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BREEDING HIGH YIELDING AND DISEASE RESISTANT MUNGBEAN (*VIGNA RADIATA* (L.) WILCZEK) GENOTYPES

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Abstract

Genetic variability was created for seed yield and its components in mungbean through hybridization by using local and exotic germplasm and through induced mutations only in local germplasm during summer and kharif 2004, respectively. The stable and high yielding genotypes developed through selections from the segregating populations were screened for Mungbean Yellow Mosaic Virus (MYMV) during kharif 2006 and evaluated in replicated yield trials for seed yield and some important agronomic traits at NIFA, Peshawar during summer 2007. The mutants/recombinants with significantly higher seed yield than check variety showed seed yield of 2250 to 3042 kg ha^{-1}. The 1000 seed weight, days to flowering and physiological maturity of all the evaluated mutants/recombinants ranged from 39 to 51g, 40 to 49 days and 79 to 84 days, respectively. The MYMV rating of the mutants/recombinants was from resistant to highly resistant.

Introduction

Mungbean is the major kharif pulse crop grown in NWFP. The major mungbean growing areas in the province are D. I. Khan, Kuram agency and Dir. Mungbean breeding programmes for the improvement of this crop in the province are purely based on the evaluation of the existing germplasm for selection of high yielding line to release as variety for general cultivation (Khattak *et al*., 2007). Creation of genetic variability using selected local and exotic germplasm following selection in the targeted environment for the desired traits is the utmost requirement for the exploitation of potential available for increase in mungbean production through increase in cultivated area and yield per unit area in the province. “Ramzan” is the first mungbean variety in the province, which was developed through hybridization and evolved for general cultivation in 2005 by Nuclear Institute for Food and Agriculture, Peshawar (Khattak *et al*., 2006a)

There are many researchable areas for the improvement of mungbean but breeding for seed yield and Mungbean Yellow Mosaic Virus (MYMV) are the most important aspects for the improvement of this crop. MYMV is the most important disease of mungbean but it is not a yield limiting factor in Pakistan because local land races and cultivated varieties in the country have tolerant to resistant behavior for this disease. On other hand, AVRDC’s mungbean germplasm with high yield potential is highly susceptible to MYMV; therefore, continuous screening of segregating material is essential when MYMV susceptible germplasm from AVRDC is used in hybridization programme for the improvement of yield potential of the local varieties. MYMV resistance is monogenic recessive but its degree of resistance depends upon the number of modified genes, which needs to be accumulated in a genotype to reduce the losses due to MYMV (Khattak *et al*., 1999, 2000).

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Genetic variability was created in well adapted mungbean varieties through induced mutations, and between local and AVRDC germplasm through hybridization for high seed yield and large seed size. The development and performance of the developed mutants/recombinants have been described in this paper.

Materials and Methods

Seeds of two mungbean varieties NM 92 and NM 98 were irradiated at 0.20, 0.30 and 0.40 KGy doses of gamma rays using ^{60}Co gamma cell and raised M_1 generation at NIFA during Kharif 2004. All M_1 plants were harvested individually and planted as plant progeny rows in M_2 population along with parent during summer 2005. Single plants were selected in M_2 populations on the basis of more pods and good plant type. M_3 and M_4 generations of the selected mutants were raised as line-progeny-rows along with parent to confirm the desired breeding behavior of the selected mutants during kharif 2005 and summer 2006, respectively. The selected mutants were evaluated during kharif 2006 as line progeny rows for stability performance of the desired traits and seed increase for conducting replicated preliminary yield trials.

The exotic (VC 1560D, VC 1482C and VC 3902A) and local mungbean genotypes (NM 92 and NM 98) were hybridized in various cross combinations at Nuclear Institute for Food and Agriculture (NIFA), Peshawar during summer 2004 following the crossing technique of Khattak *et al*. (1998). The F_1 generations of these crosses were planted during kharif 2004 and the hybrid plants were picked individually. The F_2 populations of each cross were raised as plant progeny rows during summer 2005 for selecting high yielding recombinants and selected single plants on the basis of more pods and good plant type. The F_3 populations of each cross were raised as plant progeny rows for selecting high yielding recombinants with resistance to MYMV during kharif 2005. 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. The generation of the selected recombinants was advanced to confirm their breeding behavior/genetic stability for the desired traits during summer and kharif 2006.

