INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
11–045/AWB/2011/13–6–1033–1036
http://www.fspublishers.org

Short Communication

Genetic Analysis of Physiochemical Traits in Chickpea (*Cicer arietinum*) Seeds

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ABSTRACT

Forty genotypes of chickpea were evaluated to estimate genetic variability, heritability, genetic gain and correlation among physiochemical traits. Significant genotypic differences were revealed for all traits except hydration index. Maximum 100-seed weight of 35.7 g was recorded in genotype NCS-0607 and NCS-0529, seed volume of 0.28 mL seed^{-1} in Flip 02-18C, hydration capacity of 10.37 g seed^{-1} in Flip 02-36C and swelling capacity of 0.94 mL seed^{-1} in NCS-0708. The high phenotypic and genotypic coefficients of variation were observed for 100 seed weight, seed volume and hydration capacity i.e., 17.89, 22.02 and 17.82, respectively. High heritability and genetic gain was observed in all characters except hydration index. A positive and significant association of 100-seed weight occurred with seed volume (0.723), with hydration capacity (0.732) and with swelling capacity (0.695). Seed volume showed positive correlation with hydration capacity (0.651) and swelling capacity (0.311). Genotypes Flip 02-63C, NCS-0708, NCS-0529, AZC-06, Punjab-2008, CMC-211S appeared promising based on their phenotypic performance. Selection was based on swelling capacity in small and medium seeded genotypes. Hydration capacity, hydration index and swelling capacity in large seeded genotypes may prove advantageous for improvement of physiochemical traits in chickpea.

Key Words: Chickpea; Heritability; Physiochemical traits; Correlation; Genetic variability

INTRODUCTION

Chickpea (*Cicer arietinum*), an important grain legume crop, is cultivated in about 45 countries of the world in diverse climatic regions. Among grain legumes, it acquires fourth position based on cropped area and fifth regarding production in the world (FAO-STAT, 2008). Chickpea is an excellent source of protein and carbohydrate and its protein is of high quality as compared to other pulse crops (Ercan *et al.,* 1995). A number of vital mineral like calcium, magnesium, zinc, potassium, iron, phosphorus and vitamins thiamine and niacine required by human body are also found in chickpea (Zia-Ul-Haq *et al.,* 2007). Along with dietary value, chickpea eminence is also judged by physiochemical and cooking traits (Patane, 2006), which are very important attributes. Intensive efforts are in progress for the genetic improvement in chickpea with regard to high yield, early maturity and multiple disease resistance. However, such efforts are lacking for quality traits. By and large, the breeding for improvement of quality traits requires variation among the genetic materials to be used for breeding purposes.

Genetic analysis of seed quality traits is prerequisite for breeders in selection of desired genotypes. The variation in seed physical parameters depends upon numerous factors such as genotype, seed characteristics, seed composition, climatic factors etc. A few reports are available on various quality traits and their utilization in breeding programs. Waldia *et al.* (1996) evaluated kabuli chickpea genotypes for seed physical and gravimetric properties and their role in cooking quality; Yadav and Sharma (1999) had found substantial variation for seed weight in more than 100 chickpea genotypes. Mehla *et al.* (2001) studied 55 chickpea genotypes for physical characters. Seed mass, seed volume, swelling capacity and hydration capacity were important quality attributes that were mutually correlated. Singh *et al.* (2003) estimated genetic diversity for consumer's quality traits in chickpea. Dry and soaked weight of 100 grains, seed volume, hydration capacity and swelling capacity contributed towards genetic diversity.

The provision of realistic estimates is imperative for deciding an efficient and effective selection strategy regarding quality traits in breeding program. The current study was carried out to evaluate released varieties, newly developed breeding lines of Desi chickpea and some exotic Kabuli chickpea lines for seed quality parameters.

MATERIALS AND METHODS

Experimental details: Twenty two desi and 18 kabuli type chickpea varieties and lines were evaluated in randomized complete block design with two replications during 2008-

To cite this paper: Malik, S.R., M. Saleem, U. Iqbal, M.A. Zahid, A. Bakhsh and S.M. Iqbal, 2011. Genetic analysis of physiochemical traits in chickpea (*Cicer arietinum*) seeds. *Int. J. Agric. Biol*., 13: 1033–1036

2009 at the research area of pulses program, NARC, Islamabad. Three composite samples were drawn randomly from each plot for recording observations on seed quality traits viz., 100-seed weight, seed volume, hydration capacity, hydration index, swelling capacity and swelling index using procedures described by Williams *et al.* (1983). Methods used in recording data on these traits are briefly expressed below:

Seed characteristics: Three randomly selected samples of 100 seed, from the bulk grain produced from each plot, were weighed to get 100 seed weight. For seed volume, 100 seeds were taken in a 250 mL graduated cylinder and 25 mL of deionized water was put in it and volume of seed was found by Seed volume = total volume-25/100. Seed hydration capacity was calculated as percentage using the formula:

$$HC = (W_f - W_0)/100$$

Where, W_f is the weight of 100 seed soaked for 24 h and W_0 is the weight of 100 seed without soaking. Seed hydration index was computed as the ratio between hydration capacity and seed weight and estimated according to equation: HI = hydration capacity/seed weight. Seed swelling capacity was determined using the formula:

$$SC = (V_f - V_0)/100$$

Where, V_f is the volume of 100 seed after 24 h soaking and V_0 is the volume of 100 seed before soaking. Seed swelling index was measured as ratio between swelling capacity and seed volume and estimated according to equation: Swelling index= swelling capacity/seed weight.

