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Research Note

Genetic variability and trait association in chickpea (*Cicer arietinum* L.) genotypes at seedling stage

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Abstract :
Eighty elite lines including ten standard varieties of chickpea were evaluated for various seedling parameters. Positive and significant genotypic and phenotypic correlations were found for different parameters like seedling length, root length, root/shoot ratio, seedling biomass, leaf length, leaf width and leaf area while root length was positively and significantly correlated with other parameters. Root/shoot ratio was positively and significantly correlated with all parameters. Seedling biomass had positive and significant genotypic and phenotypic correlations with all the parameters. Leaf length, leaf width and leaf area also had positive and significant correlation among each other and with other parameters. The estimates of the heritability were high for seedling length, root length, moderate for the root/shoot ratio, seedling biomass and primary leaf area and slightly low for the primary leaf length and leaf width. Higher estimates of heritability and positive correlation coefficients for seedling length, root length, seedling biomass, leaf length, leaf width and leaf area suggest that selection of elite genotypes at seedling level might be effective for further breeding programme.

Key words:
Cicer arietinum, variability, heritability, correlation.

Chickpea (*Cicer arietinum* L.) ranked first in south Asia and second most important cool season pulse crop worldwide. It is grown in about 33 countries of central and west Asia, Europe, Ethiopia, North Africa, North and South America and Australia (Ladizinsky and Alder, 1976; Singh and Ocampo, 1997). It has manifold benefits both for human and livestock as the pods and seed coats can be utilized as fodder. Chickpea is the cheapest and readily available source of protein (19.5%), fats (11.4%), carbohydrates (57-60%), ash (4.8%) and moisture (4.9-15.59%) (Huisman and Van der Poel, 1994). Apart from providing dietary benefits to human beings chick pea is very useful in the management of soil fertility due to its nitrogen fixation ability (Maiti 2001; Kantar *et al*., 2007).

It has two cultivated types i.e. Kabuli and Desi based on seed size, shape and colour. The former is grown in temperate regions while the latter i.e desi type is grown in semi-arid tropics (Muehlbauer and Singh, 1987). 'Kabuli' types had large creamy seeds with no anthocyanin while 'desi' chickpeas are small seeded with various colours, purplish flowers and have anthocyanin pigmentation. Chickpea is the most important *rabi* pulse crop of Pakistan predominantly grown in vast rainfed area of 1046 thousand hectares with an annual production of 823 thousand tons and an average yield of 786.68 kg/ha (Anon., 2007-2008).

Despite its nutritional values and economic importance, chickpea grain production is relatively low in Pakistan as compared to world. Advances and modifications in plant breeding and agricultural systems have narrowed the genetic base of cultivated chickpea (Robertson *et al*., 1997). These modifications compelled plant breeders to explore new sources of variation that might be used in plant breeding programs (Brown *et al*., 1990). Genetic variability is a prerequisite for any breeding programme, which provides opportunity to a plant breeder for selecting high yielding genotypes. Present study was conducted to collect information on genetic variability for seedling parameters and their associations in chickpea to suggest some seedling selection criteria for future breeding programme.

This study was conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during *rabi* 2007-2008. Seventy elite genotypes including ten check varieties (AUG-27, AUG-424, AUG-786, Balkasar-2000, Bittle-98, CM-98, Piadar-91, Pb2000, Noor-91 and Wanhar-

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2000) were sown in RCBD with three replications. Seedling lengths were calculated after eight days as 100 per cent germination completed after first seedling emergence. Similarly, the data of ten seedlings per replication for other seedling parameters were recorded and subjected to statistical analysis (Steel and Torric., 1997). Genotypic and phenotypic correlation coefficients were calculated (Kown and Torrie. 1964). The estimation of heritability and genetic advance were calculated as described by Falconer (1989).

