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BREEDING HIGH YIELDING DESI CHICKPEA (*CICER ARIETINUM* L.) MUTANTS

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Abstract

Seeds of two desi chickpea varieties viz., Pb-91 and C-44 were irradiated at 300 and 400 Gys doses of gamma rays using ^{60}Co during the year 2004. Raised M_1 and advanced mutated segregating generations, and gained phenotypic homozygosity from 2004 to 2009. High yielding and large seeded mutants were evaluated in replicated yield trials during 2009-10. Days to 50% flowering, 90% pods maturity, plant height, 100-grains weight and seed yield for mutants derived from Pb-91 ranged from 120 to 124 days, 169 to 174 days, 77 to 87 cm, 22 to 24 g 100^{-1} grains and 1454 to 2011 kg ha^{-1}, respectively. Similarly, the same parameters for the mutants derived from C-44 ranged from 120 to 127 days, 167 to 175 days, 72 to 97 cm, 20-25 g 100^{-1} grains and 1079 to 2018 kg ha^{-1}, respectively. Mutant NDC-20-5, NDC-15-1, NDC-25-13 and NDC-30-16 derived from Pb-91 produced significantly higher seed yields of 2011 kg ha^{-1}, 1927 kg ha^{-1}, 1873 kg ha^{-1} and 1838 kg ha^{-1}, respectively as compared to the average seed yield of 1598 kg ha^{-1} of the standard check-NIFA-2005. Mutants derived from C-44 were significantly high yielding with seed yields range from 1803-2018 kg ha^{-1} against average seed yield of the standard check (1598 kg ha^{-1}). Mutant NDC-15-1 and NDC-30-16 from Pb-91 and NDC-4-30-3 from C-44 possessed highest 100-grains weights of 24 g 100^{-1} grains, 24 g 100^{-1} grains and 25 g 100^{-1} grains, respectively among all other mutants of these two parents. The best performing mutant(s) with wider adoptability in different field tests will be released as mutant variety for general cultivation.

Introduction

Chickpea is major food legumes crop in around 45 countries the world including Pakistan. It is grown as major rabi pulse crop on sandy soils of Pakistan (Khattak *et al*., 2007). Though chickpea is suited to sandy soils, it is being grown for the last few years on irrigated lands in chickpea growing areas after rice is harvested as cereal-legume rotation, thus reducing depletion of scarce soil nutrients (Mansoor, 2007). Chickpea plays an important role as its early pre-flowering robust vegetative growth provides an ample opportunity for food and feed as the young shoots are used as vegetables for human consumption and green fodder as animal feed.

Potential yield of chickpea crop in Pakistan is very low mainly due to the lack of improved varieties suitable for cultivation both in rain-fed as well as irrigated areas. This problem can be overcome by developing high yielding genotypes so as to supplement the needs of the farmers of these areas, which are fulfilled by wheat cultivation. High yielding and large seeded varieties of this crop are also needed to increase its total production in the country and to improve livelihood of chickpea growing farmers (Khattak *et al*., 2003; 2004). The importance of large seed size as an important yield contributing component in chickpea is well recognized by chickpea breeding programmes in the world (Akhtar *et al*., 2011). Upadhyaya *et al*., (2006) reported large seed size as trade related trait and component of yield and adaptation in chickpea. Many other researchers reported the importance of large seed size in yield improvement (Bicer, 2009; Mehla *et al*., 2000). Induced mutation has been reported as an efficient technique to breed chickpea genotypes with large seed size (Khattak *et al*., 2007; Barshile *et al*., 2009).

This manuscript describes the induction of large seed size, development of phenotypically homozygous mutants and evaluation of large seeded and high yielding chickpea mutants in advanced replicated yield trials.

Materials and Methods

Healthy and uniform seeds with 12% moisture from Pb-91 and C-44 were irradiated at 300 and 400 Gy doses of Gamma rays using ^{60}Co source at Nuclear Institute for Food and Agriculture (NIFA), Peshawar during 2004. M_1 generations of both varieties were sown dose-wise during the same season. All M_1 plants were picked and threshed individually. M_2 generation was space-planted as plant-progeny-rows during 2005-06 for selection of single plants on the basis of more branches per plant, more pods per plant and large seed size. Single plant selection was carried out on the basis of above-mentioned criteria and the selected plants were again space-planted as progeny-rows in M_3 generation during 2006-2007 for carrying out single rows selection on the basis of phenotypic uniformity and desirable yield and yield components. Rows with phenotypic uniformity, large seed size and high yield were selected for further evaluation and confirmation of their breeding behavior as progeny-rows-lines during 2007-09. High yielding and large seeded mutants were selected and evaluated in replicated yield trials during 2009-2010. Yield trials were conducted using Randomized Complete Block Design (RCBD) with three replications with six rows per mutant per replication. Row length of 4 m with 10 cm plant-to-plant and 40 cm row-to-row distance was maintained in all replications. The data were recorded on the following parameters;

Days to 50% flowering (DF): Days from the date of sowing to appearance of flowers on 50% plants in each plot.

