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Short Communication

Inheritance of growth vigour and its association with other characters in chickpea

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With 2 tables

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Abstract

Growth vigour plays an important role in the establishment of a normal crop. The F_2 population of a cross between high- and low-growth vigour varieties of chickpea segregated into 15 high : 1 low growth vigour. The results for recombinant inbred lines and BC_1P_2 showed a good fit to the expected 3 : 1 ratio. The results indicated that growth vigour is controlled by two genes with duplicate dominant epistasis. No gene has so far been identified for growth vigour in chickpea. Correlation between growth vigour and other characters showed that high growth vigour had significant negative correlation with days to first flower, days to 50% flowering, days to first pod and days to maturity.

Key words: *Cicer arietinum* — growth vigour — drought stress

Drought is the most common abiotic stress limiting chickpea production in different parts of the world. Chickpea frequently suffers from drought stress towards the end of the growing season in rain-fed conditions. Inadequate soil moisture is one of the main constraints on the productivity of chickpea in the rain-fed farming systems of the dry areas in west Asia and north Africa (Saxena et al. 1990). Ninety per cent of the world's chickpea is produced in areas relying upon conserved, receding soil moisture; therefore, crop productivity is largely dependent on efficient utilization of available soil moisture (Kumar and van Rheenen 2000). Early growth vigour will help to utilize moisture better (Jain et al. 1998). Considerable losses are observed because of competition of the crop with weeds, particularly in irrigated and late-sown conditions (Lather et al. 1997). Poor early vigour can decrease yields; decreased emergence may lead to sub-optimal populations of irregularly distributed plants and any seedlings which do emerge will grow more slowly. This can affect final yields, even when the anticipated sub-optimal emergence is compensated for by increasing the seed rate (Roberts and Osei-Bonsu 1988). No published information on the inheritance of growth vigour in chickpea has been found so far. Therefore, this study was undertaken to investigate the inheritance of this trait and its association with other characters.

The high-growth vigour kabuli type ICCV2 and low growth vigour desi type JG62 of chickpea, *Cicer arietinum* L., were used as parents. The F_1 and F_2 generations were grown in 1993 and 1994 *Rabi* (post-rainy) seasons at ICRISAT. One hundred and twenty-six random F_2 plants were advanced to the F_9 generation through single-seed descent. Three generations were advanced per year under lights in a green house to rapidly achieve homozygous recombinant inbred lines (RILs). The experiments were conducted on conserved moisture in a deep vertisol field during the rabi (post-rainy season) 1998–1999, 1999–2000 and 2000–2001 at ICRISAT Patancheru near Hyderabad (latitude 17.6°N, altitude 550 m) Andhra Pradesh, India.

One hundred and twenty-six RILs, parents, F_1 and three checks were grown in an Alpha design with three replications. Each plot consisted of two rows of 4 m length with a 60 cm spacing between the rows and 10 cm between plants. The four generations (F_1, F_2, BC_1P_1 and BC_1P_2) were planted in an unreplicated design and planted as single rows with a spacing of 60 cm between rows and 20 cm between plants. Visual observations on growth were recorded at 15–20 days after germination, based on 1–5 scale. Ratings of 1 and 2 were grouped as low and those with 3–5 as high growth vigour. Visual observations on growth vigour were taken 20 days after germination and simultaneously recorded on three random plants for height and plant width in 2000–2001. The chi-squared test was used to test the goodness-of-fit to different genetic ratios.

Results

The segregation ratios are given in Table 1. The F_2 population segregated into 15 high : 1 low growth vigour indicating two genes. The results obtained in BC_1P_2 and RILs gave a good fit of expected 3 : 1 ratio for high and low growth vigour. Growth vigour was also studied in F_1 (JG62♀ × ICCV2♂ and ICCV2♀ × JG62♂) and BC_1P_1 (F_1♀ × ICCV2♂). Reciprocal crosses and BC_1P_1 plants had high growth vigour. High growth vigour had significant negative correlation with characters for earliness and number of branches, pods and seeds (Table 2). There was a positive correlation between growth vigour and 100-seed weight, leaf size and leaf weight and plant height but no consistent correlation with plant width and yield.

Discussion

The results of the present study indicated that growth vigour is controlled by two pairs of genes. Homozygous recessive condition for both loci is necessary for low growth vigour. No published information could be found on the inheritance of growth vigour of chickpea and the two genes were named as Gv_1 and Gv_2.

