

Induced Mutations in Mungbean Breeding : Regional Yield Trial of Mungbean Mutant Lines

Arunee Wongpiyasatid¹, Somsong Chotechuen², Praparat Hormchan³,
Sumana Ngampongsai² and Wilaiwan Promcham²

ABSTRACT

Comparison of mungbean mutant lines with the standard varieties was conducted at various stations during 1998 and 1999, RCB was employed with 4 replications. In the year 1998, 12 selected mutant lines were planted in 10 experimental plots at 7 locations and the three lines of M5-5, M5-1 and M4-2 were found to give the high yields of 243, 235 and 229 kg/rai, respectively, comparing to 213 and 228 kg/rai of KPS1 and CN36, respectively. During 1999, 12 mutant lines were planted in 6 plots at 5 locations and it was found that M5-10, M4-2, M5-5 and M5-22 gave yields of 240, 240, 236 and 232 kg/rai, respectively, while KPS1 and CN36 gave 227 and 232 kg/rai, respectively. Whereas the highest yield was obtained from M5-5 in 1998, it was M4-2 in 1999. The 2 year-tests resulted in the selection of M5-5, M5-1 and M4-2 for further comparing study with the standard varieties in the farmers' fields.

Key words: mungbean, induced mutation, mutant lines, yield

INTRODUCTION

Induced mutation using physical and chemical mutagens is one method to create genetic variation resulting in new varieties with better characteristics. The application of radiation and chemical in mungbean (*Vigna radiata* (L.) Wilczek) breeding of various aspects were undertaken. The selection and development of mutants into recommended varieties for the farmers have been successfully made in many countries (Bahl and Gupta, 1983; Chow and Loo, 1988; Lamseejan *et al.*, 1988; Wongpiyasatid *et al.*, 1998).

Mungbean breeding project to increase yield

and disease resistance by induced mutation was initiated in 1995. Seeds of KPS1 and CN36 were gamma irradiated at 500 gray or soaked in 1% ethylmethane sulphonate (EMS) after which varietal selection from M₂ was conducted (Wongpiyasatid *et al.*, 1998). Preliminary comparison of yield in 1997 revealed that most mungbean lines had yield and other agronomic characters not statistically different from the standard checks. Yet, some lines gave higher yields with less powdery mildew infection than the checks (Wongpiyasatid *et al.*, 1999). Twelve lines were then selected and comparison for regional yield trial was made in 1998 and 1999 with the objective on selection of

1 Department of Applied Radiation and Isotopes, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand.

2 Chai Nat Field Crops Research Center, Chai Nat 17000, Thailand.

3 Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.

mungbean lines giving higher yield and disease resistance than those of the standards.

MATERIALS AND METHODS

1) 1998 experiment

Twelve selected mutants namely M4-2, M5-1, M5-4, M5-5, M5-7, M5-8, M5-11, M5-15, M5-16, M5-22, M5-28 and M5-29 were grown comparing with the standard varieties, KPS1 and CN36. RCB was used in the experiment with 4 replicates. Each plot was 4×5 m². The chemicals were applied during vegetative growth, flowering and podding as needed for insect control. Yield (in 3×5 m²), agronomic characters and score of cercospora leaf spot (CLS) and powdery mildew (PM) in natural incidence were recorded.

Location

In the dry season, the experiments were conducted at Chai Nat Field Crops Research Center (Chai Nat FCRC) and Phitsanulok Field Crops Experiment Station (Phitsanulok FCES). Early rainy season crop was planted at Chai Nat FCRC while late rainy season crops were grown at Chai Nat FCRC, Phitsanulok FCES, Sri Samrong FCES, Ban Mai Samrong FCES, Phetchabun FCES, Suranaree University of Technology (Suranaree U. of Tech.) and Rajamangala Institute of Technology, Ayutthaya Campus.

2) 1999 experiment

Experimental design, cultivation field maintenance and data recording were similar to those undertaken in 1998, except for the mutant lines employed. The result of disease resistance by artificial inoculation in the greenhouse was also used in consideration of line selection. Four lines namely M5-4, M5-7, M5-8 and M5-11 were discarded whereas 2 lines, M5-10 and M5-25 were added in the dry season test. As for the rainy season

experiment, M5-8 was brought back for comparison since it was found to give high yield in some locations. Apart from these, line 9-5 which had been in the process of variety recommendation from Department of Agriculture by FCRC was also brought in. This resulted in 12 mutant lines namely M4-2, M5-1, M5-5, M5-8, M5-10, M5-15, M5-16, M5-22, M5-25, M5-28, M5-29 and 9-5 being planted in comparison with the standards, KPS1 and CN36.

Location

The dry and early rainy season tests were undertaken at Chai Nat FCRC while late rainy season crops were grown at Chai Nat FCRC, Ban Mai Samrong FCES, Phetchabun FCES and Sri Samrong FCES.

Data analysis

Stability parameters for comparing varieties used in this experiment followed Eberhart and Russell's stability model (Eberhart and Russell, 1966):

$$Y_{ij} = \mu_i + \beta_i I_j + \delta_{ij}$$

where :

Y_{ij} = variety mean of the i^{th} variety at the j^{th} environment ($i = 1, 2, \dots, v; j = 1, 2, \dots, n$)

μ_i = mean of the i^{th} variety over all environments

β_i = regression coefficient measuring the response of the i^{th} variety in various environments

δ_{ij} = deviation from regression of the i^{th} variety at the j^{th} environment

I_j = environmental index obtained as the mean of all varieties at the j^{th} environment minus the grand mean

Varieties with a regression coefficient less than 1.0 ($b_i < 1.0$) usually have average yields (\bar{X}_i) below the grand mean. Hence, variety with a high mean (\bar{X}_i), unit regression coefficient ($b_i = 1.0$) and

the deviations from regression as small as possible ($S^2d_i = 0$) is desirable.