The highest genotypic and phenotypic variances were found for root length, while the lowest genotypic and phenotypic variances were observed for primary leaf length (Table 2). Low coefficient of variation was found for seedling shoot length (0.76%) moderate for root length (2.48%), seedling biomass (2.81%) and root/shoot ratio (3.74%) while primary leaf length, leaf width and leaf area (5.76%, 5.56% and 5.24%, respectively) had high coefficients of variability in chickpea (Table 2). Phenotypic coefficients of variation were found lower for primary leaf length, leaf width, root/shoot ratio (0.589%, 0.567% and 0.645%) and seedling biomass (0.924%). It was moderate for seedling length (4.178%) and primary leaf area (3.831%) but higher genotypic coefficient of variation was found for root length (10.056%). Genotypic coefficients of variability were observed lower for primary leaf length, leaf width, root/shoot ratio (0.652%, 0.607% and 0.662%) and seedling biomass (0.950%) while it was moderate for seedling length (4.021%) and primary leaf area (3.926%) but higher genotypic coefficient of variation was found for root length (10.259%). Wahid and Ahmed (1999) studied that the phenotypic coefficient of variation was found greater than GCV and ECV. Regarding means for seedling length, the genotypes 1288, 781, CM-98, 5006 and 698 remained at top (Table 2), while for shoot length the genotypes1002, Bittle-98, 1006, 1288 and 620 gave highest mean values. Maximum root shoot ratio was shown by the genotypes 5006, 1049, 117, 1288 and CM-98 and maximum seedling biomass exhibited by the genotypes i.e., 1004, CM-88, 810, Pb2000 and AUG-27. Maximum primary length was obtained from the genotypes like Pb2000, 117, 119, 210 and CM-98 and maximum leaf width shown by the strains i.e., 810, Pb2000, AUG-27, 848 and CM-98. Maximum mean primary leaf area was obtained from genotypes like 810,161, 210, 5006 and 103 respectively.

High heritability estimates (Table 2) were observed for seedling length (99.21%), root length (98.03%), root-to-shoot ratio (97.34%), seedling biomass (97.17%) and primary leaf area (97.56%) while it was slightly less for primary leaf length (90.42%) and primary leaf width (93.48%). These results are in agreement with the findings of Waldia *et al*. (1991) who reported high heritability estimates for seed mass, shoot length, root length and seedling biomass. But Arshad *et al*. (2002) observed high heritability and genetic advance for plant height.

Ozcelik and Bozoglu (2004) also found high heritability and correlation between seed yield and some characters of newly registered chickpea (*Cicer arietinum* L.) cultivars. High heritability and high genetic advance is indicative of additive genetic effects. As far as the genetic advance is concerned in this study high values of 148.23, 173.125, 16.771, 8.564, 34.466, 9.571 and 7.884 were found for all the traits, respectively (Table 2) thus showing the presence of additive genetic effects. These results are in agreement with the findings of Waldia *et al*. (1991) who reported highest genetic advance for root length and seedling length. Kashiwagi *et al*., (2006) investigated genetic variability of root traits and found moderate heritability. They also concluded that root trait study provide valuable information through which we can study the phenomena of drought avoidance in chick pea genotypes

The genotypic and phenotypic correlations among the seedling traits are presented in Table 3. The seedling length was positive and significantly correlated with the root length, root/shoot ratio, seedling biomass, primary leaf length, leaf width and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. Wahid and Ahmed (1999) studied a strong and positive correlation for plant height and pods per plant with seed yield in chickpea (*Cicer arietinum* L.). The root length was positively correlated with the seedling length, seedling biomass, primary leaf length, leaf width and leaf areas ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. The selection can be made on the basis of root length for drought tolerance.

The root/shoot ratio was positively correlated with the seedling length, seedling biomass, primary leaf length, leaf width and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. The seedling biomass was positively correlated with the primary seedling length, root length, root/shoot ratio , primary leaf length, leaf width and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. Toker and Cagirgan

(2004) estimated that the grain yield was positively and significantly correlated with biological yield and with some other traits.

The primary leaf length was positively correlated with the seedling length, root length, root/shoot ratio, seedling biomass, leaf width and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. Rehman *et al*. (1996) reported that grain yield was positively associated with 100-seed weight, pods per plant, seeds per pod and plant height.

The primary leaf width was positively correlated with the seedling length, root length, root/shoot ratio, seedling biomass, leaf length and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. Wahid and Ahmed (1999) found that plant height and pods per plant had a strong and positive association with the seed yield.

The primary leaf area was positively correlated with the seedling length, root length, root/shoot ratio, seedling biomass, leaf length and leaf area ($P< 0.05$) at genotypic level while the correlation coefficient being highly significant ($P< 0.01$) at the phenotypic level. The broad and long primary leaf at the seedling stage could be used as an early and efficient indicator for the selection of large seeded and long hypocotyls plants in the segregation population (Khattak *et al*., 2003). On the basis of these results, it may be concluded that seedling length, root length, seedling biomass, leaf length, leaf width and leaf area are significantly related with the seedling health. The genotypes, 117, 119, 1004, 1288, 5006, and checks CM-98, Pb-2000, Noor-98 exhibited promising results for all the physiological traits studied. We may select these genotypes at seedling level.

