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SEED COAT THICKNESS IN CHICKPEA: VARIATION AND INHERITANCE IN A DESI × KABULI CROSS

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ABSTRACT

Large variation was observed for seed coat thickness among 40 cultivars of chickpea (*Cicer arietinum* L.). It was even greater between the two main types, desi and kabuli. The ranges did not overlap for the two types studied. The appearance of only 3% individuals of parental types and a number of nonparental types in a cross between the two types indicates that several genes govern this trait. The genes for thick seed coat appear to be partially dominant (DD+0.5) over those for thin seed coat. Desi type segregants with relatively thinner seed coat were obtained, indicating that desi cultivars with thin seed coat could be developed.

Key words: *Cicer arietinum*, chickpea, seed coat thickness, inheritance.

Generally two types of chickpea (*Cicer arietinum* L.) are recognized: desi, with brown colour and angular seed shape, and kabuli, with cream colour and owl's head seed shape [1]. These two types also differ in their fibre content, which is mainly deposited in the seed coat [2]. The proportion of seed coat plays an important role in the nutritive value and processing of grain legumes. The recovery of dal, the major form of chickpea consumption, is affected, among other factors, by the proportion of the seed coat [3]. In recent years, there is much interest in desi × kabuli chickpea introgression [4, 5]. Singh et al. [3] observed wide variation for seed coat thickness between desi and kabuli cultivars. Also, the anatomical structures of desi and kabuli types have shown discrete differences [6]. This paper reports on variation for seed coat thickness in chickpea, and its inheritance in a cross between a desi and a kabuli cultivar. The anatomical structure of seed coats of the two parents of the cross is also described.

MATERIALS AND METHODS

We have studied 21 desi and 19 kabuli cultivars, which originated from different parts of the world. Their 100-seed weight, seed coat (%), and seed coat thickness (μm) were measured.

T3 (GW) (ICC 5864), a desi cultivar having thick seed coat (138±5.5 μm), was crossed with C 104 (ICC 4928), a kabuli cultivar having thin seed coat (34±3.9 μm). The parents, F_1 and F_2 generations of the cross were grown in the postrainy (rabi) season of 1981/82 at ICRISAT Centre, Patancheru, near Hyderabad, A.P., India.

The seed coat was removed manually by soaking the seeds in distilled water for 16 h at 5°C. Excess water was discarded, and seed coat removed using forceps. Both cotyledons and seed coat components were dried in oven at 50°C. For recording thickness, each seed coat was measured in μm at 5 different points, using Vernier calipers. Each value is a mean of five measurements recorded approximately at the same position of each seed coat. The seed coat of each parent and F_1 was measured in five seeds, and in F_2 in 490 seeds. To avoid variation due to differential maturity, seeds of approximately same size were picked in each generation for recording seed coat thickness.

For microscopic studies, seed coat samples of the two parents, T3 (GW) and C 104, were processed for light microscopy of fixing them in 3% gluteraldehyde, followed by dehydration in methyl cellulose, ethanol, n-propanol and n-butanol series for 24 h each [7]. The dehydrated samples were infiltrated and then embedded in glycol methacrylate (Historesin TM, LKB, Broma, Sweden).

Section of 3 μm thickness were cut using a glass knife, stained in 0.1% aqueous toluidine blue, and examined under a light microscope.

RESULTS AND DISCUSSION

The two groups of desi and kabuli cultivars exhibited a large variation for 100-seed weight, seed coat percentage and thickness within and between themselves (Table 1). The ranges for the last two traits for desi and kabuli types did not overlap and, therefore, we studied a cross between the two types in greater detail. Since seed size appeared to influence seed coat percentage ($r = -0.94$) but not the seed coat thickness ($r = -0.19$), we decided to study only the latter trait.

