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Varietal differences in seed size and seedling growth of pigeonpea and chickpea

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ABSTRACT

The influence of seed size on seedling growth of pigeonpea [*Cajanus cajan* (Linn.) Millsp.] and chickpea (*Cicer arietinum* Linn.) was investigated to predict probable consequences of selection for seed size in breeding programmes. Seeds of 20 pigeonpea varieties with 100-seed weights of 4.5 to 22 g and 23 chickpea varieties with 100-seed weights of 5 to 32 g were sown in the field, and the leaf area and dry weight of the seedlings were measured at intervals up to 56 and 30 days respectively. In both species there was a close linear relationship between 100-seed weight and seedling weight ($r = 0.77^{*}$ for 14-day-old pigeonpea; $r = 0.82^{**}$ for 16-day-old chickpea). In pigeonpea the relationship was even closer ($r = 0.95^{**}$) when varieties having 100-seed weights of over 15 g were excluded. With the advancement of growth the closeness of these relationships declined. Large-seeded varieties of these crops produce larger and more vigorous seedlings, which will have an advantage in stand establishment under adverse conditions.

The 100-seed weights of different varieties of pigeonpea [*Cajanus cajan* (Linn.) Millsp.] range from 4 to 24 g and of chickpea (*Cicer arietinum* Linn.) from 4 to 60 g. In both crops there is a moderate heritability for seed size (Athwal and Gill, 1964; Sharma *et al.*, 1972) and breeders are at present selecting for seed sizes preferred by consumers (Ariyanayagam, 1975; Singh and Auckland, 1975). In other species, seed size is known to influence seedling growth (Black, 1959; Haskins and Gorz, 1975; Kneebone and Cramer, 1955). It seemed possible that in pigeonpea and chickpea selection for seed size would have important consequences for seedling growth, which could in turn influence stand establishment, especially under adverse environmental conditions. This study was taken up to investigate the influence of varietal differences in seed size on seedling growth of pigeonpea and chickpea.

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MATERIALS AND METHODS

Twenty varieties of pigeonpea with 100-seed weights of 4.5–22.2 g were sown at a depth of 3 cm in a vertisol (fine clayey, calcareous, montmorillonitic, hyperthermic, family of Typic Chromustert) at the ICRISAT Centre on 25 June 1975 in a randomized-block design with 2 replications in 7 m × 3 m plots, with plant-to-plant spacings of 75 cm × 30 cm. From each plot samples of 5 adjacent plants were taken 14, 28, 42 and 56 days after sowing. The leaf area and dry weights of leaves, petioles and stems were recorded.

Twenty-three varieties of chickpea with 100-seed weights of 4.9–31.9 g were sown at a depth of 3 cm in a vertisol on 10 November 1975 in a randomized-block design with 2 replications in 2.5 m × 1.2 m plots with plant-to-plant spacings of 30 cm × 10 cm. Samples of 5 adjacent plants/plot were dug up 16 and 30 days after sowing; the roots were washed free of soil and the leaf area and the dry weights of leaves, petioles, stems and roots were recorded. The total dry weight

and yield were measured at the time of harvest from an area of 1.9 m^2/plot.

RESULTS AND DISCUSSION

Pigeonpea

There was a more or less linear relationship between the dry weight of shoots of the 14-day-old seedlings and the 100-seed weight, up to 100-seed weights of 15 g (Fig. 1). The correlation coefficients of all varieties and of 15 varieties with 100-seed weights up to 15 g was higher when the 5 largest-seeded varieties were excluded (Table 1).

The relationship between 100-seed weight and the leaf area and dry weight of shoot of the seedling decreased with increase in the age of the plant (Table 2). This is illustrated by the greater scatter of the points when 100-seed weights are plotted against the dry weight of shoot of the 56-day-old seedlings (Fig. 1) com-

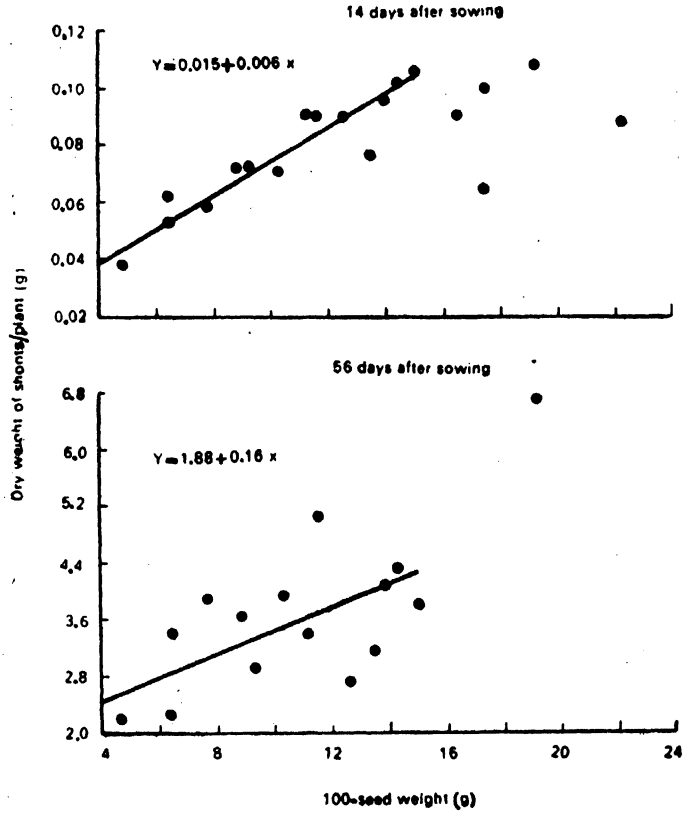

Fig. 1. Relationship between dry weight of the shoot system and 100-seed weight of 20 pigeonpea varieties 14 days after sowing (*top*) and 56 days after sowing (*bottom*).