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Table 1. Mean performance of genotypes for various characters

S.NO.	Genotypes	Seedling length (cm)	Root length (cm)	Root to shoot ratio	Seedling biomass (g)	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf area (cm^2)
1	1288	19.27	11.92	0.53	1.22	0.66	0.46	1.47
2	781	19.13	11.52	0.47	1.16	0.66	0.46	1.46
3	CM-98	18.76	11.48	0.47	1.16	0.65	0.45	1.43
4	5006	18.67	11.47	0.47	1.16	0.65	0.45	1.42
5	698	18.43	11.39	0.46	1.15	0.65	0.44	1.36
6	Bittle-98	18.38	11.29	0.46	1.15	0.64	0.44	1.29
7	Pb2000	18.29	11.28	0.46	1.15	0.64	0.44	1.29
8	205	18.23	11.23	0.45	1.13	0.64	0.44	1.28
9	117	18.21	11.03	0.45	1.13	0.64	0.43	1.23
10	1205	18.17	11.01	0.45	1.13	0.62	0.43	1.23
11	1007	18.11	10.98	0.45	1.13	0.62	0.43	1.23
12	Wanhar-2000	18.09	10.89	0.44	1.13	0.61	0.43	1.19
13	27-Aug	18.01	10.83	0.44	1.13	0.61	0.43	1.18
14	620	17.99	10.75	0.43	1.12	0.61	0.42	1.17
15	9605	17.96	10.66	0.43	1.12	0.61	0.42	1.17
16	1014	17.91	10.60	0.43	1.11	0.61	0.42	1.16
17	810	17.89	10.54	0.43	1.11	0.61	0.42	1.15
18	114	17.86	10.53	0.43	1.11	0.61	0.42	1.15
19	1006	17.85	10.53	0.43	1.11	0.61	0.42	1.15
20	115	17.82	10.53	0.42	1.11	0.61	0.42	1.15
21	118	17.69	10.53	0.42	1.11	0.61	0.42	1.14
22	2006	17.67	10.47	0.42	1.09	0.61	0.41	1.14
23	1049	17.63	10.44	0.41	1.09	0.60	0.41	1.14
24	868	17.60	10.44	0.40	1.09	0.60	0.41	1.13
25	212	17.57	10.41	0.40	1.09	0.60	0.41	1.13
26	102	17.56	10.38	0.39	1.08	0.60	0.41	1.13
27	112	17.55	10.35	0.38	1.08	0.60	0.41	1.12
28	Paidar-91	17.55	10.34	0.38	1.08	0.59	0.41	1.12
29	818	17.51	10.34	0.37	1.07	0.59	0.41	1.11
30	Balkasar-2000	17.49	10.34	0.37	1.07	0.59	0.41	1.10
31	5008	17.48	10.31	0.37	1.06	0.59	0.41	1.10
32	103	17.45	10.28	0.37	1.06	0.59	0.41	1.10
33	4025	17.44	10.27	0.37	1.06	0.59	0.41	1.09

Table 1. Contd..

S.NO.	Genotypes	Seedling length (cm)	Root length (cm)	Root to shoot ratio	Seedling biomass (g)	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf area (cm^2)
34	1005	17.43	10.25	0.37	1.06	0.58	0.41	1.09
35	1002	17.42	10.25	0.37	1.05	0.58	0.40	1.09
36	101	17.41	10.20	0.37	1.05	0.58	0.40	1.09
37	932	17.39	10.17	0.37	1.05	0.58	0.40	1.08
38	62262	17.37	10.16	0.37	1.05	0.58	0.40	1.08
39	820	17.36	10.09	0.36	1.04	0.58	0.40	1.08
40	1017	17.35	10.09	0.36	1.03	0.58	0.40	1.08
41	4047	17.31	10.08	0.36	1.03	0.58	0.40	1.07
42	2008	17.31	10.01	0.36	1.03	0.57	0.40	1.07
43	110	17.25	10.01	0.36	1.03	0.57	0.40	1.07
44	406	17.25	9.99	0.36	1.03	0.57	0.40	1.07
45	161	17.23	9.99	0.36	1.02	0.57	0.40	1.06
46	1001	17.22	9.91	0.36	1.02	0.57	0.40	1.06
47	1021	17.15	9.86	0.36	1.01	0.57	0.40	1.05
48	119	17.13	9.80	0.36	0.99	0.56	0.40	1.05
49	1010	17.12	9.71	0.35	0.99	0.56	0.39	1.05
50	120	17.09	9.62	0.35	0.99	0.56	0.39	1.05
51	1015	17.07	9.57	0.35	0.99	0.56	0.39	1.05
52	214	17.07	9.55	0.35	0.98	0.56	0.38	1.05
53	217	17.01	9.54	0.35	0.97	0.56	0.38	1.04
54	106	17.00	9.53	0.35	0.96	0.56	0.38	1.04
55	108	16.73	9.47	0.35	0.96	0.56	0.38	1.03
56	635	16.70	9.42	0.35	0.96	0.56	0.38	1.03
57	1118	16.69	9.41	0.35	0.96	0.55	0.37	1.03
58	709	16.63	9.40	0.35	0.96	0.54	0.36	1.02
59	1004	16.57	9.35	0.35	0.96	0.53	0.36	1.02
60	846	16.56	9.32	0.35	0.95	0.53	0.35	1.01
61	1012	16.54	9.26	0.35	0.95	0.53	0.34	1.00
62	219	16.51	9.25	0.35	0.95	0.53	0.34	0.96
63	AUG-786	16.49	9.25	0.34	0.95	0.53	0.33	0.96
64	1003	16.47	9.23	0.34	0.95	0.52	0.33	0.93
65	848	16.46	9.21	0.34	0.95	0.52	0.32	0.89
66	Noor-91	16.45	9.18	0.34	0.94	0.49	0.32	0.85

