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HIGH YIELDING KABULI MUTANT CHICKPEA (*CICER ARIETINUM* L.) VARIETY "CM 2008"

TARIQ MAHMUD SHAH*, BABAR MANZOOR ATTA, S. SARWAR ALAM, HINA ALI, MUHAMMAD AHSANUL HAQ AND MAHMUDUL HASSAN

Plant Breeding & Genetics Division, Nuclear Institute for Agriculture and Biology (NIAB), Jhang Road, Faisalabad, Pakistan
**Corresponding author e-mail: Shahge266@gmail.com*

Abstract

Air dried seeds of local variety Punjab-1 were treated with 0.2% and 0.3% solution of ethylmethane sulphonate (EMS) and planted in the field during Rabi 1996-97 to raise M_1 generation. The subsequent generations were raised alongwith parents and standard check varieties from 1996 to 2000 and selections were made on the basis of high yielding, bold seeded and wilt resistance. The wilt resistance was checked and confirmed by growing the mutants in natural wilt sick plot. During 2000-01, twelve mutants were evaluated in the yield nursery and eight high yielding mutants were selected. The potential of the mutant line CM94/99 alongwith parent (Pb-1) and check variety (CM2000) was evaluated for yield and adaptation in station and multilocational yield trials conducted from 2001-02 to 2007-2008.

CM2008 is a high yielding variety (30% higher yield than check CM2000 and 34% higher yield than Pb-1). The major improvement in CM2008 is manifested in the form of increase in the seed size. The bold seed size (24.0 g) as compared to parent variety Pb-1 (16.5 g) was the main contributing factor towards increase in seed yield. It is resistant to *Fusarium* wilt and tolerant to *Ascochyta* blight. Its average yield is 1800 kg/ha and yield potential is 3000 kg/ha. Punjab Seed Council approved CM94/99 variety as a commercial variety under the name of "CM2008" for general cultivation in Punjab. This resistant variety will greatly help to stabilize the chickpea production in the country.

Introduction

Chickpea is the most important grain legume crop of Pakistan and is a cheap source of good quality vegetable protein and carbohydrates that complement the cereal protein, thus enhancing the nutritional value of the cereal dominated diet. In Pakistan, 'Desi' type of chickpea accounts for nearly 85% area under cultivation and `Kabuli' type is grown in around 15% area because of its higher susceptibility to various stresses compared to desi type (Haq *et al.*, 2002). The chickpea crop occupies an area of 928.1 thousand hectares with a production of 741.1 thousand tons in Punjab during 2006-07 (Anon., 2007). The kabuli chickpea is cultivated in the rainfed areas of Pothowar and irrigated areas of Thal. Pakistan has spent 6275 million rupees during 2006-07 to import 166 thousand tones of kabuli chickpea from Myanmar, Iran, India, Turkey, Australia and Canada to meet the local demand.

At Nuclear Institute for Agriculture and Biology (NIAB) Faisalabad, a chickpea breeding program aiming to evolve high yielding and disease resistant varieties of chickpea through the use of mutation breeding and related breeding methods is in progress (Atta *et al.*, 2006; Ali *et al.*, 2007). Prior to this, three desi chickpea varieties CM72, CM88 and CM98 and one kabuli variety CM2000 having resistance to *Ascochyta* blight and *Fusarium* wilt were released (Haq *et al.*, 1984, 1988, 1999, 2001, 2002).

Large scale cultivation of these high yielding and disease resistant varieties has helped greatly to stabilize/ increase chickpea production in the country and since their release no serious blight epidemic has been reported in the country.

The contribution of kabuli chickpea is further declining because it is generally more prone to various stresses such as *Fusarium* wilt, *Ascochyta* blight and drought. As a result the price of kabuli chickpea remains high and to meet the local demand, existing varieties of Kabuli chickpea i.e., Pb-1 (released in 1930), Noor-91 (released in 1991) and CM2000 (released in 2000) have become susceptible to patho-types of the fungus *Ascochyta rabiei* and wilt/ root rot diseases (Akhtar *et al.*, 2008). This compels substitute of these varieties with new high yielding and resistant varieties.

Efforts were therefore made to improve yield potential and disease resistance in the local blood (Punjab-1) through induced mutations. As a result a high yielding and disease resistant mutant CM94/99 (approved as CM2008) was developed through the use of chemical mutagen (EMS). This variety will greatly help to stabilize the kabuli chickpea production in the country.