There are two main approaches to the breeding of plants for drought-prone environments. The conventional approach is to use seed yield under drought stress as the main selection criterion. The second involves the identification and selection

Table 1: Segregation for growth vigour in F_1, F_2, BC_1P_1, BC_1P_2, and recombinant inbred lines (RILs) of ICCV2 × JG62 cross of chickpea during 1998–1999 and 1999–2000

Year	Generations	Plant no. with growth vigour		Tested ratio	χ^2	P
		High	Low			
1998/1999	F_1 (JG62♀ × ICCV2♂)	29	0	–	–	–
1998/1999	F_2	191	11	15 : 1	0.22	0.64
1998/1999	RILs	91	25	3 : 1	0.73	0.39
1999/2000	F_1 (JG62♀ × ICCV2♂)	14	1	–	–	–
1999/2000	F_1 (ICCV2♀ × JG62♂)	19	0	–	–	–
1999–2000	F_2	279	27	15 : 1	3.45	0.06
1999–2000	BC_1P_1 (F_1♀ × ICCV2♂)	38	1	–	–	–
1999–2000	BC_1P_2 (F_1♀ × JG62♂)	32	5	3 : 1	2.60	0.11
1999–2000	RILs	81	35	3 : 1	1.66	0.20

Table 2: Correlation coefficient between initial growth vigour and some other characters in recombinant inbred lines (RILs)

Trait	RILs		
	1998–1999	1999–2000	2000–2001
Days to first flower	−0.98**	−0.99**	–
Days to first pod	−0.98**	−0.99**	–
Days to 50% flowering	−0.98**	−0.99**	–
Days to maturity	−0.95*	−0.99**	–
Plant height	–	–	0.99**
Plant width	–	–	0.10
Number of pods per plant	−0.90*	−0.98**	–
Number of primary branches per plant	−0.83	−0.95*	–
Number of secondary branches per plant	−0.98**	−0.98**	–
Number of seeds per plant	−0.92*	−0.99**	–
Number of seeds per pod	−0.85	−0.82*	–
Yield per plant	0.37	−0.30	–
100-seed weight	0.99**	0.99**	–
Leaf size	–	0.98**	–
Leaf weight	–	0.98*	–
Specific leaf weight	–	−0.95**	–

*, ** Significant at P = 0.05 and P = 0.01, respectively.

of morpho-physiological traits associated with drought tolerance, which was used here. Breeding efforts to increase drought resistance in chickpea are limited, despite the fact that drought is the most important yield-reducing factor in production (van Rheenen et al. 1990). A major reason for this has been a lack of reliable screening techniques for large-scale evaluation of germplasm and breeding materials. Although chickpea is more drought-resistant than other cool-season food legumes, drought is the most important yield reducer in this crop (Saxena 1987, Singh 1993, Johansen et al. 1994).

Landraces of chickpea, pigeonpea and groundnut growing in their natural environments often face terminal drought stress (Singh and Reddy 1986). For instance, newly-bred short-duration genotypes of groundnut are generally more successful compared with traditional long-duration genotypes in west African regions characterized by short growing seasons (Virmani and Singh 1986). There are many examples of development of short-duration pulses with the potential to increase yield and yield stability in drought-prone environments viz., chickpea (Gupta 1985, Singh et al. 1990, Kumar et al. 1996, Singh et al. 1997), cowpea (Hall and Patel 1985), pigeonpea (Laxman et al. 1990) and soybean (Rose et al. 1992).

High growth vigour had a significant negative correlation with measures of earliness such as days to first flower, so that genotypes with high growth vigour flowered, podded and matured earlier. Therefore, by selecting for high growth vigour a genotype may have an increased option for escaping terminal drought stress. These results confirmed the association between rapid seedling growth and early maturity, as suggested by Gupta (1985) and Singh et al. (1997) in chickpea and also the correlation between vigour scores and time of flowering reported by Silim et al. (1993) in lentil. Positive correlation between growth vigour and 100-seed weight, leaf size and leaf weight in this investigation support the findings of Black (1959) in herbage legume, Haskins and Gorz (1975) in sweet clover and Raje (1992) in chickpea. The selection of large-seeded varieties appears to result in better seedling vigour (Narayanan et al. 1981). Van der Maesen (1972) suggested that large-seeded varieties of chickpea produce larger and more vigorous seedlings that will have better stand establishment under adverse conditions. Singh et al. (1997) reported that seed yield under drought conditions was positively correlated with early plant vigour. It is clear that in drought conditions, early maturing chickpea genotypes have higher yields compared with late-maturing genotypes. But in general, when moisture is not limited, late-maturing genotypes have a higher yield potential than in genotypes with early maturity. Therefore, non-significant correlation between growth vigour and yield per plant may be due to the absence of drought conditions in the 2 years of the experiment.

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