Statistical analysis: The data were used in estimation of analysis of variance (Steel & Torrie, 1980) to determine the significance difference between genotypes. Genetic parameters and correlation coefficients were worked out according to the method suggested by Singh and Chaudhary (1979) using software package M STAT-C.

RESULTS

Data on 40 chickpea genotypes and six physiochemical traits are presented in Table I. Investigation of variance proved significant genotypic distinctions for the entire traits under study except hydration index. One 100 seed weight ranged from 16.64 g (Paidar-91) to 35.69 g (NCS-0607 & NCS-0529). Seed volumes varied from 0.11 mL/seed recorded in variety Lawagar to 0.28 mL/seed in Flip 02-18C. Lowest value for hydration capacity was observed in Paidar-91 (0.14 g seed^{-1}), while the line Flip 02-63C (10.37 g seed^{-1}) showed maximum hydration capacity value. The swelling capacity ranging from 0.60-0.94 mL/seed and swelling index (2.28-3.78) varied significantly among 40 genotypes. The maximum swelling capacity was observed in NCS-0708, followed by F02-18C and the minimum swelling capacity was observed in Paidar-91. The phenotypic and genotypic coefficients of variation expressed in terms of percent were comparatively high for 100 seed weight, seed volume and hydration capacity (17.89, 22.02 & 17.82, respectively).

The estimates of range, phenotypic and genotypic coefficients of variability are presented in Table II. Maximum heritability and genetic gain was observed in all characters except hydration index. High heritability was recorded in 100 seed weight (0.99), followed by seed volume (0.95) and swelling index (0.91). Genetic advance varied from hydration index of 6.64 to seed volume of 44.25.

Correlation coefficients of six quality parameters are presented in Table III. The results indicated that 100-seed weight had significant positive association with seed volume (0.723), hydration capacity (0.732) and swelling capacity (0.695). This trait was negatively correlated with hydration index and swelling index. Seed volume showed positive interrelationship with hydration capacity (0.651) and swelling capacity (0.311): however, it had strong negative correlation with swelling index (-0.753). Hydration index and swelling capacity also had significant positive association with hydration capacity. Swelling capacity and index were negatively correlated.

DISCUSSION

The success of breeder in selecting genotypes possessing higher yield and suitable quality parameters lies largely on the existence and exploitation of genetic variability to the fullest extent. The estimates of phenotypic coefficients of variability for all traits indicated that environment does have effect on these parameters. The difference between genotypic variance (GCV) and phenotypic variance (PCV) for 100 seed weight, seed volume, hydration capacity and swelling index was little, indicating the minimum influence of the environment for its expression. Ali *et al.* (2002), Patane *et al.* (2004), Singh *et al.* (2003) and Lokare *et al.* (2007) observed little influence of environment on seed physiochemical traits in chickpea.

Genotypic and phenotypic variances make available the information of variability only but the heritable portion of this variation is determined by the estimates of heritability. Genetic structure of the breeding materials determines the extent of heritability of various characters (Kahirizi *et al.*, 2010). For that reason awareness of these values of the resources in which breeders are paying attention is of enormous importance. High heritability estimates signify the effectiveness of these characters through selection for crop improvement, as less environmental influences are involved in it (Maniee *et al.*, 2009). Highest heritability together with high genetic advance expressed as percent average in 100 seed weight, seed volume and swelling index suggested effective selection for these characteristics. Pandey *et al.* (2007) and Malik *et al.* (2010) reported the high heritability and genetic advance in chickpea lines for these traits.

Table I: Mean performance and analysis of variance for quality traits in 40 chickpea genotypes