Days to 90% pods maturity (DM): Days from the date of sowing to 90% pods maturity on each plant per plot.

Plant height (PH) (cm): Length of the main stem from the base to the top of 10 randomly selected representative plants per plot.

100-grains weight (g): Two samples of 100 grains were taken from each genotype in each replication. The samples were subsequently weighed and averaged.

Seed yield (SY) (kg ha^{-1}): The middle four rows from each plot were harvested, threshed and seed yield was taken in grams which was then converted into kg ha^{-1}.

Data for the above-mentioned parameters were statistically analyzed for Analysis of Variance (ANOVA) according to Steel & Torrie, 1980 using MSTATC-a micro computer program (Michigan State University and Agricultural University of Norway).

Results

Results for the yield and its components of mutants derived from Pb-91 and C-44 along with standard check i.e. NIFA-2005, are presented in Table 1, 2 and 3. Significant variations were observed among the mutants for all parameters under study in all trials. Mutants derived from Pb-91 took 120 to 124 days to produce flowers on 50% plants, 169 to 174 days to 90% maturity, attained 77 to 87 cm plant height, possessed grains weight of 22-24 g 100^{-1}grains. Seed yield ranged from 1454 to 2011 kg ha^{-1}. NDC-20-5, NDC-15-1, NDC-25-13 and NDC-30-16 gave the highest significant yields of 2011 kg ha^{-1}, 1927 kg ha^{-1}, 1837 kg ha^{-1} and 1838 kg ha^{-1}, respectively against NIFA-2005 (standard check) which produced an average seed yield of 1598 kg ha^{-1}, whereas NDC-15-1 and NDC-30-16 attained maximum 100-grains weight of 24 g each in comparison to other mutants with the same parentage.

In case of mutants derived from C-44, the ranges for days to 50% flowering, days to 90% pods maturity, plant height, 100-grains weight and seed yield were 120-127 days, 167-175 days, 72-97 cm, 20-25 g 100^{-1} grains and 1079-2018 kg ha^{-1}, respectively. NDC-4-25-12, NDC-4-25-10, NDC-4-25-14, NDC-6-15-12, NDC-4-25-15, NDC-4-25-11, NDC-4-25-7, NDC-6-15-5, NDC-6-15-9, NDC-6-15-1, NDC-6-15-6, NDC-4-30-3, NDC-4-20-1, NDC-4-25-13 and NDC-4-25-5 produced significantly higher seed yields of 2018 kg ha^{-1}, 1987 kg ha^{-1}, 1983 kg ha^{-1}, 1972 kg ha^{-1}, 1969 kg ha^{-1}, 1950 kg ha^{-1}, 1944 kg ha^{-1}, 1929 kg ha^{-1}, 1917 kg ha^{-1}, 1900 kg ha^{-1}, 1895 kg ha^{-1}, 1856 kg ha^{-1}, 1818 kg ha^{-1}, 1809 kg ha^{-1} and 1803 kg ha^{-1}, respectively as compared to the average seed yield of 1598 kg ha^{-1} by the standard check (NIFA-2005). NDC-4-30-4 possessed the highest per 100-grains weights of 25 g among all other evaluated mutants of the same ancestry.

Table 1. Performance of chickpea mutants derived from Pb-91 in advanced lines yield trial conducted during 2009-10.

Genotype	Parentage	DF (50%)	DM (90%)	PH (cm)	100-SW (g)	SY (kg ha^{-1})
NDC-15-1	Pb-91	120	171	85	24	1927
NDC-15-4	-do-	122	169	87	23	1454
NDC-20-5	-do-	121	173	78	23	2011
NDC-20-6	-do-	123	171	78	22	1733
NDC-20-9	-do-	124	173	85	23	1738
NDC-25-13	-do-	121	170	77	22	1873
NDC-30-16	-do-	123	174	83	24	1838
NIFA-2005	Standard check	120	173	77	22	1743
SE		0.88	1.41	0.45	0.88	39.98
LSD (5%)		1.88	3.03	0.98	1.88	85.75

Table 2. Performance of chickpea mutants derived from C-44 in advanced lines yield trial conducted during 2009-10.