pared with the 14-day-old seedlings. A similar relationship was found in seed weight and seedling weight within varieties of pigeonpea; small seeds gave smaller seedlings, and large seeds large seedlings, but there was no significant effect on final yield. The removal of approximately half the seed reserves reduced the size of the seedlings by about 50% compared with intact-seeded controls (unpublished

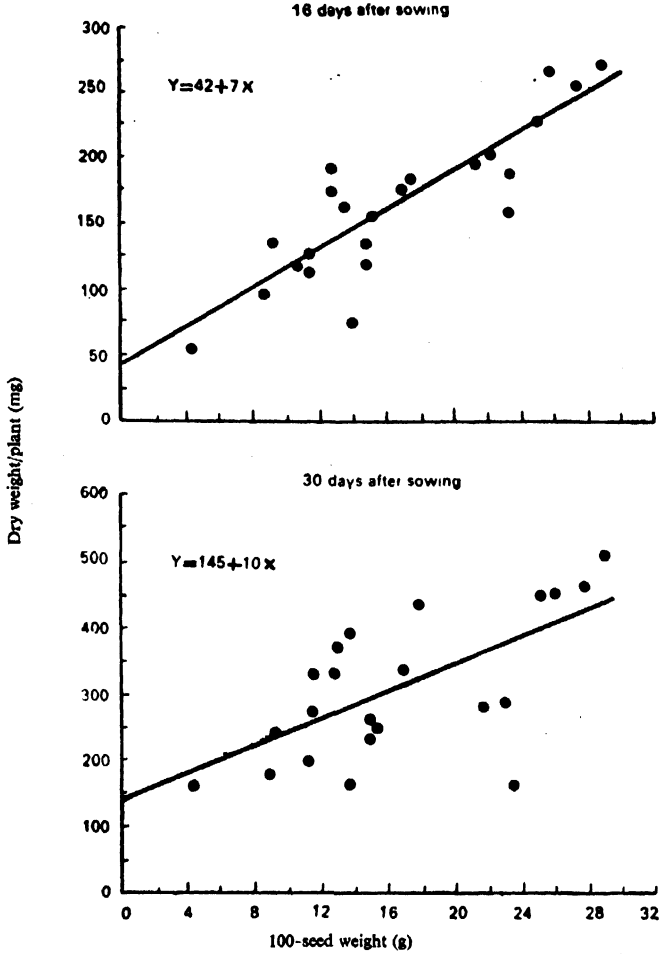

Fig. 2. Relationship between total dry weight (mg) and 100-seed weight (g) of 23 chickpea varieties 16 days after sowing (*top*) and 30 days after sowing (*bottom*).

Table 1. Simple correlation coefficients for 100-seed weight correlated with leaf area and dry weight of shoot of 20 pigeonpea varieties 14, 28, 42 and 56 days after sowing

Character correlated with 100-seed weight	Days after sowing			
	14	28	42	56
Leaf area per plant				
For all varieties (df : 18)	0.77**	0.70**	0.67**	0.48**
For varieties with 100-seed weights up to 15 g (fr : 13)	0.94**	0.80**	0.85**	0.60*
Dry weight of shoot/plant :				
For all varieties (df : 18)	0.77**	0.78*	0.53**	0.52**
For varieties with 100-seed weights up to 15 g (df : 13)	0.95**	0.87**	0.78**	0.61*

*P = 0.05; **P = 0.01.

Table 2. Simple correlation coefficients for 100-seed weight correlated with leaf area and dry weights of leaves, stems and roots of 23 chickpea varieties 16 and 30 days after sowing.

Character correlated with 100-seed weight	Days after sowing	
	16	30
Leaf area/plant	0.78**	0.71**
Leaf weight/plant	0.67**	0.54**
Stem weight/plan t	0.79**	0.55**
Root weight/plant	0.78**	0.71**
Total weight/plant	0.82**	0.56**

**P = 0.01 (df = 44).

data), indicating that the seed reserves rather than the size of the plumule and radicle were the major factors determining seedling size. The differences in seedling size and weight between genotypes with different seed weights may also primarily reflect the different amount of seed reserves. However, in large seeds other factors, such as the ability to translocate or utilize the reserves, may become limiting; this may have been the case in the pigeonpea varieties with 100-seed weights above 15 g (Fig. 1).

There was a highly significant positive correlation between seed weight and the leaf area and dry weight of chickpea seedlings (Table 2) but, as in pigeonpea, the relationship was close in older plants. The total dry weight of the 16-day-old and 30-day-old plants plotted against 100-seed weight showed an increased scatter of points at the time of second sampling (Fig. 2). There was no significant relationship between 100-seed weight and total dry weight at the time of harvest (r=0.07) or yield (r=0.13).

The selection of larger-seeded varieties seems likely to result in better seedling vigour. Larger pigeonpea seedlings are of advantage in establishing the plants in intercropping situations when they are soon shaded by the companion crop. In soybean [*Glycine max* (Linn.) Merr.], whose germination is epigeal, seedlings derived from small seeds are able to emerge better than those from large seeds, but in pigeonpea, which like chickpea germinates hypogeally, larger-seeded varieties may have an advantage in seedling emergence from crusted soils. In chickpea, the larger seedlings of larger-seeded varieties may emerge better after deep sowing, which is often necessary when the crop is sown in seed-beds which are drying out (Van der Maesen, 1972). We are currently investigating these possibilities.

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