



TRANSGRESSIVE SEGREGATION FOR SEED SIZE IN PIGEONPEA

Agricultural Science

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ABSTRACT

The present paper, perhaps for the first time, reports the occurrence of transgressive segregation for seed size in inter-specific crosses of genus *Cajanus*. The gains in seed size due to this event in three *C. scarabaeoides* crosses ranged from 37.18 to 49.47% over the better parent. In the two other crosses involving *C. sericeous* and *C. albicans* such gains were 26.83% and 53.85%, respectively. It is concluded that genetic diversity of parents and advancement of the populations without selection up to F₅ generation played significant roles in the emergence of transgressive segregants for seed size in pigeonpea.

KEYWORDS

C. scarabaeoides, *C. sericeous*, *C. albicans*, pigeonpea, transgressive segregation, seed size

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is a key pulse crop of India that is known for its nutritive food and other domestic and commercial uses (Saxena et al., 2021). According to FAO (2021) the crop is annually sown on over 5 m ha land in India under diverse soil types, precipitation, photoperiods, temperatures etc. The adaptation and cropping patterns in these areas vary considerably; and for this reason, over 200 pigeonpea varieties, differing in maturity (120-250 days) and plant types (compact, spreading, tall and dwarf) were bred in the past seven decades (Singh et al., 2016). Seed size in these varieties, however, is limited to a maximum of around 12 g/100 seeds due negative genetic linkages between seed size and yield (Saxena and Srivastava, 2022).

To infuse greater genetic diversity in future cultivars three wild species were included in the pigeonpea breeding programme at ICRISAT. Under this activity five inter-specific crosses were made and in the advanced generations of these crosses some segregants, exceeding seed size of the large-seeded parents by significant margins, were found. These genotypes were tagged as "transgressive segregants for seed size". In this brief communication the authors report the process of selection along with some characteristic traits.

MATERIALS AND METHODS

Three crossable wild relatives of pigeonpea of secondary gene pool were selected for this experiment. *Cajanus scarabaeoides* is a creeper and has certain undesirable heritable agronomic traits like pod shattering, low yield, and undesirable seeds with hard seed coat. Flowering in this species is profuse this rich continues for an extended period. Most flowers, however, drop before fertilization but still the plants produce a lot of pods. The pods of *C. scarabaeoides* are hairy with 3-5 ovules in each. Its seeds are small (2-3 g/100 seeds), dark brown, and rich (28.4%) in protein content but unfit for consumption. *Cajanus sericeous* is endemic to deciduous monsoon forests of Western and Eastern Ghats of India. It is an erect perennial, approaching the height of 1.0 -1.5 m. The primary branches are erect and there are no secondary and tertiary branches. Flowering is moderate and the flowers are sessile, axillary, and emerge in bunches of 1-3. Pods are small (2-3 seeds/pod) and with shattering habit. Its seeds are rich (29.4%) in protein, dark coloured and small with 100-seed weight of 1.9 g. *Cajanus albicans* is a perennial climber with a hardened woody base. It is found in the dry deciduous forests of peninsular India and Sri Lanka. It is highly sensitive to photo-period. Flowering in *C. albicans* is profuse. The pods are somewhat flattened, hairy, and on average contain 3-4 locules. Seeds are small (2.8 g/100 seeds), dark and carry a protein load of 30.6%.

All the three wild *Cajanus* species possess hard seed coat which protect seeds from dangerous insects, water-logging, and various soil-borne pathogens. The hard seed coat also delays the process of seed germination by 2-3 weeks or even more. Therefore, to facilitate rapid germination, their seeds were scarified with a sharp blade. Seeds of the three wild species and three pigeonpea cultivars Baigani, T21 and Pant A2 were sown in a crossing block. For hybridization the wild species

were used as male and pigeonpea cultivars as female; and a total of five inter-specific crosses were produced. To affect crossing the floral buds of pigeonpea genotypes were emasculated and pollinated simultaneously using fresh pollen of the wild species. In different crosses the success rates varied from 3 to 20%. Since the hard seed coat in the wild species is governed by a single dominant gene (Reddy, 1990), its frequency in the segregating generations was high. Therefore, in each generation all the seeds were scarified.