Genotype	Parentage	DF (50%)	DM (90%)	PH (cm)	100-SW (g)	SY (kg ha^{-1})
NDC-4-15-5	C-44	124	173	87	23	1255
NDC-4-20-1	-do-	126	171	84	23	1818
NDC-4-20-6	-do-	124	172	89	22	1079
NDC-4-25-5	-do-	124	169	83	23	1803
NDC-4-25-7	-do-	121	167	89	23	1944
NDC-4-25-9	-do-	122	169	82	22	1798
NDC-4-25-10	-do-	122	170	89	21	1987
NDC-4-25-11	-do-	123	171	88	22	1950
NDC-4-25-12	-do-	123	168	81	21	2018
NDC-4-25-13	-do-	122	170	91	21	1809
NDC-4-25-14	-do-	121	169	81	22	1983
NDC-4-25-15	-do-	124	169	84	23	1969
NDC-4-30-1	-do-	120	173	91	23	1195
NDC-4-30-2	-do-	124	175	92	22	1475
NDC-4-30-3	-do-	124	174	88	22	1856
NDC-4-30-4	-do-	121	174	97	25	1402
NIFA-2005	Standard check	120	169	83	22	1574
SE		0.64	0.61	1.33	0.38	28.32
LSD (5%)		1.32	1.27	2.74	0.80	58.46

Table 3. Performance chickpea mutants derived from C-44 in advanced lines yield trial conducted during 2009-10.

Genotype	Parentage	DF (50%)	DM (90%)	PH (cm)	100-SW (g)	SY (kg ha^{-1})
NDC-6-15-1	C-44	123	169	89	21	1900
NDC-6-15-2	-do-	127	169	83	21	1722
NDC-6-15-4	-do-	122	169	90	21	1709
NDC-6-15-5	-do-	127	168	94	23	1929
NDC-6-15-6	-do-	127	169	92	23	1895
NDC-6-15-7	-do-	124	168	83	21	1795
NDC-6-15-8	-do-	124	168	76	20	1491
NDC-6-15-9	-do-	124	167	76	21	1917
NDC-6-15-10	-do-	122	168	83	21	1228
NDC-6-15-11	-do-	125	167	72	22	1466
NDC-6-15-12	-do-	126	169	88	22	1972
NDC-6-15-13	-do-	127	169	80	21	1104
NIFA-2005	Standard check	120	167	84	21	1721
SE		0.72	0.51	2.36	0.45	35.89
LSD (5%)		1.49	1.05	4.88	0.93	74.07

Discussion

Seed setting in chickpea through hybridization during harsh environments in its growing areas is difficult and even some times impossible. Thus creation of genetic variability through induced mutation is a suitable procedure to evolve better cultivars with improved agronomic traits like seed size and seed yield (Micke, 1988; Haq *et al*., 2003; Khattak *et al*., 2007; Barshile *et al*., 2009). The official release of more than 2252 mutant varieties clearly indicates the practical success of mutation breeding in crops (Maluszynski *et al*., 2000; Ahloowalia *et al*., 2004; Khatri *et al*., 2005 Gaur *et al*., 2007). Number of pods, large seed size and number of branches per plant are main yield contributing factors in pulses (Haq *et al*., 2003; Khattak *et al*., 2003, 2004, 2006, 2007). More selection pressure was given to large seed size in segregating populations along with more number of pods during developing mutants in the current study. Seed size is more stable, highly heritable and easy in selection during segregating populations among yield components for the improvement of seed yield in mungbean and chickpea (Gan *et al*., 2003; Upadhyaya *et al*., 2006; Bicer, 2009; Khattak *et al*., 2006, 2007).

Stable and wider adaptable mutant (s) after evaluations in multi-locations and National Uniform Yield trials can be released as chickpea variety apart from sharing with chickpea breeding programmes in the country.

References

Ahloowalia, B.S., M. Aaluszynski and K. Nichterlein. 2004. Global impact of mutation derived varieties. *Euphytica*, 135: 187-204.

Akhtar, L.H., M.A. Pervez and M. Nasim. 2011. Genetic divergence and inter-relationship studies in chickpea (*Cicer arietinum* L.). *Pak. J. Agri. Sci*., 48: 35-39.