Material and Methods

Lay out of experiment: Air dried seeds of local well adapted variety Punjab-1 were treated with 0.2% and 0.3% solution of EMS and M_1 generation was raised in the chickpea field at NIAB, Faisalabad during Rabi 1996-97. At maturity all healthy plants were harvested individually. The plant progenies of M_2 segregating population was raised during rabi 1997-98 and desirable plants with improved yield and yield parameters were selected. The selected mutants were evaluated by raising M_3 generation in the field during 1998-99 for confirmation of mutational traits. Wilt resistance was checked by growing one set of mutants in natural wilt sick plot. During 1999-00, M_4 mutants were evaluated for various morpho-agronomic traits alongwith the parent genotype Pb.1 and standard check variety CM2000. The yield performance of CM94/99 along with standard varieties was evaluated in various replicated yield trials at NIAB and multilocations during 2001-2007. Breeding history of chickpea variety "CM2008" is presented in sequential array (Table 1). All the yield trials were laid out in a completely randomized design with three replications and the plant-to-plant and row-to-row spacing of 10 and 30 cm, respectively. The row length was 4 meter and numbers of rows were four per plot per replication in all trials. The data was subjected to analysis of variance by using computer software MSTAT-C.

Disease reaction

a. *Ascochyta* blight: The screening was carried out in *Ascochyta* Blight Screening Nursery at NIAB, Faisalabad during 2001-07 under sprinkle system developed for creating artificial humidity (about 70-80%) by producing mist. The material was sown in the last week of October. Seed of each line (20 plants) was sown (about 2cm deep) in a single 4 meter row plot with inter and intra-row spacing of 30 and 15cm, respectively. The experiment was conducted in a randomized block design with two replications. The variety K850 (highly susceptible to *Ascochyta* blight and resistant to *Fusarium* wilt) was used as check (spreader) after every two lines to monitor possible variation in the level of infection. During the first week of February, when the plants were about eight to ten-leaf stage, these were inoculated by spraying with a hand plastic/steel sprayer until run-off. The disease reactions of

individual plants were scored 14 days after inoculation on 1-9-scoring scale modified from Reddy & Singh (1984), and described by Shah *et al.,* (2005). Mean disease scores were subjected to analysis of variance (ANOVA) in order to detect differences between different lines. Difference between mean disease scores of cv. K-850 the susceptible control and mean disease scores of individual lines were calculated using t-test.

b. *Fusarium* wilt: A set of M_2 population and advance mutant lines were screened for resistance to *Fusarium* wilt in natural wilt sick plot during 2001-2007. The field was highly infested causing 100% wilt to all lines of the susceptible check AUG-424. The mutants were sown in this field in the third week of October. Sixty seeds per test mutant were sown in a two row, 4 meter long with inter and intra row spacing of 30 and 15 cm with three replications, respectively. The susceptible check (Aug 424) was sown after every two test lines. The level of resistance and susceptibility of each mutant line was determined by using the rating scale of Iqbal *et al.*, (1996).

Table 1. Breeding history of chickpea variety CM2008.

Rabi 1996-97	M_1	2000 air dried seeds of chickpea variety Pb-1 treated with 0.2% and 0.3% EMS. At maturity, 1782 surviving M_1 plants harvested individually.
Rabi 1997-98	M_2	The segregating material alongwith nontreated control planted in the field at NIAB on plant progeny basis. 69 morphological mutants were selected.
Rabi 1998-99	M_3	The selected mutants evaluated for confirmation of mutational traits. 50 true breeding mutants were selected.
Rabi 1999-00	M_4	Selected mutants evaluated for various morpho-agronomic traits. 12 high yielding mutants selected.
Rabi 2000-01	M_5	Twelve mutants evaluated in the yield nursery at NIAB, eight high yielding mutants were selected.
Rabi 2001-02	M_6	Eight selected progenies evaluated in the Chickpea Preliminary Yield Trial (CPYT) at NIAB. Progenies also tested in the *Ascochyta* Blight Nursery (ABN) and *Fusarium* wilt sick plot for resistance against *Ascochyta* blight and *Fusarium* wilt respectively. Four high yielding and disease resistant mutants were selected.
Rabi 2002-03	M_7	Four high yielding mutants were tested in Chickpea Advance Yield Trial (CAYT) at multilocations. On the average of six locations CM 94/99 and CM98/99 exhibited highest yield.
Rabi 2003-04	M_8	CM 94/99 yield tested in multilocation Chickpea Cooperative Yield Trials (CCYT)-kabuli and continuous monitoring of disease resistant reactions. Same year CM 94/99 was evaluated in Chickpea National Uniform Yield Trials (CNUYT)-kabuli at multilocations. The mutant proved to be highest yielding.
Rabi 2004-05	M_9	CM 94/99 yield tested in Cooperative Yield Trials and National Uniform Yield Trials.
Rabi 2005-06	M_{10}	CM 94/99 yield tested in National Uniform Yield Trials, continuous monitoring of disease resistance reaction alongwith production of prebasic seed.
Rabi 2006-07	M_{11}	Conducted Agronomical Yield Trials (Sowing dates and Fertilizer Trails) at NAIB, Faisalabad and BARS, Fathejang. Production of sufficient quantity of prebasic seed for distribution to Punjab Seed Corporation/ progressive farmers.