Table 1. Mean and range for 100-seed weight, seed coat percentage, and seed coat thickness of desi and kabuli cultivars of chickpea, and the correlation coefficients between them

Component		Desi	Kabuli	Desi and kabuli
100-seed weight, g	(A) Mean	16.4	25.4	20.7
	Range	11.6–33.6	11.3–43.9	11.3–43.9
Seed coat, %	(B) Mean	14.2	4.9	9.6
	Range	9.7–17.3	3.7–7.0	3.7–17.3
Seed-coat thickness (μm)	(C) Mean	144.0	58.5	103.4
	Range	115.0–205.0	36.5–106.0	36.5–205.0
Correlation coefficient				
A vs. B		−0.74**	−0.66**	−0.94**
B vs. C		0.59**	−0.62**	0.92**
C vs. A		−0.13	0.16	−0.19

**Significant at 0.01 level.

The differences in seed coat content of desi and kabuli types could be attributed to the differences in the anatomical structures of these two types (Fig. 1). In the kabuli seed coat (cv. C 104), the outermost layer (epidermis) develops into the uniseriate palisade layer, without thickening of the cell wall. In the desi seed coat [T3 (GW)], it develops into a multiseriate palisade layer, which later becomes thick walled. This layer is heavily stained with toluidine blue, indicating the possible presence of phenolic compounds contributing to seed colour. Like epidermal cells, the walls of subepidermal cells do not thicken in kabuli seeds, whereas in desi seeds these cells develop into a thick wall as the seed matures.

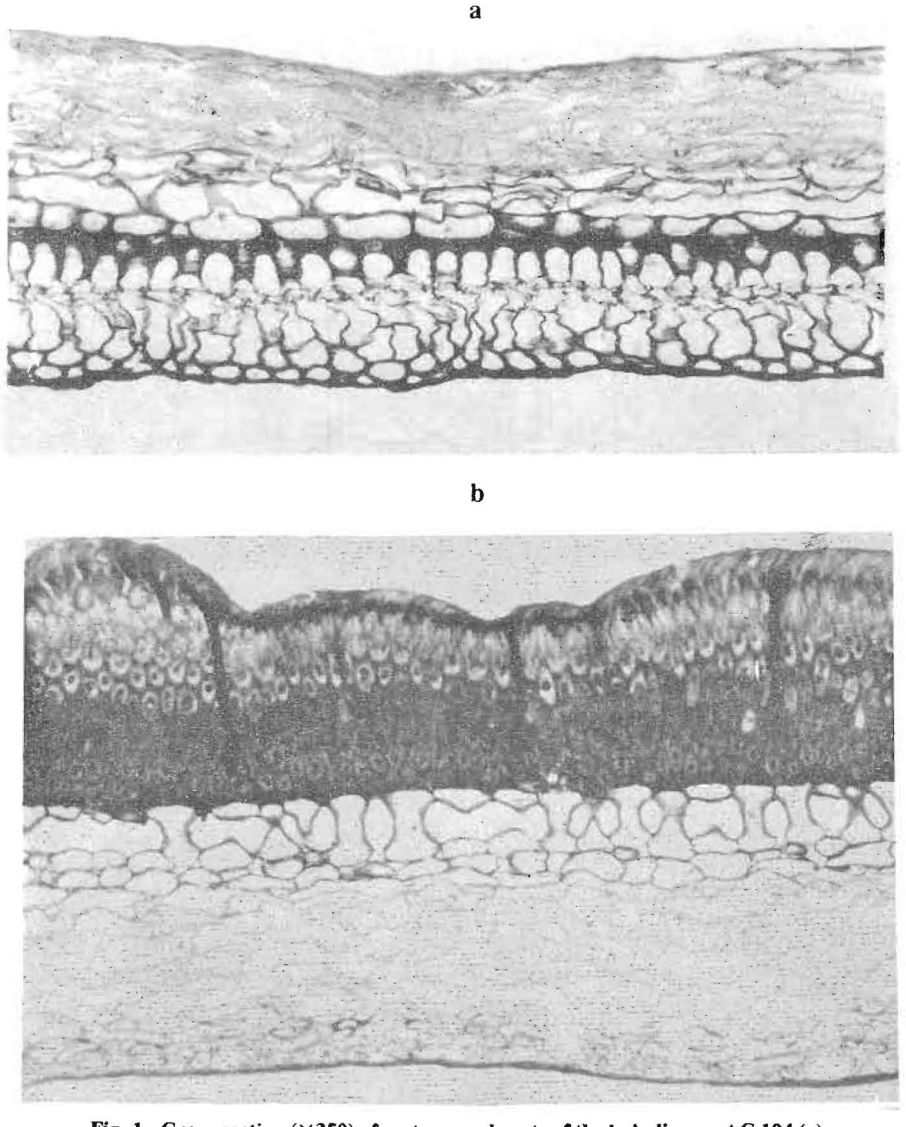

Fig. 1. Cross-section (×350) of mature seed coats of the kabuli parent C 104 (a) and desi T 3 (GW) (b).