Genotypes	100 seed weight (g)	Seed volume (ml/seed)	Hydration capacity (g/seed)	Hydration Index	Swelling capacity (ml/seed)	Swelling index
DASHT	27.26	0.23	0.25	0.90	0.79	2.88
PARBAT	23.65	0.18	0.22	0.96	0.69	2.96
BITTAL-98	29.03	0.23	0.26	0.88	0.78	2.68
PUNJAB-2000	32.03	0.26	0.28	0.87	0.85	2.66
PUNJAB-91	25.92	0.2	0.24	0.92	0.75	2.90
C-44	27.29	0.22	0.25	0.91	0.76	2.75
CM-98	29.92	0.21	0.26	0.88	0.79	2.66
CM-72	20.09	0.16	0.20	0.98	0.75	3.72
THAL-2000	28.99	0.21	0.25	0.87	0.81	2.79
KK-1	18.97	0.15	0.18	0.94	0.70	3.70
SHEENGAR	29.97	0.14	0.26	0.88	0.85	2.83
KK-2	26.38	0.2	0.24	0.90	0.73	2.73
PAIDAR-91	16.64	0.12	0.14	0.89	0.63	3.92
DG-89	22.99	0.18	0.24	1.03	0.72	3.16
PUNJAB-2008	24.04	0.16	0.28	1.17	0.79	3.30
CM-2008	24.11	0.21	0.25	1.01	0.74	3.05
CMC211S	26.67	0.16	0.24	0.92	0.78	2.96
CMC59S	25.95	0.19	0.24	0.95	0.72	2.80
AZC-06	28.97	0.23	0.28	0.97	0.75	2.60
SL-03	27.06	0.22	0.26	0.94	0.72	2.65
A16*ICCI1597	19.82	0.14	0.18	0.92	0.67	3.43
A16*ICCI3416/2	19.16	0.14	0.17	0.88	0.67	3.47
CM-2000	28.12	0.2	0.24	0.86	0.74	2.62
NOOR-91	24.95	0.19	0.22	0.90	0.71	2.86
KC-98	31.94	0.26	0.26	0.82	0.65	2.05
LAWAGAR	27.24	0.11	0.23	0.85	0.85	3.09
DG-92	18.56	0.13	0.17	0.93	0.69	3.78
70022	25.45	0.19	0.23	0.93	0.75	2.99
NCS-0607	35.69	0.27	0.32	0.90	0.81	2.28
NCS-0534	29.02	0.22	0.25	0.88	0.75	2.59
NCS-0529	35.69	0.27	0.36	1.00	0.86	2.42
NCS-0616	32.38	0.23	0.30	0.94	0.84	2.62
NCS-0707	30.47	0.24	0.28	0.94	0.75	2.49
NCS-0708	33.71	0.15	0.30	0.91	0.93	2.78
F02-49C	29.39	0.22	0.28	0.95	0.79	2.70
F02-18C	36.54	0.28	0.34	0.93	0.87	2.36
F02-61C	31.56	0.24	0.30	0.96	0.84	2.68
F01-63C	33.15	0.21	0.21	0.64	0.79	2.36
NCS-0623	29.50	0.21	0.21	0.73	0.78	2.67
F02-63C	27.84	0.26	0.37	1.35	0.84	3.03
Mean Squares	48.186**	0.004**	0.005**	0.022 $^{N.S}$	0.009**	0.354**
CV%	1.12	4.67	12.61	12.93	4.19	4.44

^{NS}: Not significant, **: Highly significant at 5.0% LSD = Level of significant difference

Table II: Genetic analysis of seed physical quality traits in 40 chickpea genotypes

Character	Mean	SE	Range	GCV%	PCV%	H^2 (B.S)	GA
100 seed weight (g)	27.41	0.546	16.07-36.86	17.89	17.93	0.996	10.08
Seed volume (ml seed^{-1})	0.20	0.005	0.10-0.28	22.02	22.58	0.951	0.09
Hydration capacity (g seed^{-1})	0.25	0.006	0.14-0.41	17.82	21.82	0.667	0.08
Hydration index	0.92	0.015	0.52-1.49	6.84	14.51	0.222	0.06
Swelling capacity (ml seed^{-1})	0.77	0.008	0.60-0.94	8.25	9.22	0.800	0.12
Swelling index	2.87	0.048	2.03-3.95	14.30	14.96	0.914	0.81

Table III: Association among quality traits in 40 chickpea genotypes

	Seed volume	Hydration capacity	Hydration. Index	Swelling capacity	Swelling index
100 seed wt	0.723**	0.732**	-0.145	0.695**	-0.883
Seed volume		0.651**	0.070	0.311**	-0.753**
Hydration capacity			0.557**	0.624**	-0.602**
Hydration. Index				0.054	0.193
Swelling cap					-0.325**

**Highly significant at 5.0% level

Seed size (weight & volume) is an important attribute that determine the consumer preference and cooking quality of chickpea cultivars. Seed weight had positive and significant correlations with hydration capacity, seed volume and swelling capacity. Iqbal *et al.* (2006) found that seed size was related to hydration and swelling capacities. Khattak *et al.* (2006) and Nizakat *et al.* (2007) reported the strong and positive correlation between seed size and hydration capacity, seed volume and swelling capacity. Positive association between seed volume and hydration capacity showed that there was an increase in volume of seed after over night soaking in water. Hydration index exhibited insignificant correlation with swelling capacity and swelling index, where as swelling capacity and swelling index had significant negative association. These findings were in contradiction with the results of Pandey *et al.* (2007) and this might be due to use of different genotypes.

It was observed that kabuli genotypes in general had high values of seed weight, hydration and swelling capacity than the desi ones, which indicate that seed coat differences may also affect these quality traits. Genotypes Flip 02-63C, NCS-0708, NCS-0529 (Kabuli) and AZC-06, Punjab-2008, CMC-211S (Desi) appeared promising based on their phenotypic performance. Selection based on swelling capacity in small and medium seeded genotypes, hydration capacity, hydration index and swelling capacity in large seeded genotypes may prove advantageous for improvement of quality traits in chickpea.

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(Received 17 January 2011; Accepted 05 May 2011)