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A NEW HIGH YIELDING MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK) VARIETY "RAMZAN" FOR THE AGRO CLIMATIC CONDITIONS OF NWFP

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Abstract

An exotic genotype VC 1482C and a local mungbean genotype NM 92 were hybridized at the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during kharif (July-October) 1998. Selection of the high yielding recombinant NFM-12-12 from segregating populations, and evaluation in various replicated yield trials for yield potential and stability test were carried out from 1999 to 2004. The proposal of the recombinant NFM-12-12 was submitted for approval as commercial variety for NWFP to the Provincial Seed Council meeting held on 19th September 2005 at NWFP Agricultural University, Peshawar. The Provincial Seed Council approved the recombinant NFM12-12 as a commercial variety under the name "**Ramzan"** for general cultivation in NWFP.

The major improvement in NFM-12-12 is manifested in the form of increase in seed size, decrease in plant height, stiff stem and earliness in maturity by a margin of 10 days as compared to standard variety NM 98. The large seed size of NFM-12-12 is the main contributing factor towards the increase in seed yield compared to NM 98. The high harvest index of NFM-12-12 invokes its greater physiological efficiency in partitioning the photosynthates towards grain formation leading to marked increase in grain yield. Short stature and stiff stem of NFM-12-12 helps in showing resistance to lodging. Clusters per plant, pods per plant, branches per plant, pod length, seeds per pod and protein contents of NFM-12-12 also compare favorably with parent NM 92 and standard NM 98. NFM-12-12 has 28-36% high seed yield potential compared to the standard variety NM 98 and parent NM 92. An average experimental seed yield of Ramzan was 1962 kg ha^{-1} at NIFA, Peshawar.

Introduction

Mungbean is the major kharif pulse crop grown in Pakistan (Khattak *et al*., 2004a, b). It can be easily cultivated on relatively light soils, marginal for cereal cultivation. The mungbean growing areas have relatively poor infrastructure and farmers have below average resources and house hold inventories. The country's major kharif crop has low yielding potential; therefore, the region's farmers cannot compete with farmers elsewhere. Other crops of this season cannot compete with mungbean in these areas due to less return to the growers. These factors make "mungbean" a low-input kharif crop suitable for the region. Mungbean is mainly grown in July-August and harvested in October, followed by wheat cultivation. Mungbean Yellow Mosaic Virus (MYMV) is the main disease of this crop in kharif season in Pakistan (Khattak *et al.*, 1999, 2000).

In NWFP, Nuclear Institute for Food and Agriculture (NIFA), Peshawar has initiated and is actively engaged in the improvement of mungbean through induced mutations and cross breeding techniques. In NWFP two mungbean varieties i.e., Karak mung-1 (2003) and Swat mung-1 (2004) have been released by Agricultural Research Station Karak and Mingora, respectively. Both varieties are selections from local germplasm evaluated at these stations. Most of the mungbean growers in the province grow mungbean land races or varieties, which have been released for different environmental conditions in the country.

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Table 1. Chronological order breeding history of mungbean variety "Ramzan".

S. No.	Year	F. Gen./Trial	Remarks
1.	Kharif 1998	F_0	Cross attempted
2.	Summer 1998	F_1	Harvested hybrid plants individually
3.	Kharif 1999	F_2	Single plant selection for MYMV resistance and high yield
4.	Summer 2000	F_3	Confirmation of breeding behavior and single plant selection
5.	Kharif 2000	F_4	Generation advancement, screening for MYMV and selected high yielding lines
6.	Kharif 2002	Evaluation in trials	Evaluated NFM-12-12 in PYT and screened for MYMV disease
7.	Kharif 2003	Evaluation in trials	Evaluated NFM-12-12 in ALYT, AYT and NUYT, and screened for MYMV disease.
8.	Kharif 2004	Evaluation in trials	Evaluated NFM-12-12 in ALYT, AYT, ZVT and NUYT

There is a great potential for increasing mungbean area and production in NWFP by evolving high yielding mungbean genotypes suitable for major mungbean growing areas in the province. The mungbean variety "**Ramzan**" has been developed through hybridization between local and exotic germplasm. It would be the best option for the NWFP farmers to grow this variety for harvesting high yields compared to growing land races/old varieties.

In this paper, the development and evolution of the new high yielding mungbean variety "**Ramzan**" is described.

