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Short Communication

Identification of cold tolerant chickpea (*Cicer arietinum* L.) genotypes suitable for mid-hills of northern India

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Low temperature is a major constraint in chickpea (*Cicer arietinum* L.) production in the hilly zones. It was therefore, considered worthwhile to screen the chickpea genotypes for cold tolerance and to understand its association with other plant traits. A field experiment using 125 chickpea diverse cultures was conducted in augmented RBD design having five block and three checks during *rabi* 2003-04. The average minimum temperature during the crop season was 3.4°C (range : 0.7°C to 10.9°C). The plot size for each genotype was single row of 3 m length sown on November 21, 2003. Germination (at 25 days after sowing), days to anthesis (first flower opening), flowering (50%) and maturity of each genotype were recorded accordingly on plot basis. Following methods described earlier, pod partitioning coefficient (%) and pod setting (%) [1] of all the genotypes were recorded per plant sharply at the end of cold spell. Plant height (cm). grain yield (q/ha) and 100 seed weight (g) of each plot were measured at harvest. The .cold tolerance was scored on a 1-5 scale (1: > 75%; 2: 50-75%; 3: 25-50%; 4:5-25%; 5: < 5% pod set) sharply at the end of cold spell as described elsewhere [3]. Path analysis using cold tolerance, as dependent characters while other characters under study were treated as independent, was carried out following the method of Dewey and Lu [2].

Present study revealed that chickpea genotypes differed significantly for germination (14.13-95.23 %), days to anthesis (94.24-125.31), flowering (101.07-131.31), maturity (149.97-168.57), pod partitioning coefficient (0.01-53.35 %), pod setting (0.03-52.27), plant height (17.87-44.94 cm), 100 seed weight (11.02-29.59 g), grain yield (0.65-16.14 q) and cold severity score (1.98-5.01). Germination varied significantly among the chickpea genotypes. Chilling-sensitive plant species become restricted in their germination as they loss turgor and die under low temperature (0°-10°C) [3] Genetic variations in terms of days to flower, plant height, pod setting and partitioning under low temperature field conditions was also noted by earlier workers [1, 4].

Grain yield of chickpea genotypes ranged from 0.65 to 16.14 q/ha. The genotypes differed in reaction to low temperature. Cold severity, score (1-5 where, 1 = very tolerant-5 = susceptible) also varied from 2 (tolerant) to 5 (susceptible). Genetic variation for cold tolerance was also noted earlier [1, 5, 6]. Amongst the 125 genotypes only two genotypes namely 1C 268855 and 1C 269087 showed the cold tolerance while 74 genotypes were found moderately tolerant, 44 genotypes moderately susceptible and rest 5 genotypes were susceptible.

Germination, pod partitioning, pod setting and plant height exhibited significant positive association with grain yield while days to anthesis, flowering, maturity day had significant negative association with yield. Days to flowering, and maturity indicated the importance of earliness for high seed yield. Present results are in agreement of earlier report [7]. Grain yield also showed significant negative association with cold severity score which in turn indicated that cold tolerance is positively associated with high grain yield (Table 1). Cold severity score (1-5) showed significant negative association with germination, plant height, pod setting and partitioning while significant positive association with days to anthesis, flowering and maturity days which in turn suggested that pod setting, partitioning, plant height germination coupled with earliness may be considered the selections criteria for cold tolerance.

Important plant traits showed significant either negative or positive correlation with the cold severity. It was therefore, considered necessary to study the direct and indirect effects (Table 2) of various plant traits on cold tolerance. All the characters except pod setting were used as independent characters. Pod

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Table 1. Simple correlation coefficient amongst different plant traits under low temperature condition in chickpea

Plant traits	Yield (q/ha)	Germination (%)	Days to anthesis	Days to flower	Plant height (cm)	Pod setting (%)	Pod partitioning coefficient (%)	100 seed weight (g)	Maturity days
Germination (%)	0.803**								
Days to anthesis	–0.725**	–0.618**							
50% flowering days	–0.773**	–0.669**	0.959**						
Plant height (cm)	0.167*	0.0391	–0.453**	–0.454**					
Pod setting	0.510**	0.4.66**	–0.632**	–0.689**	0.395**				
Pod partitioning	0.541**	0.546**	-0.684**	–0.719**	0.224**	0.796**			
100 seed weight (g)	–0.303	–0.260**	0.349**	0.353**	–0.140	–0.252**	–0.289**		
Maturity days	–0.691**	–0.605**	0.890**	0.872**	–0.511**	–0.610**	–0.616**	0.317**	
Cold severity	–0.395**	–0.387**	0.505**	0.572**	–0.322**	–0.853**	–0.695**	0.162	0.497**

Table 2. Direct and indirect effects on cold severity score in chickpea

Plant traits	Yield (q/ha)	Germination (%)	Days to anthesis	Days to flower	Plant height (cm)	Pod partitioning coefficient (%)	100 seed weight (g)	Maturity days
Yieldt (g)	0.057	0.0457	–0.041	–0.044	0.010	0.031	–0.017	–0.039
Germinationt (%)	–0.006	–0.007	0.005	0.005	–0.001	–0.004	0.002	0.005
Days to anthesis	0.427	0.364	–0.590	–0.565	0.267	0.403	–0.206	–0.525
50% flowering	–0.470	–0.408	0.584	0.609	–0.276	–0.437	0.215	0.531
Plant heightt (cm)	–0.024	–0.006	0.066	0.066	–0.146	–0.033	0.020	0.075
Pod partitioning coefficient	–0.333	–0.337	0.421	0.443	–0.138	–0.616	0.178	0.380
100 seed wt. (g)	0.018	0.016	–0.021	–0.021	0.008	0.017	–0.060	–0.019
Maturity days	–0.063	–0.055	0.081	0.080	–0.047	–0.056	0.029	0.091
Cold severity score	–0.395**	–0.387**	0.505**	0.572**	–0.322**	–0.695**	0.162	0.497**

$P < 0.05$; $^{**}P < 0.01$

setting was not used in partitioning into direct and indirect effect because cold severity was scored using pod setting percent as a parameter [3]. The results revealed that the highest negative direct effect on cold severity was by partitioning coefficient (–0.616) followed by days to anthesis (–0.590) while days to flowering had a positive contribution towards cold severity. In addition, days to flowering, anthesis and maturity contributed to cold severity through pod partitioning coefficient, while yield and germination percentage negatively contributed to cold severity through pod partitioning coefficient. Similarly yield, germination percentage and pod partitioning coefficient were indirectly positively contributing through days to anthesis, while flowering and maturity were indirectly contributed to cold severity through days to anthesis. The contribution of days to anthesis, maturity and seed weight was indirect positive while other characters contributed negatively through days to flowering. The tolerance of the genotypes to cold may therefore be expressed as high pod set, high pod partitioning and earliness.

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