Seeds of each cross were sown in field at the onset of rainy season. Each population was advanced up to F₅ generation through bulk method of breeding. In F₆ generation, 200 - 1500 seeds were sown. Some of the plants were killed, early in the season by dry root rot and later by Fusarium wilt. At maturity each surviving plant was harvested separately and their seeds cleaned and oven-dried at 55°C for 24 h. An electronic seed counter was used to draw two samples of one hundred seeds from each plant and their weights were recorded using an automatic electronic balance and their mean values were used in this study.

RESULTS AND DISCUSSION

Attractive seed size in legume adds to their overall market value. In pigeonpea, the seed size of most early maturing cultivars is around 8-9 g/100 seeds, while the corresponding value for the medium and late maturing varieties is 10-12 g/100 seeds. Although the genetic variability for seed size in pigeonpea germplasm is large (4 -25 g/100 seeds), but for breeding high yielding cultivars a seed size limit exists due to a prominent curvilinear relationship between seed size and yield (Saxena and Srivastava, 2022). Consequently, breeding of high-yielding pigeonpea cultivars with seed size greater than 14 g/100 seeds is a remote possibility.

In the present study transgressive segregations for seed size was observed recorded in all five inter-specific crosses. The gains in seed size due to transgressive segregation in the three *C. scarabaeoides* crosses ranged from 37.18 to 68.20% (Table 1). The highest gain was recorded when this species was crossed with cv T21 and the lowest with that of Pant A2. Interestingly, in both the pigeonpea cultivars the seed size (8.2 vs 7.8) and plant population (219 vs 268) in the crosses were similar, but the transgressive segregant in cross involving T21 was significantly larger than that of Pant A2. The superiority of this transgressive segregant over its pigeonpea parent was double in magnitude. This leads to believe that Pant A2 and T21 have different genetic constitution with respect to their seed size; and the complementation of T21 alleles with those present in *C. scarabaeoides* produced larger seeds. Cultivar Pant A2 also responded differently in producing transgressive segregants when it was crossed with *C. albicans* and *C. scarabaeoides* and the former wild species exhibited greater efficiency (Table 1). Similarly, *C. scarabaeoides* scored over *C. sericeous* when these were crossed with cv T21.

Transgressive segregation is a genetic situation when a given hybrid population produces an extreme phenotype whose values are outside the range of both the parents. It often results when certain rare parental

alleles combine in a single individual to produce a phenotype which is significantly different from the parents. Such entities arise from specific complementary gene actions (Rick and Smith, 1953). By performance, such transgressive or extreme phenotypes could be either on positive or negative side of the population curve. Their emergence within a population is often correlated with genetic divergence of the parental lines and presence of some hiding recessive complementary alleles whose expression are masked by common dominant or epistatic alleles. According to Grant (1975) and Vega and Frey (1980) the complementary gene actions are more probable reasons for the emergence of transgressive segregants. Such conclusions were also confirmed through marker-based QTL studies conducted by de Vicente and Tanksley (1993). The transgressive segregants add to the genetic wealth of a crop for use in the future breeding programmes.

Table 1. Seed Size (g/100 Seeds) Of The Parents And % Gains In Seed Size Recorded In The Best Transgressive Segregants In F_2 Populations.

Inter-specific cross	Wild species	Pigeonpea cultivar	Total plants	Mid parent	Transgressive segregant	
					Seed size	%Gain
Baigani x <i>C. scarabaeoides</i>	2.3	9.5	1231	5.40	14.2	49.47
T 21 x <i>C. scarabaeoides</i>	2.3	8.2	219	5.25	13.7	68.20
Pant A 2 x <i>C. scarabaeoides</i>	2.3	7.8	268	5.05	10.7	37.18
T 21 x <i>C. sericeous</i>	1.9	8.2	91	5.05	10.4	26.83
Pant A 2 x <i>C. albicans</i>	2.6	7.8	165	5.20	12.0	53.85

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