Materials and Methods

An exotic genotype VC 1482C with high yield potential, inadaptable in the agro climatic conditions of Pakistan and highly susceptible to MYMV, and local mungbean genotype NM 92 of short stature and highly resistant to MYMV were hybridized at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad during kharif 1998 following the crossing technique of Khattak *et al*., (1998). F_1 generation of the cross was planted during summer (March-June) 1999 and the hybrid plants were harvested individually. F_2 populations were raised as plant progeny rows for selecting high yielding recombinants with resistance to MYMV during kharif 1999. Mung Kabuli, a highly susceptible check for MYMV was used as spreader and planted after each five rows to intensify MYMV inoculums from natural sources. Chemical spray was avoided so as to maintain the natural population of whitefly (*Bemisia tabaci*) in the experimental field. The high yielding and MYMV resistant plants were selected. Generation of the selected recombinants was advanced to confirm its breeding behavior/genetic stability for desired traits, and MYMV screening during 2000. The percent MYMV infection was recorded and converted to disease score and disease reaction according to the MYMV disease score scale (0-8) reported by Malik (1992). The high yielding line NFM-12-12 was evaluated in replicated Preliminary Yield Trial (PYT), Advanced Lines Yield Trials (ALYT), Adaptation Yield Trials (AYT), Zonal Varietal Trials (ZVT) and National Uniform Yield Trials (NUYT) during 2002-2004. All replicated yield trials were conducted using Randomized Complete Block Design (RCBD) with plant-to-plant and row-to-row spacing of 10 and 30 cm, respectively. The row was 4m long and numbers of rows in PYT were 4, and in all others trials, 6 rows per plot per replication. The yield trials data were analyzed according to Steel & Torrie (1980).

Table 2. Yield performance of NFM-12-12 in Preliminary yield trial (PYT) conducted during kharif 2002 and advanced lines yield trial (ALYT) conducted during kharif 2003 at NIFA, Peshawar.

Entry	Parentage	Yield kg ha^{-1}	
		PYT-2002	ALYT-2003
NFM-12-3	VC 1482C x NM 92	2017	1895
NFM-12-5	VC 1482C x NM 92	747	1182
NFM-12-6	VC 1482C x NM 92	767	1513
NFM-12-7	VC 1482C x NM 92	850	1803
NFM-12-8	VC 1482C x NM 92	1063	1652
NFM-12-9	VC 1482C x NM 92	2210	1200
NFM-12-10	VC 1482C x NM 92	1907	1581
NFM-12-11	VC 1482C x NM 92	1840	1771
NFM-12-12	**VC 1482C x NM 92**	**2100**	**1820**
NFM-12-13	VC 1482C x NM 92	1507	1133
NFM-12-14	VC 1482C x NM 92	2003	1743
NFM-12-15	VC 1482C x NM 92	2117	1655
NFM-12-16	VC 1482C x NM 92	1740	925
NFM-12-17	VC 1482C x NM 92	1143	1360
NFM-12-18	VC 1482C x NM 92	1603	972
NM 92 (Check)	VC 2768B x NM 36	1510	1247
NM 98 (Check)	NM 20-21 x VC 1482E	1480	1478
SE		17.47	44.65
LSD 5%		50	167.84

Results

The results of yield trials conducted at NIFA during kharif 2002 and 2003 are presented in Table 2. In both trials NFM-12-12 out yielded the local parent NM 92 and standard check NM 98. During kharif 2002, NFM-12-12 produced significantly higher seed yield of 2100 kg ha^{-1} compared to NM 92 and NM 98, which produced seed yield of 1510 kg ha^{-1} and 1480 kg ha^{-1}, respectively. In advanced lines yield trial conducted during 2003, NFM-12-12 gave significantly higher seed yield (1820 kg ha^{-1}) than NM 92 (1247 kg ha^{-1}) and NM 98 (1478 kg ha^{-1}).

NFM-12-12 produced significantly higher seed yield at NIFA (1974 kg ha^{-}1), and Agricultural Research Institute (ARI) D. I. Khan (1263 kg ha^{-}1) compared to the local parent NM92 and standard check NM 98 in adaptation yield trial conducted during kharif 2003 (Table 3). NFM-12-12 showed an increase of 37% and 28% in seed yield over NM 92 and NM 98, respectively on average basis at two locations. Similarly NFM-12-12 gave significantly higher seed yield of 1944 kg ha^{-1}, 1810 kg ha^{-1} and 630 kg ha^{-1} at NIFA, ARI, D. I. Khan and ARS, Karak, respectively compared to NM 92, NM 98 and Karak mung-1 in adaptation yield trial conducted during 2004 (Table 4). The increase in seed yield of NFM-12-12 calculated on average basis of three locations over NM 92, NM 98 and Karak mung-1 was 36, 34 and 39%, respectively.