Results

In M_1 generation, 904 and 878 plants survived in 0.2% and 0.3% EMS treated population respectively were harvested individually at maturity (Table 2). During rabi 1997-98, M_2 segregating material was raised by growing 831 plant progenies in normal and 851 of both doses in wilt sick plots. All the viable morphological and wilt resistant mutants were scored throughout the growth period. Out of total population of 10207 plants, 15 early, 5 dwarf, 7 spreading type, 36 leaf type and 6 wilt resistant mutants were selected (Table 3). During 1998-99, 69 mutants were evaluated in M_3 generation for confirmation of mutational traits. Fifty true breeding mutant lines were identified which included 11 early flowering /maturity, 5 spreading type, 3 dwarfs, 27 leaf type and 4 wilt resistant. The wilt resistance was again confirmed by growing the mutants in natural wilt sick plot. During 1999-00, 50 selected mutants were evaluated for various morpho-agronomic traits alongwith the parent genotype Pb.1. During 2000-01, twelve mutants were evaluated in the yield nursery at NIAB and eight high yielding mutants were selected.

Eight high yielding mutants were tested alongwith parent variety Pb-1 in CPYT conducted at NIAB during 2001-02 (Table 4). Mutant lines CM94/99 (2232 Kg/ha) and CC98/99 (2110 kg/ha) gave higher yield than parent Pb-1 (1692 kg/ha) and check variety CM2000 (1982 kg/ha). Both the mutants produced 12.6% and 6.16% higher yield respectively. Eight high yielding disease resistant kabuli type mutant/ hybrid lines were tested along with two check varieties viz. Pb-1 and CM2000 in multilocation CAYTs during 2002-03 (Table 5). Overall CM94/99 exhibited highest yield (1556 kg/ha) (34.14% higher yield than check) in the trials at seven locations while check varieties viz. Pb-1 and CM2000 yielded 1241 kg/ha and 1160 kg/ha respectively. Three mutants (CM457/92, CM94/99 and CC102/99) and three hybrid lines (CH41/90, 88194 and 90395) were yield evaluated in the Cooperative Yield Trials-K (CCYT) during 2003-04 (Table 6). Based on average of five locations, CM 94/99 exhibited highest yield (1348 kg/ha) (14.24% higher yield than check) while Pb-1 and CM2000 gave 1120 kg/ha and 1180 kg/ha yield, respectively. Six varieties/mutants were evaluated in the National Uniform Yield Trials-K (CNUYT) laid out at six locations during 2003-04 (Table 7). On the average of six locations, CM 94/99 exhibited highest yield (1990 kg/ha) (37.91% higher yield than check) while CM2000 gave 1443 kg/ha yield. Eight genotypes were tested in Cooperative Yield Trials-K (CCYT) conducted at multilocations during 2004-05 (Table 8). Based on average of five locations, CM 94/99 exhibited highest yield (1127 kg/ha) (63.33% higher yield than check) while Pb-1 and CM2000 gave 945 kg/ha and 690 kg/ha yield, respectively. Six varieties were included in the National Uniform Yield Trials-K laid out at six locations during 2004-05 (Table 9). CM94/99 exhibited highest yield (1324 kg/ha) (92.72% higher yield than check) on average of six locations, while check variety CM2000 gave 687 kg/ha yield. In National Uniform Yield Trials-K, two high yielding, blight tolerant and wilt resistant mutants viz. CM94/99 and CM315/99 were yield evaluated during 2005-06 (Table 10). CM94/99 exhibited 2147 kg/ha (14.32% higher yield than check) as compared with 1878 kg/ha of CM2000.