The selected high yielding mutants/recombinants were also evaluated during kharif 2006 in MYMV screening nursery with two replications in isolation as described in evaluation of F_3 generation. Two rows of each entry with 4 meter length in each replication were planted. The plant-to-plant and row-to-row spacing of 10cm and 30cm, respectively was maintained. The MYMV percent infection was recorded on individual plant basis of all plants in a plot 4 weeks after sowing when 100% plants of the susceptible check (mung kabuli) were completely infected with MYMV. The mean disease score of each entry was calculated as (infection rate x frequency)/total number of plants. The percent MYMV infection was converted to disease score and disease reaction according to the MYMV disease score scale (0-8) reported by Malik (1992).

The stable high yielding mutants/recombinants were evaluated during summer 2007 in preliminary yield trials with 3 replications. Four rows of each entry with 4 meter length in each replication were planted. The plant-to-plant and row-to-row spacing of 10cm and 30cm, respectively was maintained. The agronomic data recorded from replicated trials were as bellow:

Table 1: Performance of mungbean advanced mutants in yield trial during summer 2007 at NIFA, Peshawar

Entry	Parentage	Days to flowering	Days to maturity	Plant height (cm)	1000 seed weight (g)	*Reaction to MYMV	Yield kg/ha
92-2-11	NM 92 mutant	44	81	40	49	R	2188
92-2-20	-do-	41	80	40	50	R	2229
92-2-23	-do-	42	80	44	43	R	2125
92-2-31	-do-	40	79	40	50	HR	2229
92-2-34	-do-	41	80	43	51	HR	1979
92-2-36	-do-	42	81	40	49	R	2625
92-3-4	-do-	41	80	40	50	R	2188
92-3-8	-do-	43	81	47	51	R	2667
92-4-3	-do-	41	80	40	50	R	2875
92-4-12	-do-	41	80	40	49	R	2563
NM 92	VC2768B x NM36	42	81	45	51	HR	1792
Ramzan	VC1482C x NM92	45	79	47	49	HR	2055
SE		0.44	0.48	1.43	0.58		22.6
LSD 5%		1.30	1.41	4.19	1.72		271

Table 2: Performance of mungbean advanced mutants in yield trial during summer 2007 at NIFA, Peshawar

Entry	Parentage	Days to flowering	Days to maturity	Plant height (cm)	1000 seed weight (g)	Reaction to MYMV	Yield kg/ha
98-2-1	NM 98 mutant	45	81	52	41	HR	2396
98-2-9	-do-	45	81	47	41	R	2250
98-2-22	-do-	46	80	42	41	R	1564
98-2-32	-do-	46	81	49	42	R	1793
98-2-36	-do-	46	79	47	41	HR	1751
98-3-1	-do-	44	80	44	40	R	2396
98-3-3	-do-	45	80	48	44	HR	1625
98-3-7	-do-	45	81	44	44	R	2625
98-4-1	-do-	44	79	46	42	R	2397
98-4-5	-do-	45	81	40	40	HR	2604
98-4-16	-do-	44	81	50	42	R	2042
98-4-17	-do-	44	81	44	39	R	2458
NM 98	NM20-21 x VC1482E	43	80	46	39	R	1563
Ramzan	VC1482C x NM92	41	79	40	48	HR	1854
SE		0.39	0.36	1.21	0.38		29.9
LSD 5%		1.14	1.05	3.58	1.22		261

Table-3: Performance of mungbean advanced lines in yield trial during summer 2007 at NIFA, Peshawar

Entry	Parentage	Days to flowering	Days to maturity	Plant height (cm)	1000 seed weight (g)	Reaction to MYMV	Yield kg/ha
5-63-5	VC 1482C x NM 92	46	78	43	50	HR	2417
5-63-11	-do-	43	80	54	45	R	2564
5-63-15	-do-	42	80	42	44	R	2459
5-63-18	-do-	43	80	48	50	HR	3021
5-63-22	-do-	41	80	40	49	R	2833
5-63-26	-do-	44	80	53	50	R	2853
5-63-28	-do-	45	80	45	48	HR	2625
5-63-29	-do-	44	81	46	50	R	2376
5-63-30	-do-	41	80	55	49	R	2979
5-63-33	-do-	45	81	43	50	R	2751
5-63-51	-do-	41	80	40	47	R	2563
Ramzan	-do-	44	80	40	48	HR	2042
NM 92	VC 2768B x NM 36	43	77	45	51	HR	1845
SE		0.41	0.63	1.05	0.50		28.9
LSD 5%		1.19	1.84	3.05	1.47		256

Table-4: Performance of mungbean advanced lines in yield trial during summer 2007 at NIFA, Peshawar

