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Natural out-crossing in dwarf pigeonpea

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Summary

Natural out-crossing rate in pigeonpea was studied at ICRISAT Center using plant stature (tall plants in dwarf progenies) as the genetic marker. The data indicated natural out-crossing rates of 9.7% to 24.1% with a pooled value of 13.1% in the six populations studied. These data were comparable to earlier studies at the same site using stem colour and growth habit as genetic markers in tall pigeonpea cultivars thus suggesting that foraging of insect pollination vectors is not influenced by plant type. The implications of natural out-crossing on breeding and maintenance of genetic purity of cultivars is discussed.

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important grain legume of the semi-arid tropics (SAT). Its floral biology favours self-pollination. However, self-pollination is not a rule and a considerable degree of natural out-crossing has been reported from various parts of the world (Saxena et al., 1990).

Saxena et al. (1990) reported wide variation for natural out-crossing in pigeonpea cultivars. They reported that for determining the degree of natural out-crossing in pigeonpea, simply inherited characters such as stem colour (green vs purple), leaf type (obtuse vs normal), seed colour (white vs brown), growth habit (determinate vs indeterminate), and flower colour (yellow vs red) can be used. The number of plants with the dominant allele observed within an open pollinated single plant progeny of a recessive definite pure line will determine the extent of natural out-crossing that occurred in the preceeding generation. All the reports summarized by Saxena et al. (1990), however, refer to tall pigeonpea cultivars. There is no information available on natural out-crossing in dwarf cultivars since they were identified recently. Available information on natural out-crossing in tall cultivars cannot be directly assumed for dwarf cultivars since the two types of cultivars differ highly in their plant type, branching and podding behaviour and, hence, the present study was undertaken.

Materials and methods

Genetic dwarfs, D_6, PD_1, and PBNA of pigeonpea were identified at ICRISAT Center and described by Saxena et al. (1989). These dwarfs have many short secondary and tertiary branches. Their primary branches are held at an acute angle to the main stem thus making the plants appear like short compact bushes with most of the flowers at the top of the canopy. The tall cultivars ICPL 1, ICPL 366, BDN 1, and NP (WR) 15 on the other hand, have comparatively less secondary and tertiary branches, and their flowers are distributed over a long length of the branches.

Genetic studies conducted on three pigeonpea dwarf cultivars (D_6, PD_1, and PBNA) at ICRISAT Center indicated that dwarfness in these cultivars was inherited as a monogenic recessive trait relative to tallness (Saxena et al., 1989). Tall plant stature can, therefore, be used as a genetic marker in studying natural out-crossing in dwarf pigeonpea.

The F_2 populations of D_6 × ICPL 1, D_6 × BDN 1, PD_1 × ICPL 1, PD_1 × BDN 1, PBNA × ICPL 366, and PBNA × NP (WR) 15 were grown at ICRISAT Center in 1986 rainy season. Sowings were made in rows that were four metres long with inter- and intra-row spacings of 60 cm and 30 cm respectively. The cross PBNA × ICPL 366 was grown next to the unsprayed area of ICRISAT farm, while other crosses were grown further away from the unsprayed block. Two sprayings with Endosulfan 35% EC (2 l a.i. ha^{-1}) were made to control pigeonpea pests at flowering and early podding stage. The experiments were weeded twice. Open-pollinated seed from 99 F_2 dwarf plants representing the six crosses were harvested. F_3 progenies from these selections were grown in two-row plots in 1987 rainy season. Within each F_3 progeny, tall and dwarf plants were counted for estimating the extent of natural out-crossing in the preceeding generation. The frequency of tall plants among F_3 dwarf progenies was used as an estimate of natural outcrossing.

Results and discussion

The frequency of tall plants observed in the F_3 dwarf progenies in different crosses are given in Table 1. These estimates assumed no selective foraging by insects. The data indicated that natural out-crossing ranged from 9.7% to 24.1% and the pooled value was 13.1%. This compares favourably with out-crossing rates of 24% reported by Bhatia et al. (1981) while using stem colour marker and 15% reported by Saxena et al. (1987) while using growth habit marker in tall pigeonpea cultivars at ICRISAT Center. These results suggest that despite differences in the morphologies of tall and dwarf pigeonpea cultivars, the natural out-crossing rates in the two types of cultivars are similar.

The data indicated a slightly higher natural out-crossing (24.1%) in the cross PBNA × ICPL 366 relative to other crosses which could be attributed to the location of the field. The F_2 population of the cross PBNA × ICPL 366 was grown close to the unsprayed section of ICRISAT farm where the population of the insect pollinating vectors was high. Insecticide sprays made on the crop perhaps reduced the population of both the pest and the pollination vectors. Overall, this procedure could not account for the out-crossing from dwarf to tall, among talls, and among dwarfs and it should, therefore, be inferred that the total amount of natural out-crossing would be considerably higher.

Although most breeders maintain pigeonpea cultivars as if the crop is self-fertilized, these data indicated that some significant amount of natural out-crossing occurs that must be considered in order to maintain genetic purity of germplasm accessions and varieties. The data compared favourably with earlier reports at the same site in tall cultivars thus suggesting that natural out-crossing is not influenced by plant type. It can be inferred that insect pollination vectors move freely from plant to plant irrespective of plant type. The data also indicated that the location of the field in relation to the insect habitat was important in determining the degree of out-crossing. Artificial self-pollination, using cages or muslin cloth bags, or planting in isolation would

Table 1. Percent natural out-crossing recorded in F_3 dwarf progenies at ICRISAT Center during 1987 rainy season.

Cross	No. of progenies	No. of plants			Natural out-crossing (%)
		Total	Dwarf	Tall	
D_6 × ICPL 1	19	300	271	29	9.7
D_6 × BDN 1	19	322	286	36	11.2
PD_1 × ICPL 1	18	234	204	30	12.8
PD_1 × BDN 1	17	326	284	42	12.9
PBNA × ICPL 366	11	169	126	40	24.1
PBNA × NP (WR) 15	15	279	242	37	13.3
Total	99	1630	1413	214	13.1

be of great help in maintaining genetic purity of pigeonpea cultivars. On the other hand, the natural out-crossing nature of pigeonpea could be exploited with advantage for population improvement (Khan, 1973; Onim, 1981) or development of hybrids in conjunction with genetic male sterility (Saxena et al., 1986).

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