Table 2. Seed irradiation and M_1 generation during 1996-97.

Variety	Treatment	No. of Seeds	Survival
Pb-1	0.2% EMS	1000	904
	0.3% EMS	1000	878
	Total	2000	1782

Table 3. Selection of mutants from M_2 generation raised at NIAB during 1997-98.

Variety	Treatment	Progenies grown	Plants studied	Mutants				
				Early flowering	Dwarf	Spreading	Leaf type	Wilt resistant
Pb-1	0.2% EMS	388	4886	8	2	4	20	4
	0.3% EMS	443	5321	7	3	3	16	5
	Total	831	10207	15	5	7	36	6
						Grand total		69

Table 4. Yield performance of CM94/99 in chickpea preliminary yield trial conducted at NIAB during 2001-02.

Sr. No.	Variety/ mutant	Yield gm/plot				Yield (kg/ha)	% increase over check
		R1	R2	R3	Average		
1.	CC93/99	1070	1210	1160	1147	1915 bc	
2.	CM94/99	1310	1330	12.61	1337	2232 a	12.61
3.	CC98/99	1250	1330	1210	1263	2110 ab	6.06
4.	CC102/99	980	920	830	910	1520 d	
5.	CC104/99	1030	950	910	963	1609 d	
6.	CC106/99	560	520	620	567	946 e	
7.	CC107/99	260	640	290	397	662 f	
8.	CC124/00	110	90	140	113	189 g	
9.	Pb-1	940	1030	1070	1013	1692 cd	
10.	CM2000 (C)	1150	1180	1230	1187	1982 ab	

Screening against *Ascochyta* blight and *Fusarium* wilt: CM94/99 was tested for its resistance against major diseases of chickpea like *Ascochyta* blight and *Fusarium* wilt alongwith its parent and check varieties during 2001-2007. The results obtained under artificial inoculation at AARI Faisalabad, NARC Islamabad and NIAB Faisalabad are given in Tables 11 and 12. Tolerance against *Ascochyta* blight makes CM2008 a better option for blight prone areas. This variety showed the resistant behavior under high wilt disease pressure in the wilt sick plot. On the basis of data recorded in various trials it was concluded that under diseased (wilt) and disease free conditions CM94/99 performance was equally good as compared to check varieties while its performance was much better with regard to grain yield than those of checks under severe blight incidence.

Important agronomic, morphological and qualitative characteristics of CM2008 along with parent and check are presented (Table 13). CM94/99 (approved as CM2008) showed large seed size, semi-erect growth habit, higher average yield and yield potential as compared to the check varieties, Pb-1 and CM2000.

Table 5. Yield performance of mutants/varieties in multilocations chickpea advance yield trial conducted during 2002-03.

Sr. No.	Variety/ mutant	Locations							Yield (kg/ha)	% Increase over check
		NIAB Faisalabad	KNC Kundian	AZRI Bhakar	ARF Karor	GBRS Attock	BARI Chakwal	BARS Fathjang		
1.	CH22-18/93	799 b	1285 ^{NS}	1595 a	3073 ^{NS}	507*	1063 ^{NS}	1406 f	1390	
2.	ICCV 95503	489 d	1110	1221f	2331	333	1125	1133 g	1106	
3.	CM446/92	484 d	1650	936 g	2625	292	1090	2293 e	1339	
4.	CM444/92	458 d	1475	1344 de	2828	147	826	1361 b	1206	
5.	CM94/99	1024 a	1891	1527 ab	3354	232	1125	1741 f	1556	34.14
6.	CC93/99	754 bc	1735	1257 ef	2187	271	1042	2357 c	1372	
7.	CC98/99	611 cd	1198	1603 a	2995	208	1090	2009 a	1388	
8.	CC102/99	549 d	1181	1465 bc	2708	306	1042	2200 d	1350	
9.	Pb-1	507 d	1527	970 g	2943	333	1007	1400 f	1241	
10.	CM2000 (C)	632 cd	833	1385 cd	2786	215	1181	1089 g	1160	

Table 6. Yield performance of mutants/varieties in chickpea cooperative yield trials-Kabuli conducted at multilocations during 2003-04.

