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Short Communication

Pod volume and pod-filling percentage as additional traits for the characterization of chickpea (*Cicer arietinum* L.)

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With 2 tables

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Abstract

Thirty short- to medium-duration chickpea germplasm accessions from diverse geographic origins and with a wide range of physiological and morphological traits were grown in three environments at ICRISAT Asia Center, Patancheru, during 1992/93. Data were recorded on time to flowering, leaf area, 100-seed mass, pod volume, and pod-filling percentage. Quantitative data on the last two traits were recorded for the first time to examine their relevance to the characterization of germplasm accessions and their use as selection criteria in breeding. The accessions exhibited considerable variation for the traits. The broad-sense heritabilities were 0.98 for pod volume and 0.85 for pod-filling percentage. The two traits showed consistent relationships with other morphological characters indicating that the pod volume and pod-filling percentage traits can be utilized in genotype characterization of chickpea.

Key words: *Cicer arietinum* — pod volume — pod filling — heritability

Chickpea, *Cicer arietinum* L., is a leguminous crop and a source of protein-rich food. Generally, this crop is grown under marginal farm input conditions and yields are low and unstable. However, chickpea has merits which many other crops do not have for it can be cultivated with little initial tillage, cultural operations, fertilizers, and soil moisture. In general, it does not compete with other crops for land owing to differences in sowing dates. However, chickpea has considerable genetic diversity, and therefore deserves research efforts to make it higher-yielding, and more remunerative. To facilitate better characterization of genotypes and to focus on selection in chickpea breeding, recording of two additional traits, namely, pod volume and pod-filling percentage, is suggested. The technique to record these traits is described and the relevance of the traits to research is discussed.

From the world collection of chickpea germplasm maintained in the ICRISAT genebank (Pundir et al. 1988), we sampled 30 accessions of diverse geographical origin, with early to medium maturity (90–110 days). These accessions grew and ripened satisfactorily under the ICRISAT Asia Centre (IAC), Patancheru conditions (18°N and 78°E ordinates, 542 m altitude, 75 cm average annual rainfall; vertisol fields). They include released cultivars and represented a full range of variation for size of leaf, pod, and seed. They were sown at the IAC during the 1992/93 post-rainy season on vertisol fields in three environments: (1) early sowing (14 October 1992), on ridges, 60 × 10 cm spacing, and rainfed; (2) usual sowing date (28 October 1992: common in AC environment), on ridges, 60 × 10 cm spacing, and with one irrigation; (3) usual sowing date (28 October 1992) on 1.5 m wide flat beds, 30 × 10 cm spacing, and with one irrigation. The experiment was replicated twice in each environment. Days to flowering were recorded as the number of days from sowing until 50% of the plants in a plot began flowering. Data on leaf area were based on averages of 10 leaves, one each from 10 plants (pod-filling stage), plucked from the 15th node from the base of the fully expanded branches. Leaf area was measured by an automatic LI-COR (Lincoln, NE, USA) area meter. For measuring pod size and pod-filling percentage, the pod and seed volumes were measured by water displacement. The equipment used was fabricated locally and consisted of a glass jar, 2.5 cm wide, its mouth having a moulded outlet in the form of a sharp beak; a narrow, graduated cylinder with 10 ml capacity; and a metal coil. The steps followed to measure the volume of pods are given below:

- A representative and undamaged pod was picked from the basal fruiting node of a fully developed branch of five plants at crop maturity;
- The glass jar was filled with water.
- Five pods were put in the jar and submerged with the help of a metal coil;
- The water released through the beak of jar was collected in the graduated cylinder and its volume noted. The volume of the water was equal to the volume of the five pods.

To measure pod-filling percentage, the seeds from the same five pods were removed and their volume was measured in a similar manner. Pod-filling percentage was calculated using the following formula:

$$\text{Pod filling \%} = \frac{\text{Volume of seeds from 5 pods}}{\text{Volume of 5 pods}} \times 100\%$$

The summarization of data, estimates of broad sense heritabilities and correlations between traits were obtained using GENSTAT program run on a VAX 11/780 computer.

All accessions flowered in December–January and completed pod set before the onset of hot weather and this resulted in normal performance of all accessions. Observations were recorded on the five traits listed in Table 1. Of these, the relevance of two traits, time to flower and seed size is well understood in chickpea research. The observations on leaf area, and pod size and filling are new concepts. Generally, chickpea plants have a thick plant canopy, which often makes them vulnerable to foliar

Table 1: Mean, range and heritability of some seed yield traits of chickpean, ICRISAT Asia Centre, 1992–93

Trait	Mean	Range	Heritability
Time to flower (days)	61.0±1.8	42–82	0.914
Leaf area (cm^2)	5.52±0.37	1.90–15.38	0.948
Pod volume (cm^3)	1.14±0.06	0.26–3.32	0.984
Pod filling (%)	21.29±1.08	5.1–35.1	0.850
100-seed mass (g)	22.93±0.98	4.0–52.0	0.985

Table 2: Phenotypic and genotypic correlations among some morphological traits of chickpea, ICRISAT Asia Center, 1992–1993[1]

		1	2	3	4
1. Time to flower	P				
	G				
2. Leaf area	P	−0.291**			
	G	−0.300			
3. Pod volume	P	−0.150	0.960**		
	G	−0.149	0.967		
4. Pod filling %	P	0.258*	−0.565**	−0.601**	
	G	0.280	−0.596	−0.631	
5. 100-seed mass	P	−0.070	0.756**	0.789**	−0.114
	G	−0.072	0.769	0.792	−0.128

[1],*,** Significant at P = 0.05 and P = 0.01, respectively (df = 28)

diseases and also affects photosynthesis. Differences in leaf size are relevant because this will have an effect on canopy thickness. Pod volume is an indicator of seed size, an important diagnostic trait and component of seed yield. A high pod-filling percentage indicates a positive relationship between pod volume and seed size, and should result in more effective selection in segregating populations.

Considerable variation was observed for five traits (Table 1). Leaf area showed about an eightfold variation, pod volume 13-fold, pod-filling percentage sevenfold and seed mass 13-fold. The broad-sense heritability (h^2) estimates of the five traits were in the range of 0.850–0.985, indicating large genetic effects relative to environmental effects. High estimates of h^2 for time to flowering, leaf area and seed size have been reported previously (Jivani and Yadvendra 1988, Sandhu et al. 1988, Sadhu and Mandal 1989, Singh et al. 1990, Misra 1991, Pundir et al. 1991), and our results are of the same order. The h^2 of pod volume and pod-filling percentage are reported for the first time; the values were 0.984 and 0.850, respectively. This indicates that expression of both the traits was fairly consistent over environments.

The correlations between the five traits are given in Table 2. In general, the phenotypic and genotypic correlations showed similar trends and the genotypic values were similar or slightly greater than the phenotypic values. Time to flowering was negatively correlated with leaf area, whereas it was positively correlated with pod-filling percentage. Time to flowering, however, did not reveal any particular relationship with pod volume and seed mass, indicating that it should be possible to combine crop duration and seed size in any desired fashion. Leaf area showed a strong positive relationship with pod volume and seed mass, but was negatively correlated with pod-filling percentage. Pod volume and seed mass were positively correlated, confirming the earlier observation by Pundir et al. (1992). The two traits, pod volume and pod-filling percentage were negatively correlated, indicating that an increase in pod volume will result in a decrease in pod-filling percentage.

Pod volume and pod-filling percentage have definite relationships with other relevant traits and showed fairly consistent expression and, therefore, can be used as additional traits for the characterization of chickpea lines. They may also have relevance as selection criteria in chickpea breeding.

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