The two parents showed very large difference for their seed coat thickness (Fig. 2). The F_1 value (111±3.5 μm) was much higher than the midparental value (86 μm), which indicated partial dominance (degree of dominance +0.5) for thicker seed coat. Even the F_2 mean value (92 ± 1.0 μm) was significantly higher than the midparental value, further supporting the partial dominance theory.

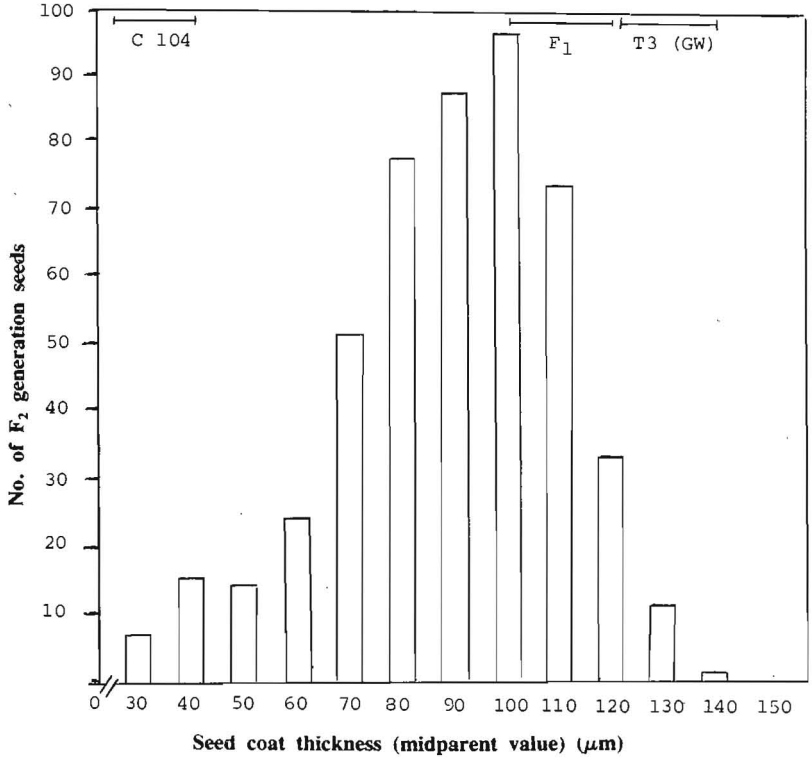

Fig. 2. Seed coat thickness (μm) for the seeds of F_2 generation of cross T 3 (GW) × C 104. Mean seed coat thickness: 138±5.5 μm in T 3 (GW), 34±3.9 μm in C 104, 111±3.5 μm in F_1, and 92±1.0 μm in F_2. Scales above show the range.

The F_2 range was between the two parental values. This indicates that the parent with thick seed coat, T3 (GW), did not contribute any genes for thinner seed coat, nor did C 104 (parent with thin seed coat) for thicker seed coat. The recovery of only 5 (i.e. 1%) individuals of T3 (GW) and 9 (2%) of C 104 with thick seed coats and many with intermediate seed coat thickness in the F_2 generation indicates that this character may be governed by several genes.

Several desi type segregates with relatively thinner seed coats were observed in this cross. If the thinner seed coat of some of these can be stabilized in the later generations, such genotypes may produce a higher proportion of dal than those available at present; this will be useful from nutritional point of view, as most of the chickpea produced in India is consumed as dal after decortication. However, the higher susceptibility of such varieties to root diseases and bruchids will have to be considered before such cutlivars are developed, as kabuli types (with thinner seed coat) are more susceptible than desi types [8].

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