Sr. No.	Variety/ mutant	Locations					Yield (kg/ha)	% increase over check
		NIAB Faisalabad	AARI Faisalabad	BARI Chakwal	AZRI, Bhakar	ARF, Karor		
1.	CH41/91	1597 ab	906	594 a	740 a	2332 ^{NS}	1234	
2.	CM457/92	1613 ab	672	211c	533 b	1916	989	
3.	CM94/99	1792 a	1255	339 b	731 a	2624	1348	14.24
4.	CC102/99	1497 bc	1286	567 a	576 b	2624	1310	
5.	88194	1508 b	854	550 a	496 b	2499	1181	
6.	90395	1563 ab	1458	378 b	572 b	2499	1294	
7.	Pb-1	1275 c	1016	431 b	461 b	2416	1120	
8.	CM2000 (C)	1442 bc	885	344 b	481b	2749	1180	

Table 7. Yield performance of mutants/varieties in chickpea national uniform yield trials Kabuli conducted during 2003-04.

Sr. No.	Variety/mutant	Locations						Yield (kg/ha)	% increase over check
		NARC Islamabad	NIAB Faisalabad	ARI D.I.K han	BARI Chakwal	RRI Dokri	AZRI Bhakar		
1.	CM94/99	3064	2179	2998	1133	869	1699	1990	37.91
2.	CC98/99	4193	1613	2582	1163	626	1518	1949	
3.	K-90395	2503	1392	2467	1307	691	1475	1639	
4.	NCS2001	2498	587	2372	1137	454	1115	1360	
5.	FLIP97-172C	2234	529	2614	1081	381	719	1260	
6.	FLIP97-179C	3020	929	2483	1119	374	973	1483	
7.	CM2000 (C)	2478	1566	1409	1256	509	1438	1443	

Table 8. Yield performance of genotypes in Chickpea Cooperative Yield Trials-Kabuli conducted at different locations during 2004-05.

Sr. No.	Variety/mutant	Locations					Yield (kg/ha)	% Increase over check
		NIAB Faisalabad	BARI Chakwal	AARI Faisalabad	AZRI Bhakar	ARF Karor		
1.	CM94/99	1808 a	867 a	706	1044 abc	1212 a	1127	63.33
2.	CC98/99	948 b	500 bc	1311	1309 a	1250 a	1064	
3.	CC102/99	1294 d	400 bc	1017	1159 ab	1041b	982	
4.	CM256/99	1637 b	367 c	1078	965 bc	1004 b	1010	
5.	CM305/99	1453 c	600 abc	750	880 bcd	1041 b	945	
6.	CM315/99	1641 b	550 bc	928	1110 ab	831 c	1012	
7.	91310	1040 f	683 ab	1106	669 de	1250 a	950	
8.	92019	1499 c	683 ab	1006	1152 ab	1008 b	1070	
9.	Pb-1 (C)	1144 e	467 bc	1494	788 cde	833 c	945	
10.	CM2000 (C)	1115 ef	667 ab	122	504 e	1041b	690	

Table 9. Yield performance of genotypes in Chickpea National Uniform Yield Trials Kabuli conducted at different locations during 2004-05.

S. No.	Variety/ mutant	Locations						Yield (kg/ha)	% increase over check
		NIAB Faisalabad	ARI D.I.Khan	BARI Chakwal	AZRI Bhakar	NIFA Peshawar	QAARI Larkana		
1.	CM94/99	1921	1524	114	1598	1347	1440	1324	92.72
2.	CC98/99	1251	1277	181	1515	1682	1241	1191	
3.	90395	985	1068	235	1213	1110	1253	977	
4.	92026	1236	1119	333	1645	1185	1223	1124	
5.	NCS2001	691	1142	208	1473	1406	1310	1038	
6.	F 97-179C	710	1029	98	1000	610	1409	809	
7.	CM 2000 (C)	1112	323	202	1578	136	772	687	

Table 10. Yield performance of genotypes in Chickpea National Uniform Yield Trials-Kabuli conducted at eight locations during 2005-06.