Variety	Parentage	Days to flowering	Days to maturity	Plant height (cm)	1000 seed weight (g)	Reaction to MYMV	Yield kg/ha
5-36-8	VC 1560D x NM 92	43	82	45	50	R	2333
5-36-24	-do-	46	84	46	50	HR	3042
5-36-25	-do-	44	82	45	48	R	2813
5-36-26	-do-	44	81	44	50	R	2875
5-36-41	-do-	45	81	55	46	R	2896
5-36-50	-do-	45	80	40	50	R	2604
5-36-51	-do-	41	80	43	45	HR	2896
5-36-59	-do-	43	82	42	48	R	2646
5-36-60	-do-	45	82	40	50	HR	2125
5-36-61	-do-	46	84	45	49	R	2563
5-36-63	-do-	45	81	44	49	R	2750
5-36-64	-do-	45	80	40	45	HR	2396
5-36-67	-do-	44	79	40	48	R	2792
Ramzan	VC 1482C x NM 92	44	79	40	49	HR	2313
NM 92	VC 2768B x NM 36	43	79	43	51	HR	2083
SE		0.45	0.49	1.01	0.73		34.50
LSD 5%		1.32	1.43	2.92	2.12		244

Table 5: Performance of mungbean advanced lines in yield trial during summer 2007 at NIFA, Peshawar

Variety	Parentage	Days to flowering	Days to maturity	Plant height (cm)	1000 seed weight (g)	Reaction to MYMV	Yield kg/ha
5-91-9	NM 98 x VC 3902A	45	80	40	50	HR	2563
5-91-17	-do-	49	85	40	49	R	2479
5-91-21	-do-	47	82	40	50	HR	2813
5-91-22	-do-	47	82	40	50	R	2458
5-91-26	-do-	43	82	40	47	R	2667
5-91-28	-do-	44	81	40	49	HR	2688
5-91-29	-do-	39	80	46	47	HR	2438
5-91-30	-do-	45	82	41	46	R	2750
5-91-40	-do-	44	81	41	47	R	2875
5-91-43	-do-	44	82	41	46	R	2688
Ramzan	VC 1482C x NM 92	43	80	40	50	HR	2125
NM 98	NM 20-21 x VC 1482E	49	83	41	40	R	1771
SE		0.47	0.47	0.78	0.58		25.2
LSD 5%		1.40	1.38	2.31	1.72		249

*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)

Days to 50% flowering: Average days of 3 replicated plots counted from sowing to the 50% plants flowering.

Days to 90% pods maturity: Average days of 3 replicated plots counted from sowing to 90% pods maturity on most of the plants.

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

1000 seed weight (g): Average weight of three random samples of 1000 seed from a genotype.

Seed yield (kg ha^{-1}): Recorded plot seed yield in grams and converted in to kg ha^{-1} as follow: Yield kg ha^{-1}= Plot seed yield x 10/Plot size

Replicated trails data were analyzed for Analysis of Variance (ANOVA) according to Steel and Torrie (1980).

Results

The mungbean-advanced mutants derived from NM 92 and NM 98, and recombinants selected from three different cross combinations of local and exotic genotypes showed highly significant differences for seed yield and other traits (Table 1-5).

Days to flowering and physiological maturity ranged from 40 to 49 days and 79 to 84 days respectively. Plant height ranged from 40 to 55 cm while the 1000 seed weight ranged from 39 to 51g. The reaction to MYMV was resistant to highly resistant. The range of seed yield of those mutants/recombinants, which showed significantly higher seed yield than the standard check Ramzan was 2250 to 3042 kg ha^{-1}.

Discussion

Seed size and pods per plant are the main yield contributing factors in mungbean but the former trait is more stable compared to the latter trait under environmental fluctuations High yielding genotypes developed through improvement in seed yield may produce stable yield under fluctuating environment compared to the genotypes developed by increasing number of pods per plant. (Khattak *et al*., 2001). More emphasis was given during selection on large seed size with more pods per plant to develop the mentioned high yielding mutants/recombinants. The MYMV resistance in mungbean is controlled by a major recessive gene and the modifying genes influence the degree of MYMV resistance/susceptibility (Khattak *et al*., 2002, 2006b). Efforts were made to accumulate more favorable modifying genes responsible for MYMV resistance along with large seed size and more pods per plant in current mungbean mutants/recombinants.

Conclusion: The high yielding and MYMV resistant mutants/recombinants presented in the paper will be further evaluated for adaptation and stability studies in multilocation and National Uniform Yield Trials to select the outstanding mungbean genotype for evolving as a mungbean variety for general cultivation in NWFP.

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