abilities of these sources.

References

BYTH, D.E., WALLIS, E.S., and SAXENA, K.B. 1981. Adaptation and breeding strategies for pigeonpea. Session 10, Volume 1, these Proceedings.

DUNDAS, IAN, S., SAXENA, K.B., and BYTH, D.E. 1980. Microsporogenesis and anther wall development in male sterile and fertile lines on pigeonpea (*Cajanus cajan* [L.] Millsp.). Euphytica 30(2) (Accepted).

GREEN, J.M., SHARMA, D., SAXENA, K.B., REDDY, L.J., and GUPTA, S.C. 1979. Pigeonpea breeding at ICRISAT. Presented at the Regional Workshop on Tropical Grain Legumes. University of the West Indies, 18-22 June 1979, St. Augustine, Trinidad.

REDDY, B.V.S., GREEN, J.M., and BISEN, S.S. 1978. Genetic male sterility in pigeonpea. Crop Science 18: 362-364.

REDDY, B.V.S., REDDY, L.J., and MURTHI, A.N. 1977. Reproductive variants in *Cajanus cajan* (L.) Millsp. Tropical Grain Legume Bulletin 7: 11.

WALLIS, E.S., WHITEMAN, P.C., and BYTH, D.E. 1979. Pigeonpea--A new crop for Queensland. Queensland Agricultural Journal 105(6): 487-492.