Table 1. Contd..

S.NO.	Genotypes	Seedling length (cm)	Root length (cm)	Root to shoot ratio	Seedling biomass (g)	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf area (cm^2)
67	1154	16.45	9.15	0.33	0.94	0.48	0.32	0.80
68	4009	16.45	9.14	0.33	0.93	0.48	0.32	0.80
69	206	16.42	8.85	0.33	0.92	0.48	0.32	0.79
70	1201	16.22	8.79	0.33	0.91	0.48	0.32	0.78
71	1036	16.11	8.57	0.33	0.89	0.47	0.32	0.77
72	1013	16.10	8.53	0.33	0.88	0.46	0.31	0.75
73	210	16.01	8.51	0.32	0.88	0.46	0.31	0.72
74	1276	15.83	8.41	0.32	0.86	0.45	0.31	0.72
75	107	18.81	8.37	0.32	0.85	0.45	0.31	0.71
76	2009	15.70	8.23	0.31	0.85	0.44	0.30	0.68
77	220	15.63	7.63	0.31	0.83	0.44	0.30	0.60
78	405	15.50	7.35	0.31	0.82	0.44	0.30	0.56
79	290	15.43	7.31	0.31	0.81	0.43	0.26	0.56
80	AUG-424	15.24	6.99	0.29	0.75	0.42	0.26	0.45

Table 2. Genetic parameters for various seedling traits in chickpea

Traits	Coefficient of variation (%)	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Environmental coefficient of variation (%)	Broad sense heritability (%)	Genetic advance (%)	Standard error of heritability.
Seedling shoot length	0.76	4.178	4.021	0.033	99.21	148.230	0.001
Seedling root length	2.48	10.056	10.259	0.202	98.03	173.250	0.001
Root/shoot ratio	3.74	0.645	0.662	0.018	97.34	16.771	0.018
Seedling biomass	2.81	0.924	0.950	0.027	97.17	8.564	0.009
Primary leaf length	5.76	0.589	0.652	0.062	90.42	9.571	0.015
Primary leaf width	5.56	0.567	0.607	0.039	93.48	7.884	0.019
Primary leaf area	5.24	3.831	3.926	0.096	97.56	34.466	0.005

Table 3. Genotypic and phenotypic correlation of seedling traits in chickpea

Traits	Correlation#	Seedling root length	Root/shoot ratio	Seedling biomass	Primary Leaf length	Primary leaf width	Primary leaf area
Seedling shoot length	**G**	0.754*	0.358*	0.507*	0.602*	0.589*	0.422*
	P	0.742**	0.351**	0.499**	0.572**	0.537**	0.415**
Seedling root length	**G**		-0.094	0.481*	0.559*	0.510*	0.404*
	P		-0.091	0.472**	0.529**	0.491**	0.397**
Root/shoot ratio	**G**			0.370*	0.328*	0.249*	0.185*
	P			0.359**	0.308**	0.236**	0.180**
Seedling biomass	**G**				0.490*	0.393*	0.231*
	P				0.457**	0.374**	0.224**
Primary leaf length	**G**					0.920*	0.844*
	P					0.847**	0.802**
Primary leaf width	**G**						0.827**
	P						0.803**

 # G = genotypic and P = Phenotypic

*** , ** Significant at 5 and 1 % probability level respectively**