Barshile, J.D., S.G. Auti and Apparao. 2009. Genetic enhancement of chickpea through induced mutagenesis. *Journal of Food Legumes*, 22(1): 26-29.

Bicer, B.T. 2009. The effect of seed size on yield and yield components of chickpea and lentil. *African Journal of Biotechnology*, 8(8): 1482-1487.

Gan, Y.T., P.R. Miller and C.L. McDonald. 2003. Response of kabuli chickpea to seed size and planting depth. *Can. J. Plant Sci*., 83: 39-46

Gaur, P.M., V.K. Gour and S. Srinivasan. 2007. An induced brachytic mutant of chickpea and its possible use in ideotype breeding. *Euphytica*, 159(1-2): 35-41.

Haq, M.A., M. Hassan, T.M. Shah, H. Ali, B.M. Atta and G.S.S. Khattak. 2003. Induction of genetic variability for plant type and disease resistance in chickpea and its utilization in breeding. In: *Sustainable Utilization of Plant Genetic Resources for Agricultural Production*: Proceedings of Seminar, 17-19 December 2002, NARC, Islamabad, Pakistan. (Eds.): R. Anwar, M.S. Bhatti, J. Takahshi and S. Masood. Pakistan Agricultural Research Council, Islamabad, Pakistan. pp. 28-37.

Khatri, A., I.A. Khan, M.A. Siddiqui, S. Raza and G.S. Nizamani. 2005. Evaluation of high yielding mutant of *Brassica juncea* cv. S-9 developed through gamma rays and EMS. *Pak. J. Bot*., 37(2): 279-284.

Khattak, G.S.S., M. Ashraf, I. Saeed and B. Alam. 2006. A new high yielding mungbean (*Vigna radiata* (L.) Wilczek) variety "Ramzan" for the agro climatic conditions of NWFP. *Pak. J. Bot*., 38(2): 301-310.

Khattak, G.S.S., M. Ashraf, R. Zamir and I. Saeed. 2007. High yielding desi chickpea (*Cicer arietinum* L.) variety NIFA-2005. *Pak. J. Bot*., 39(1): 93-102.

Khattak, G.S.S., R. Zamir, M.J. Qureshi and T. Muhammad. 2003. Development of high yielding and disease resistant chickpea (*Cicer areitinum* L.) mutants In: *Sustainable Utilization of Plant Genetic Resources for Agricultural Production.* (Eds.): R. Anwar, M.S. Bhatti, J. Takahshi and S. Masood. Proceddings of Seminar, 17-19 December 2002, NARC, Islamabad, Pakistan Pakistan Agricultural Research Council, Islamabad, Pakistan. pp. 73-77.

Khattak, G.S.S., R. Zamir, T. Muhammad and S. Rehman. 2004. Development of high yielding, bold seeded and disease resistant kabuli chickpea (*Cicer arietinum* L.) mutants through induced mutations. In: *Proceedings of National Executive Symposium on Technologies Developed for Commercialization-Challenges and Opportunities*. (Eds.): Ihsanullah and S.U. Khattak, 21-22 September 2003, Pearl Continental Hotel, Peshawar, Pakistan. Nuclear Institute for Food and Agriculture, Peshawar, Pakistan. pp. 52-56.

Maluszynski, K.N., L.V. Zanten and B.S. Ahlowalia. 2000. Officially released mutant varieties. The FAO/IAEA Databse. *Mut. Breed*. Rev., 12: 1-12.

Mansoor, M. 2007. Status of pulses in NWFP. In: *Proceedings of International Conference on Achieving Sustainable Pulses Production in Pakistan*. (Ed.): A.H. chaudhry. 20-22 March 2007, National Agricultural Research Centre, Islamabad, Pakistan. Agricultural Roundation of Pakistan, Islamabad. pp. 89-93.

Mehla, I.S., R.S. Waldia, V.P. Singh, V.S. Latther and S.S. Dahiya. 2000. Association of seed mass groups and seed yield in kabuli chickpea. *International Chickpea Newsletter*, 7: 7-8.

Micke, A. 1988. Genetic improvement of grain legume using induced mutation. Improvement of grain legume production using induced mutation. *IAEA Vienna*. pp. 1-51.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics*. Mc Graw Hill, New York.

Upadhyaya, H., S. Kumar, C. Gawda and S. Singh. 2006. Two major genes for seed size in chickpea (*Cicer arietinum* L.). *Euphytica*, 147(3): 311-315.

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