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BREEDING HIGH YIELDING DESI CHICKPEA (*CICER ARIETINUM* L.) GENOTYPES FOR THE AGRO-CLIMATIC CONDITIONS OF NWFP

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Abstract

Seeds of the 2 local desi chickpea varieties viz., Pb-91and C-44 were irradiated through gamma rays at 200 and 300 Gy doses during the year 2000. The M_1 to M_4 generations were raised from 2000-2001 to 2003-2004 at NIFA experimental field, Peshawar. The selected high yielding mutants were evaluated in replicated yield trials during 2004-2005 for yield and some important agronomic traits. The mutants derived from Pb-91 ranged for days to 50% flowering, 90% pods maturity and plant height from 149 to 156 days, 192 to 201 days and 62 to 80 cm, respectively. 100 seed weight ranged from 19 to 23.1 g 100^{-1} seed weight. The mutants CMN-35-23 and CMN-20-7 exhibited the larger seed size. The mutants produced 760 to 1620 kg ha^{-1} seed yield and the mutant CMN-15-4 produced the maximum seed yield.

The mutants derived from C-44 had 50% days to flowering, 90% days to maturity and plant height from 130 to 153 days, 176 to 197 days and 55 to 69 cm, respectively. The 100 seed weight of all the mutants of C-44 ranged from 19.8 to 23.9 g 100^{-1} seed weight. The seed yield ranged from 885 kg ha^{-1} to 1552 kg ha^{-1}. The mutant CMN-4-25-13 produced the highest seed yield of 1552 kg ha^{-1}among the mutants derived from the parent C-44.

These mutants will be further evaluated in yield trials at the major chickpea growing areas in different locations for seed yield and stability test. The best performing mutant will be released as commercial variety for the agro-climatic conditions of NWFP and the rest will be utilized as germplasm in the chickpea breeding programmes in the country.

Introduction

Chickpea is the major pulse crop in Pakistan. It is normally grown on the sandy soils of the country where no other crop of the rabi season can grow (Khattak *et al*., 2007). For the last few years, this crop is being grown on irrigated lands in the chickpea growing regions after rice harvesting as a cereal-legume rotation to reduce the depletion of scarce soil nutrients (Mansoor, 2007). This rotation is very beneficial in the existing intensive agricultural system.

Chickpea growers of both the irrigated and rain fed areas need high yielding genotypes to compensate their needs, which they fulfill by growing wheat crop. Farmers of the irrigated areas can get hidden benefit as restoring nitrogen deficiency in their soils but at the same time they require to get cash return to meet their daily requirements after crop harvesting. The early quick vegetative growth of the crop prior to the flowering is one of the main ideotype required by the growers to use its young shoots as vegetable for human consumption and green fodder for their animals. The development of high yielding and large seed size genotypes is the most basic demand of the chickpea growers to get ultimate return from their product (Hassan & Khan, 1991; Hassan *et al*., 2001, Khattak *et al*., 2003; 2004). The large seed size in chickpea has been reported by many researchers as an important seed yield component (Waldia *et al*., 1991, 1996; Mehla *et al*., 2000; Khattak *et al*., 2003, 2004).

The development of high yielding and large seeded mutants through induced mutations and their evaluation in replicated yield trial have been described in this paper.

Materials and Methods

Dry (12% moisture content), uniform and healthy seeds of two desi chickpea varieties Pb-91 and C-44 were subjected to 200 and 300 Gy doses through gamma rays exposure using ^{60}Co gamma cell during the year 2000 and the treated seed was planted on the same day to raise M_1 generation during 2000-2001 at the research farm of Nuclear Institute for Food and Agriculture, Peshawar. All the M_1 plants were picked separately. The M_2 generation was space planted during 2001-2002 as plant progeny rows. Selections were made for more number of pods along with large seed size on single plant basis. The high yielding single plant mutants were planted as plant progeny rows in M_3 generation during 2002-2003 for further evaluation. The lines with phenotypic true breeding behaviour along with high seed yield potential were selected. The selected lines in M_4 generation were evaluated in Preliminary Yield Trials during 2003-2004 to confirm their breeding behavior. The selected high yielding mutants along with standard checks were further evaluated in replicated yield trials during 2004-2005 for yield and some important agronomic traits. The trials were conducted in Randomized Complete Block Design and each entry was planted in three replications with 6 rows per treatment in each replication and row length was maintained at 4 meter. The plant-to-plant and row-to-row space was maintained 10 cm and 40 cm respectively. The data were recorded as follows:

Days to flowering: Days from sowing to the initiation of first flower on 50% plants of a genotype (in a plot) in each replication.

Days to maturity: Days from sowing to 90% pods maturity on all plants of a genotype (in a plot) in each replication.

Plant height (cm): Average of the 10 plants height per replication recorded from base of the plant to the top peduncle on the main branch.