Sr. No.	Variety/mutant	Locations								Yield (kg/ha)	% increase over check
		NIAB Faisalabad	ARI D.I.Khan	BARI Chakwal	ARI Queetta	RARI Bhawalpur	AZRI Bhakar	NARC Islamabad	BARS Fethejang		
1.	NCS 0503	797	3229	1870	211	582	313	2662	1842	1438	
2.	NCS 0504	422	3521	1954	492	130	304	2261	1664	1344	
3.	NCS 0505	599	4053	1664	433	390	235	2466	2204	1506	
4.	NCS 0506	401	3064	1868	292	130	330	2199	1372	1207	
5.	NCS 0507	372	3824	2021	318	364	351	1648	2305	1400	
6.	CM 315/99	1983	4482	2360	281	1144	712	3350	2254	2071	
7.	CM 94/99	2054	4865	2121	426	1248	877	2909	2672	2147	14.32
8.	K-90395	1632	4691	2399	162	832	705	2990	2388	1975	
9.	SSI-SEL-7-K	1503	4173	2227	331	816	374	2805	2639	1858	
10	NCS 0523	564	2732	1703	236	114	209	2072	2190	1228	
11.	NCS 0524	580	4002	1648	428	286	295	2070	2722	1504	
12	CM 2000 (C)	1240	4287	2925	25	1092	478	2268	2708	1878	

Table 11. Screening results of new variety CM2008 (CM94/99) along with its parent and check varieties against *Ascochyta* blight during 2001-2007 at AARI Faisalabad, NARC Islamabad and NIAB Faisalabad.

Year	Location	Disease rating (1-9 scale)		
		CM94/99	Pb 1	CM2000
2001-02	NIAB, Faisalabad	5	7	5
2002-03	NIAB, Faisalabad	5	9	5
	AARI, Faisalabad	5	7	7
	NARC, Islamabad	5	9	9
2003-04	NIAB, Faisalabad	5	9	5
	AARI, Faisalabad	5	9	7
	NARC, Islamabad	5	7	5
2004-05	NIAB, Faisalabad	5	9	7
	AARI, Faisalabad	5	7	-
	NARC, Islamabad	5	9	5
2005-06	NIAB, Faisalabad	5	9	5
	AARI, Faisalabad	5	7	7
	NARC, Islamabad	5	9	7
2006-07	NIAB, Faisalabad	5	7	7
	AARI, Faisalabad	5	-	7
	UAF, Faisalabad	5	9	7

Table 12. Screening results of new variety CM2008 (CM94/99) along with its parent and check varieties against *Fusarium* wilt during 2002-2007 at AARI Faisalabad, NARC Islamabad and NIAB Faisalabad.

Year	Location	*Fusarium* wilt rating (1-9 scale)		
		CM94/99	Pb 1	CM2000
2002-03	NIAB, Faisalabad	3	9	7
2003-04	NIAB, Faisalabad	3	9	9
2004-05	NIAB, Faisalabad	3	9	9
2005-06	NIAB, Faisalabad	3	9	9
	AARI, Faisalabad	3	-	9
	NARC,Islamabad	3	-	9
2006-07	NIAB, Faisalabad	3	9	7
	AARI, Faisalabad	3	9	7

Table 13. Important agronomic/morphological/qualitative characteristics of CM94/99 as compared to parent (Pb-1) and standard check CM2000. (Average of four years 2000-2004).

Characters	CM2000 (Check)	Punjab 1 (Parent)	CM94/99
Days to flower	117 ± 6	117 ± 7	119 ± 5 117 ± 3
Days to maturity	179 ± 7	179 ± 6	177 ± 6
Plant height (cm)	80	82	86
Pods per plant	58	68	63
Seed per pod	1.5	2	2
Primary branches per plant	3.18	3.68	4.4
Secondary branches	13.5	12.53	14.2
Pod borer (%) infestation	4.60	Not tested	1.97
100 seed weight (g)	25.8	16.5	24
Seed coat color	Reddish brown	Light beige	Beige
Reaction to *Ascochyta* blight	7/9 (S/HS)	9 (HS)	5 (T)
Reaction to wilt	7 (S)	9 (HS)	3 (R)
Yield potential (kg/ha)	2700	2200	3000 (CNUYT, 05-06, ARI, D.I. Khan: 4865)
Average yield (Kg/ha):			
NUYT (Three years)	1457	-	1983
CPYT to NUYTs	1288	1250	1675

