Relationships of Pinnate (Fern) and Simple (Unifoliate) Leaf Traits with Seed Yield and Seed Size in Kabuli Chickpea

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Chickpea typically has pinnate type of compound leaves in which the leaf lamina (blade) is differentiated into a rachis and a number of leaflets. These leaflets are generally odd in number and borne directly on the rachis. Mutants have been identified that have simple (unifoliate) leaves in which the lamina is not differentiated into rachis and leaflets, though there may be deep incisions in the lamina. A single recessive gene is known to control the simple leaf trait (Pundir et al. 1990). Most chickpea cultivars released in different countries have normal pinnate leaves. The simple leaf mutants have also been exploited in chickpea breeding and some cultivars, mainly kabuli type, with simple leaves have been released, e.g. Surutato 77 and Macarena in Mexico; Dwelley, Sanford, Evans and Sierra in USA; and CDC Diva and CDC Xena in Canada (FJ Muehlbauer, personal communication; Warkentin et al. 2003).

This study was conducted to determine if the leaf type has any relationship with seed yield and major seed yield components, particularly number of pods per plant and seed weight, in kabuli chickpea. Three crosses, ICCV 2 × ICC 14195, ICCV 2 × ICC 14215 and ICC 16644 × ICC 16670, were selected from ICRISAT's chickpea breeding program. The parents of each cross differed in leaf type and seed size. ICCV 2 and ICC 16644 have pinnate leaf and medium seed size (23–25 g 100 seed^{-1}), while ICC 14195, ICC 14215 and ICC 16670 have simple leaf and large seed size (50–59 g 100 seed^{-1}). The F_2 populations from these crosses were grown at ICRISAT-Patancheru during the postrainy season 2005/06 keeping row-to-row distance of 60 cm and plant-to-plant distance of approximately 10 cm. In each cross, observations were recorded on all plants individually. There were 226 plants in ICCV 2 × ICC 14195, 247 plants in ICCV 2 × ICC 14215, and 244 plants in ICC 16644 × ICC 16670. Observations were recorded on leaf type, number of pods per plant, number of seeds per plant, 100-seed weight and seed yield per plant. In each cross, the F_2 plants were classified into two groups based on leaf type (pinnate-leaved and simple-leaved) and then mean value of each trait was calculated for each group. The significance of difference between the mean values of two groups for each trait was tested using t-test.

The pinnate-leaved plants and the simple-leaved plants gave a good fit to the expected 3:1 ratio in two crosses (ICCV 2 × ICC 14215 and ICC 16644 × ICC 16670), but showed distorted segregation in one cross (ICCV 2 × ICC 14195) (Table 1). The pinnate-leaved plants gave significantly higher seed yield (44% in ICCV 2 × ICC 14215, 53% in ICCV 2 × ICC 14195 and 62% in ICC 16644 × ICC 16670) than the simple-leaved plants, mainly because of higher number of pods per plant (Table 1). On an average, the pinnate-leaved plants produced 23–31 pods per plant, whereas simple-leaved plants produced 14–19 pods per plant. The increased number of pods per plant in pinnate-leaved plants resulted in increased number of seeds per plant and ultimately increased yield per plant. Seed size of pinnate-leaved plants and simple-leaved plants did not differ significantly in any of the crosses.

It is interesting to note that most simple-leaved kabuli germplasm accessions (e.g. ICC 8155, ICC 8156, ICC 13821, ICC 14195, ICC 14206, ICC 14215, and ICC 16670) and cultivars (e.g. Surutato 77, Macarena, Dwelley, Sanford, Evans, Sierra, CDC Diva and CDC Xena) have large seeds (>40 g 100 seed^{-1}). This gives the impression that simple-leaf trait may be associated with large seed size. In pinnate-leaved plants, it is well-established that the large-seeded varieties have large leaflets (Dahiya et al. 1988; Sandhu et al. 2005). Thus, it also indicates that the simple-leaf trait may affect seed size. However, results of this study suggest that the simple- and pinnate-leaf types have no relationship with seed size in kabuli chickpea, and the same relationship is expected to be true for desi chickpea.

One disadvantage of using simple-leaf trait reported earlier is the higher susceptibility of simple-leaved cultivars to the foliar disease ascochyta blight, caused by *Ascochyta rabiei* (Gan et al. 2003). The results of this study reveal another negative effect of simple-leaf trait, the reduction in seed yield per plant. Thus, it is recommended that selections should be practiced for pinnate-leaved plants in crosses involving simple-leaved and pinnate-leaved types.

References

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Table 1. Differences in mean values of yield and major yield components between pinnate-leaved and simple-leaved plants in F_2 of kabuli × kabuli chickpea crosses.

Cross	Category of plants	No of plants	Mean±SE			
			No of pods/plant	No of seeds/plant	Seed yield/plant (g)	100-seed weight (g)
ICCV 2 × ICC 14195	Pinnate-leaved	185	30.7±1.1	32.3±1.2	11.8±0.4	37.5±0.5
	Simple-leaved	41	19.1±1.6	20.3±1.7	7.7±0.6	39.5±1.2
	χ^2 for a 3:1 ratio (probability)	5.67 (0.02–0.01)	–	–	–	–
	t-value (probability)	–	5.96 (<0.001)	5.77 (<0.001)	5.65 (<0.001)	1.63 (0.12) NS
ICCV 2 × ICC 14215	Pinnate-leaved	196	29.3±1.3	30.5±1.4	10.8±0.5	36.5±0.5
	Simple-leaved	51	18.7±1.5	19.9±1.6	7.5±0.7	37.9±1.1
	χ^2 for a 3:1 ratio (probability)	2.49 NS (0.90-0.10)	–	–	–	–
	t-value (probability)	–	5.75 (<0.001)	5.44 (<0.001)	3.77 (<0.001)	1.38 (0.22) NS
ICC 16644 × ICC 16670	Pinnate-leaved	192	23.3±1.6	26.7±2.0	7.3±0.5	27.8±0.7
	Simple-leaved	52	14.4±2.5	15.3±2.5	4.5±0.7	29.3±1.6
	χ^2 for a 3:1 ratio (probability)	1.77 NS (0.90–0.10)	–	–	–	–
	t-value (probability)	–	3.19 (0.002)	3.70 (<0.001)	3.33 (<0.001)	0.87 (0.39) NS