Table 3. Yield performance and % increase in seed yield of NFM-12-12 in adaptation yield trial conducted at various locations in NWFP during kharif 2003.

Entry	Parentage	Yield Kg ha^{-1}			% Increase in seed yield
		NIFA	D. I. Khan	Ave.	
NFM-6-2	VC 1971A x NM 92	2180	1317	1749	-8
NFM-12-12	**VC 1482C x NM 92**	**1974**	**1263**	**1619**	-
NFM-13-2	6601 x NM 92	1702	1072	1387	14
NM 92 (Check)	VC 2768B x NM 36	1235	812	1024	37
NM 98 (Check)	NM 20-21 x VC 1482E	1489	828	1159	28
SE		12.9	47.9	-	-
LSD (5%)		42.08	156.2	-	-

Table 4. Yield performance and % increase in seed yield of NFM-12-12 in adaptation yield trial conducted at various locations in NWFP during kharif 2004.

Entry	Parentage	Yield Kg ha^{-1}				
		NIFA	D.I. Khan	Karak	Ave.	% Increase
NFM-6-2	VC 1971A x NM 92	1238	1176	472	962	34
NFM-12-12	**VC 1482C x NM 92**	**1944**	**1810**	**630**	**1461**	-
NFM-13-2	6601 x NM 92	972	1420	370	921	37
NM 92 (Check)	VC 2768B x NM 36	1213	1161	447	940	36
NM 98 (Check)	NM 20-21 x VC 1482E	1111	1327	465	968	34
Karak Mung	Local Selection	1125	1162	394	894	39
SE		25.76	27.83	22.26	-	-
LSD (5%)		90.74	136.0	82.15	-	-

Table 5. Yield performance and % increase in seed yield of NFM-12-12 in zonal varital trial conducted on farmers' field at D. I. Khan and Dir Bala during kharif 2004.

Entry	Parentage	Yield Kg ha^{-1}		Ave.	% Increase
		D. I. Khan	Dir Bala		
NFM-6-2	VC 1971A x NM 92	1013	1743	1378	25
NFM-12-12	**VC 1482C x NM 92**	**1611**	**2042**	**1827**	-
NFM-13-2	6601 x NM 92	1332	1683	1508	17
NM 92 (Check)	VC 2768B x NM 36	1008	878	943	48
NM 98 (Check)	NM 20-21 x VC 1482E	1309	1033	1171	36
S. E.		23.51	31.35	-	-
LSD (5%)		40.38	87.84	-	-

Yield trials were conducted on farmers field at D. I. Khan and Dir Bala, respectively during 2004 (Table 5). NFM-12-12 produced significantly higher seed yield of 1611 kg ha^{-1} and 2042 kg ha^{-1} at D. I. Khan and Dir Bala, respectively compared to the standard check NM 98, which gave seed yield of 1309 kg ha^{-}1 at D. I. Khan and 1033 kg ha^{-1} in Dir Bala. The average yield of NFM-12-12 calculated from these two locations showed 48% and 36% increase in seed yield over NM 92 and NM 98, respectively.

The results of National Uniform Yield trials conducted by the pulses coordinator, Islamabad during the years 2003 and 2004 are presented in Table 6 and 7. The seed yield of NFM-12-12 was 879 kg ha^{-1} and 761 kg ha^{-1} on all locations' basis, and 1137 kg ha^{-1} and 888 kg ha^{-1} on NWFP basis during 2003 and 2004, respectively. NFM-12-12 secured 1st position during 2003 and 3rd position during 2004 on NWFP basis in National Uniform Yield Trials. NFM-12-12 showed high resistance to MYMV compared to the resistant check variety NM 98 and high susceptible exotic parent (Table 8).

The important agronomic, morphological and qualitative characteristics of NFM-12-12 along with parents and standards are presented in Table 9. NFM-12-12 showed early maturity, short stature, more seeds per pod, longer pods, high harvest index (%), more seed yield kg ha^{-1}, large seed size and stiff stem compared to the check variety NM 98.

Discussion

Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad has evolved a number of high yielding mungbean varieties through induced mutation and hybridization using AVRDC germplasm for Punjab (Ali *et al*., 1997). These varieties cannot perform well in NWFP because of different agro climatic conditions than Punjab (Khattak *et al*., 2003b). The currently evolved variety **"Ramzan"** by Nuclear Institute for Food and Agriculture (NIFA), Peshawar manifested improvement in the form of increase in seed size, decrease in plant height, stiff stem and earliness in maturity by a margin of about 10 days as compared to standard variety NM 98. The large seed size in mungbean is the main contributing factor toward seed yield in mungbean (Khattak *et al*., 2003a, b) and preferred by the farmers because of getting higher price compared to small seeded varieties (Ali *et al*., 1997).