100 seed weight (g): Three random samples of 100 seed from a genotype per replication were weighed.

Seed yield kg ha^{-1}: The seed weight of the middle 4 harvested rows of a genotype in each replication was recorded in grams and converted to kg ha^{-1}.

The recorded data of the above mentioned parameters were subjected to analysis of variance (Steel & Torrie, 1980). All the calculations were performed through microcomputer program MSTAT-C (Michigan State University and Agricultural University of Norway).

Table 1. Performance of mutants (derived from Pb-91) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-15-1	Pb-91/M/15kr	153	198	65	21.3	1375
CMN-15-2	Pb-91/M/15kr	156	200	76	21.1	849
CMN-15-3	Pb-91/M/15kr	152	197	62	20.3	906
CMN-15-4	Pb-91/M/15kr	154	198	72	21.3	1620
CMN-20-5	Pb-91/M/20kr	156	199	71	19.7	1073
CMN-20-6	Pb-91/M/20kr	156	201	69	19.7	1318
NIFA-88	6153/M	152	193	63	15.3	719
NIFA-95	6153/M	152	194	69	16.5	865
SE		0.31	0.46	1.12	0.40	63.08
LSD 5%		0.9739	2.246	8.329	2.698	152.1

Table 2. Performance of mutants (derived from Pb-91) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-20-7	Pb-91/M	151	198	73	23	1563
CMN-20-8	Pb-91/M	152	197	78	20	1203
CMN-20-9	Pb-91/M	153	197	80	19	1521
CMN-20-10	Pb-91/M	153	194	77	21	1063
CMN-20-11	Pb-91/M	156	195	81	21	1229
CMN-25-12	Pb-91/M	150	195	70	20	1542
CMN-25-13	Pb-91/M	150	195	71	21	1354
CMN-25-15	Pb-91/M	151	192	68	20	1281
CMN-30-16	Pb-91/M	153	198	68	20	1490
NIFA-88	6153/M	149	192	60	15	1099
NIFA-95	6153/M	150	191	58	16	1047
SE		0.36	0.54	1.46	0.38	65.81
LSD 5%		1.358	3.020	7.049	1.695	151.5

Results and Discussion

The seed yield and other important agronomic traits of advanced mutants derived from Pb-91 along with standard checks evaluated in three sets of yield trials are presented in Tables 1, 2 and 3. In both trials the mutants were significantly different from each other for all the studied traits. The days to 50% flowering, 90% pods maturity and plant height ranged from 149 to 156 days, 192 to 201 days and 62 to 80 cm, respectively. The 100 seed weight ranged from 19 to 23.1 g 100^{-1} seed weight compared to average seed weight of 16 g 100^{-1} seed weight of the check varieties NIFA-88 and NIFA-95. The mutants CMN-35-23 and CMN-20-7 exhibited the larger seed size in both trials. The mutants derived from Pb-91 produced 760 to 1620 kg ha^{-1} yield compared to the average seed yield of 1132 kg ha^{-1} and 768 kg ha^{-1} by the check varieties NIFA-88 and NIFA-95, respectively. The mutant CMN-15-4 produced the maximum seed yield among all the mutants evaluated in these three yield trials.

Table 3. Performance of mutants (derived from Pb-91) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-30-17	Pb-91/M	151	193	66	19.9	867
CMN-30-18	Pb-91/M	152	197	69	21.9	1203
CMN-30-19	Pb-91/M	152	197	65	21.4	1141
CMN-30-20	Pb-91/M	153	194	68	21.5	760
CMN-35-23	Pb-91/M	152	197	68	23.1	1083
CMN-35-24	Pb-91/M	151	193	63	20.9	1203
CMN-35-25	Pb-91/M	149	193	63	20.5	1104
CMN-15-26	Pb-91/M	150	196	67	21.2	781
CMN-15-28	Pb-91/M	151	193	63	21.9	1091
NIFA-88	6153/M	150	190	56	16.4	578
NIFA-95	6153/M	151	191	55	16.4	391
SE		0.22	0.43	0.99	0.44	49.13
LSD 5%		1.247	1.105	6.430	2.316	146.8

Table 4. Performance of mutants (derived from C-44) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-4-15-1	C-44/M	151	194	64	20.1	1031
CMN-4-15-2	C-44/M	151	192	62	23.3	1307
CMN-4-15-3	C-44/M	152	194	61	21	1104
CMN-4-20-1	C-44/M	153	195	64	21.7	1469
CMN-4-20-2	C-44/M	152	197	67	21.3	1219
CMN-4-20-3	C-44/M	152	193	65	22.3	1042
CMN-4-20-4	C-44/M	152	195	67	20.6	885
CMN-4-20-5	C-44/M	152	195	67	21.7	1177
CMN-4-20-6	C-44/M	152	197	69	22.3	1505
CMN-4-20-7	C-44/M	151	197	64	21.5	974
NIFA-88	6153/M	148	191	60	16.6	516
NIFA-95	6153/M	150	191	61	16.7	594
SE		0.22	2.90	0.55	0.44	56.52
LSD 5%		1.194	2.526	2.819	2.841	105.8

