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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 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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