The high harvest index of **"Ramzan"** invokes its greater physiological efficiency in partitioning the photosynthates towards grain formation leading to marked increase in the grain yield. Khattak *et al*., (2001) and Ticoo *et al*., (1996) have earlier reported to breed mungbean genotypes with improved determinate growth habit, which can only be possible to convert more photosynthates towards flowers, pods and seed formation at the initiation of reproductive growth stage.

The short stature and stiff stem of **"Ramzan"** helps in showing resistance to lodging. These two traits of this variety will encourage the sugar cane farmers for its intercropping in sugar cane. The high resistance of **"Ramzan"** to MYMV indicates the accumulation of more favorable modifying genes responsible for resistance to MYMV in an individual. The important role of modifying genes in the degree of MYMV resistance and susceptibility has earlier been reported by Khattak *et al*., (2000).

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Table 6. Mungbean national uniform yield trial conducted by pulses coordinator during Kharif 2003 (Yield Kg ha^{-1}).

Entry	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	Av. 1	Av.2
Swat Mung-1	957	440	1598	1449	502	1591	834	1001	465	755	998	1024	875	385	1329	946	988
CI/94-4-19	904	427	1285	1160	455	1109	1060	893	347	749	530	1254	825	366	1211	838	668
98-cmg-003	962	456	1668	1230	434	1441	980	857	483	658	983	1280	587	521	1254	920	981
98-cmg-016	816	429	1355	1125	401	1158	903	827	281	492	613	1166	720	372	770	762	714
98-cmg-018	1323	441	1007	462	326	1641	806	956	244	568	759	1152	531	226	1385	788	875
M-1	640	485	1529	1268	502	1295	1077	937	484	631	780	1288	510	517	1076	868	863
M-6	891	443	1598	806	380	1295	997	770	603	610	749	1068	514	355	1286	824	799
NCM-209	1191	424	1223	719	331	1303	729	1180	189	381	645	1033	554	391	1306	773	799
VC 3960 (A88)	940	476	1397	1011	498	1255	893	1155	414	873	605	1105	705	526	841	846	795
VC 3960 (A89)	862	423	1702	1174	554	1403	955	774	476	554	707	1040	704	439	951	855	849
NM 92	593	432	1129	969	324	772	1025	713	257	464	790	1306	319	742	1055	726	768
NM 98	901	429	1761	1449	436	1496	851	1223	470	402	1019	1072	630	512	926	905	1008
NFM-12-12	**707**	**445**	**1532**	**1383**	**524**	**1689**	**1042**	**832**	**488**	**208**	**1082**	**1181**	**417**	**641**	**1017**	**879**	**1137**

Av.1: Total locations average

Av.2: Average of NWFP locations i.e. L6 (NIFA, Peshawar), L11 (ARS Mingora) and L14 (D. I. Khan)

Location code	Location
L1	National Agricultural Research Center, Islamabad
L2	Rice research Institute, Dokri, Sindh
L3	Nuclear Institute for Agriculture and Biology, Faisalabad
L4	Quaid-e-Awam Agricultural Research Institute, Larkana
L5	Nuclear Institute for Agriculture, Tandojam
L6	Nuclear Institute for Food and Agriculture, Peshawar
L7	Regional Agricultural Research Institute, Bahawalpur
L8	Karakuram Agri. Res. Ins. for Northern areas, Juglote, Gilgit
L9	Arid Zone Research Institute, Bahawalpur
L10	Ayub Agricultural research Institute, Faisalabad
L11	Agricultural Research Station (North) Mingora, Swat
L12	Adaptive Research Farm, Karor, Layyah
L13	Arid Zone Research Institute, Bhakkar
L14	Agricultural Research Institute, D. I. Khan
L15	Agricultural Research Institute, Sariab, Quetta

Table 7. Mungbean national uniform yield trial conducted by pulses coordinator during Kharif 2004. (Yield Kg ha^{-1}).