The mutants derived from C-44 were evaluated in three sets of yield trials and the results are depicted in Tables 4, 5 and 6. Days to 50% flowering, days to 90% pods maturity and plant height of the mutants ranged from 130 to 153 days, 176 to 197 days and 55 to 69 cm, respectively. The 100 seed weight of all the mutants of C-44 ranged from 19.8 to 23.9 g 100^{-1} seed weight compared to the check varieties NIFA-88 and NIFA-95, which showed 16.8 and 17 g 100^{-1} seed weight, respectively. Seed yield of the mutants in these trials ranged from 885 kg ha^{-1} to 1552 kg ha^{-1}. The mutant CMN-4-25-13 produced the highest seed yield of 1552 kg ha^{-1}among the mutants derived from the parent C-44.

Table 5. Performance of mutants (derived from C-44) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-4-20-8	C-44/M	133	179	63	22.5	1000
CMN-4-25-1	C-44/M	133	178	57	21.3	1099
CMN-4-25-2	C-44/M	132	177	57	21.4	1271
CMN-4-25-3	C-44/M	132	176	54	21.5	1039
CMN-4-25-4	C-44/M	132	177	55	19.8	1042
CMN-4-25-5	C-44/M	133	177	58	23.2	1214
CMN-4-25-6	C-44/M	132	178	56	21.9	1036
CMN-4-25-7	C-44/M	130	177	56	23.9	1120
CMN-4-25-8	C-44/M	131	178	56	21.5	1021
CMN-4-25-9	C-44/M	132	178	56	22.3	1115
NIFA-88	6153/M	130	174	62	17.1	807
NIFA-95	6153/M	131	173	60	17.0	651
SE		0.22	0.34	1.07	0.40	24.76
LSD 5%		37.26	5.559	2.031	2.253	125.4

Table 6. Performance of mutants (derived from C-44) evaluated in replicated yield trial during 2004-2005.

Mutant	Pedigree/ Origin	Days to (50%) flowering	Days to 90% pods maturity	Plant height (cm)	100 Seed weight (g)	Yield kg/ha.
CMN-4-25-10	C-44/M	131	177	59	21.7	1354
CMN-4-25-11	C-44/M	131	178	65	23.3	1344
CMN-4-25-12	C-44/M	132	178	61	22.1	1286
CMN-4-25-13	C-44/M	131	178	58	22.1	1552
CMN-4-25-14	C-44/M	130	178	59	21.8	1229
CMN-4-25-55	C-44/M	131	177	61	23.3	1500
CMN-4-30-1	C-44/M	132	178	67	21.9	1495
CMN-4-30-2	C-44/M	132	178	65	22.2	1203
CMN-4-30-3	C-44/M	132	179	68	23.1	1604
CMN-4-30-4	C-44/M	133	178	70	23.9	1396
NIFA-88	6153/M	131	172	61	16.7	823
NIFA-95	6153/M	130	171	61	16.8	745
SE		0.21	0.42	0.93	0.43	47.20
LSD 5%		1.571	1.908	7.152	3.353	149.8

Mutation breeding particularly induced mutation has played an important role in developing many crop varieties in various parts of the world apart from enhancing the desired genetic variability in different traits of plants (Micke, 1988; Haq *et al*., 2003). Two desi chickpea varieties i.e., NIFA-88, NIFA-95 and a kabuli chickpea variety Hassan-2k have been developed through induced mutation and evolved for general cultivation in NWFP on the basis of high yield potential (Hassan & Khan, 1991; Hassan *et al*., 1997, 2001). Another chickpea variety CM-98 developed through induced mutation and a mungbean variety NM 98 developed through cross breeding have been evolved on the basis of high yielding for general cultivation in Punjab province (Haq *et al*., 1999; Siddique *et al*., 1999). The high yielding, large seed size with desired ideotype chickpea mutants suitable for NWFP chickpea growing areas developed through induced mutation have been reported by many researchers (Hassan & Khan, 1991; Javed & Hassan, 1995; Khattak *et al*., 2003, 2004).

The adaptation and stability evaluation of the developed mutants in multilocation and National Uniform Yield Trials would help to select the outstanding mutant for evolving as a chickpea variety for general cultivation in NWFP. The described high yielding and large seeded chickpea mutants in this paper would certainly be used to incorporate high yielding ability and large seed size in the well adapted local varieties by various chickpea breeding programs in the province.

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