Discussion

The newly released kabuli chickpea variety “CM2008” has been developed through the chemical treatment (0.2% EMS). Mutations are a widespread attribute of living organisms and provide the source of genetic variability and have played an important role in developing many crop varieties in various parts of the world (Haq *et al.,* 2003). During the past 80 years, more than 2500 officially released new mutant varieties including cereals, oilseeds, pulses, vegetables, fruits, fibers and ornamentals have been officially released in 50 countries all over the world (FAOSTAT-Agriculture 2009). Chickpea varieties (CM72, CM88, CM1918, CM98 and CM2000) with resistance to *Ascochyta* blight and *Fusarium* wilt were developed through induced mutations and released in Pakistan (Haq *et. al.,* 1984, 1988, 1999, 2001, 2002). Three desi chickpea varieties i.e., NIFA-88, NIFA-95, NIFA-2005 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). Similarly, Pusa-408, Pusa-413 and Pusa-417 with resistance to *Ascochyta* blight and *Fusarium* wilt have been released for commercial cultivation in India (Kharkwal, 1988, 2001). Mungbean mutant varieties NM-51, NM-54, NM92 and NM98 with high yielding potential were found to be resistant to yellow mosaic virus (MYMV), *Cercospora* leaf spot, and leaf crinkle in Pakistan (Haq & Shakoor, 1977; Malik *et al*., 1979; Awan, 1999; Siddique *et al.*, 1999) and mutant varieties MUM-2, BM4, LGG407 and LGG450 in India (Dixit *et al.*, 2000).

Table 14. Summary of yield performance of mutant CM94/99 along with check and parent variety in different multilocational trials.

Year	Trials	Yield (Kg/ha)		
		CM94/99	CM2000	Pb-1
2001-02	Preliminary yield trial	2232	1982	1692
2002-03	Chickpea advance yield trials	1556	1160	1241
2003-04	Chickpea cooperative yield trials	1348	1180	1120
2003-04	Chickpea national uniform yield trials	1990	1443	-
2004-05	Chickpea cooperative yield trials	1127	690	945
2004-05	Chickpea national uniform yield trials	1324	687	-
2005-06	Chickpea national uniform yield trials	2147	1878	-
	Average yield	1675	1288	1250

30% Increase from control and 34% from parent

The variety CM 2008 was developed from local kabuli variety Pb-1 which was released in 1930. It has 30% higher yield than check CM2000 and 34% higher yield than parent Pb-1 at NIAB and multilocations during 2001 to 2006 (Table 14). This variety got Ist position throughout in all the trials. It has semi-erect growth habit and plant height ranges from 75-90 cm. The branching pattern was profuse with light green foliage colour. Leaves were compound, alternate or imparipinnate, flowers were white colored and pods were large sized, yellowish brown and generally two seeded. Seed surface was smooth and ram head shaped, white in colour and weight of 100 seed is 24 g. The mutant was tolerant to *Ascochyta* blight and resistant to *Fusarium* wilt. The high yielding, large seed size with desired ideotype chickpea mutant is suitable for cultivation under rainfed conditions of Thal, irrigated and Potowar areas. The major improvement in CM2008 was manifested in the form of increase in the seed size. The bold seed size (24 g) as compared to parent variety Pb-1 (16.5) was the main contributing factor towards increase in seed yield. Its average yield was 1800 kg/ha and yield potential was 3000 kg/ha. The large seed size chickpea has been reported by many workers as an important seed yield trait (Waldia *et al*., 1991, 1996; Mehla *et al*., 2000, Khattak *et al*., 2003, 2004). The optimum sowing time is from the month of October till the last week of November. The mutant variety is bold seeded and the seed rate of 25-30 kg per acre is recommended. The row to row distance could be maintained as 30 cm for better yield and seeding depth could be 8-10 inches for good germination under insufficient moisture condition. It is fertilizer responsive and one bag DAP/acre is recommended for better yield. Punjab Seed Council approved CM94/99 variety as a commercial variety under the name of "CM2008" for general cultivation in Punjab in its 36th meeting held on September 09, 2008 at Lahore. This resistant variety will greatly help to stabilize the chickpea production in the country. With the cultivation of this high yielding kabuli variety, the yield of farmers will be increased and overall it will have certainly affirmative effect on national economy. Each year NIAB produce prebasic and basic seed for distribution to seed companies and progressive farmers. Punjab Seed Corporation and private

progressive farmers are multiplying this variety for further distribution as seed to farmers.

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