Entry	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	Av. 1	Av.2
VC 3960 (A89)	442	572	313	585	842	1354	945	653	1002	386	1706	751	1083	818	774
NM 98	641	568	122	672	923	1299	904	639	1216	288	1546	996	1080	838	753
NCM-209	914	492	35	482	844	979	789	639	740	233	1297	917	1316	744	565
99-CMG-058	653	403	139	482	1177	799	723	537	455	177	1165	746	957	647	486
NM-3	629	630	869	886	989	1583	963	667	1192	344	1976	1017	1540	1022	939
CI/94-4-19	410	538	417	979	901	1584	775	723	1001	264	1872	934	1245	896	942
DM-2	190	392	469	594	975	1598	698	653	916	254	1539	704	1331	793	815
M-1	1036	395	278	491	864	1535	844	630	777	320	1387	776	1107	803	782
M-2	1020	409	817	639	1056	1514	851	672	883	236	1803	737	1157	907	796
NFM-12-12	**265**	**480**	**52**	**509**	**943**	**1889**	**817**	**686**	**445**	**271**	**1456**	**917**	**1167**	**761**	**888**

Av.1: Total locations average

Av.2: Average of NWFP locations i.e. L6 (NIFA, Peshawar), L11 (ARS Mingora) and L14 (D. I. Khan)

Location code	Location
L1	Agricultural Research Institute, Sariab, Quetta
L2	Arid Zone Research Institute, Bhakkar
L3	Regional Agricultural Research Institute, Bahawalpur
L4	Arid Zone Research Institute, D. I. Khan
L5	Karakuram Agri. Res. Ins. for Nort areas, Gilgit
L6	Nuclear Institute for Food and Agriculture, Peshawar
L7	Nuclear Institute for Agriculture and Biology, Faisalabad
L8	Barani Agricultural Research Institute, Chakwal
L9	Agricultural Research Institute, D. I. Khan
L10	Barani Agricultural Research Station, Kohat
L11	Ayub Agricultural research Institute, Faisalabad
L12	Pulses Research Sub Station, Sahowali, Sialkot
L13	National Agricultural Research Center, Islamabad

Table 8. Reaction of NFM-12-12 to MYMV as compared to parents and standards during kharif 2000, 2002 and 2003.

Entry	Mungbean Yellow Mosaic Virus disease rating during								
	2000 at NIAB, Faisalabad			2002 at NIFA, Peshawar			2003 at NIFA, Peshawar		
	% Infection	Score	Rating	% Infection	Score	Rating	% Infection	Score	Rating
NFM-12-12	4.4	1	HR	3.8	1	HR	3.5	1	HR
NM 92 (Local parent)	3.2	1	HR	2.5	1	HR	2.3	1	HR
VC 1482C (Exotic parent)	98.6	8	HS	95.4	8	HS	92.7	8	HS
NM 98 (Standard)	7.1	2	R	5.5	2	R	6.3	2	R

MYMV disease Score

Plant parts infected/disease (%)	Score	Disease reaction
No infection	0	Immune (I)
1-5	1	Highly resistant (HR)
6-10	2	Resistant (R)
11-20	3	Moderately resistant (MR)
21-30	4	Tolerant (T)
31-40	5	Moderately tolerant (MT)
41-50	6	Moderately susceptible (MS)
51-80	7	Susceptible (S)
81-100	8	Highly susceptible (HS)

Table 9. Important agronomic/morphological/qualitative characteristics of NFM-12-12 as compared to parents (NM 92 and VC 1482C) and standards (NM 98). (Average of three years 2002-2004).

Characters	NFM-12-12	NM 98	NM 92	VC 1482C
Days to flowering	34 ± 1	44 ± 2	32 ± 1	Fail to thrive due to MYMV attack and inadaptability in Pakistan.
Days to maturity	75 ± 2	85 ± 3	70 ± 2	
Plant height (cm)	70 ± 6	82 ± 12	65 ± 8	
Pods per plant	36 ± 5	38 ± 6	25 ± 4	
Seed per pod	11 ± 1	8 ± 1	9 ± 1	
Pod length (cm)	10 ± 1	7 ± 1	9 ± 1	
Clusters per plant	17 ± 3	18 ± 3	14 ± 2	
Branches per plant	2 ± 1	3 ± 1	1 ± 1	
Harvest Index (%)	38 ± 9	25 ± 9	37 ± 10	
Seed Yield (Kg ha^{-1})	1962 ± 103	1390 ± 161	1301 ± 121	
1000 seed weight	49 ± 1	38 ± 1	52 ± 1	55 ± 1
Seed protein content (%)	24 ± 0.3	24 ± 0.3	24 ± 0.2	24 ± 0.3
Reaction to MYMV	HR	R	HR	HS
Main Stem	Stiff	Soft	Stiff	Soft

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