RESULTS AND DISCUSSION

1. 1998 experiment

The dry and rainy season experiments found the mutant lines to give variation in yield depending on location planted but there were no differences among lines except for the late rainy season tests conducted at Phitsanulok FCES and Sri Samrong FCES. Table 1 presents yields and disease resistance of mungbean lines during such times. The top three high yielding lines were found in M5-5 (243 kg/rai), M5-1 (235 kg/rai) and M4-2 (229 kg/rai) compared to those of KPS1 (213 kg/rai) and CN36 (228 kg/rai). Infection of CLS on M5-29 (2.4), M5-1 (2.5) and M5-11 (2.5) under natural condition and M5-22 (51.4), M5-7 (53.8) and M4-2 (54.3) in artificial inoculation were noticed to be higher than those of KPS1 and CN36 under both conditions. The infection of PM in M5-5 (2.5) and M5-16 (2.6) under natural condition and M5-11 (32.5) in artificial inoculation were lower than those of KPS 1 and CN 36.

2. 1999 experiment

The results from 1999 experiment were similar to those of 1998 test except that there were statistical differences among lines from the test at Banmai Samrong FCES. Yields and disease resistance of mutant lines are presented in Table 2. M5-10 (240 kg/rai), M4-2 (240 kg/rai) and M5-5 (236 kg/rai) were found to give the highest yields comparing to KPS1 (227 kg/rai) and CN36 (232 kg/rai), the recommended varieties. It was also noticed that many lines had low infection of CLS including M5-8 (1.8), M4-2 (2.0), M5-1 (2.0), M5-5 (2.0), M5-15 (2.0), M5-22 (2.0) and M5-25 (2.0), while low infection of PM was found in M5-28 (1.8), M4-2 (2.0), M5-5 (2.0) and M5-22

(2.0) compared with those of both recommended varieties.

3. Combined results of the two experiments

Table 3 presents the stability analysis of average yield and scores of disease incidences of tested mutants from both dry and rainy season experiments of 1998 and 1999. It shows the lines with high yields and stability as follows : M5-5 (240 kg/rai), M5-1 (234 kg/rai) and M4-2 (233 kg/rai), with non-significant regression coefficient (b_i) nor deviation from regression in comparison to KPS1 and CN36 whose yields were 218 and 229 kg/rai and non-significant stability parameters. The three mutants gave significantly higher yield than KPS1, but not CN36. They also had average scores of cercospora leaf spot and powdery mildew infection closed to those of the standards.

As objective stated, the line selection was based on high yield and disease resistance. In terms of high yield compared to the standards, the mutant lines selected were M4-2, M5-1 and M5-5 whose regression coefficient were a little more or less than 1, but with high deviation from regression line. Eberhart and Russell (1966) stated that a good variety was the one with high yield, regression coefficient (b_i) = 1 and deviation from regression (S^2d_i) = 0. Stability in yielding when planted under differently environmental conditions is one important selection guide as well. A good variety should have low interference to the environments but with wide adaptation. The three selected mutants evidently gave good yield under various locations in the two year experiments in spite of their high but non-significant deviation from regression. However, comparing to the standards KPS1 and CN36, they were not much different.

It was also evident that M4-2, M5-1 and M5-5 were selected in accordance with specification of resistance to cercospora leaf spot and powdery

Table 1 Yield, visual rating score and disease index (DI) of cercospora leaf spot and powdery mildew of mungbean mutant lines tested in the dry and rainy seasons of 1998.

Line/variety	Yield (kg/rai)				Cercospora leaf spot		Powdery mildew	
	Dry ^{1/}	Early rainy ^{2/}	Late rainy ^{3/}	Average ^{4/}	Natural condition ^{5/}	Artificial inoculation ^{6/}	Natural condition ^{5/}	Artificial inoculation ^{6/}
M 4-2	180	240	241	229	2.7	54.3	2.8	38.1
M 5-1	190	218	250	235	2.5	61.5	3.0	35.6
M 5-4	185	256	231	224	2.7	70.2	2.7	34.3
M 5-5	189	225	264	243	2.8	68.4	2.5	42.5
M 5-7	193	194	229	219	2.7	53.8	2.6	53.1
M 5-8	168	195	243	223	3.0	67.8	2.8	44.3
M 5-11	181	238	236	225	2.5	62.7	2.7	32.5
M 5-15	168	182	242	221	2.5	64.9	2.9	40.6
M 5-16	181	244	224	218	3.0	74.0	2.6	33.9
M 5-22	189	214	221	214	2.9	51.4	2.7	46.8
M 5-28	174	199	211	203	2.6	69.2	2.7	50.6
M 5-29	170	162	238	217	2.4	67.6	2.9	40.6
KPS 1	176	173	229	213	2.9	74.9	2.6	48.1
CN 36	188	215	241	228	2.5	74.9	2.8	33.7
Mean	181	211	236	222	2.72	65.4	2.7	41.1

^{1/} Average from dry season of 1998 experiments at Chai Nat Field Crops Research Center and Phitsanulok Field Crops Experiment Station^{2/} Early rainy season of 1998 experiment at Chai Nat Field Crops Research Center^{3/} Average from late rainy season of 1998 experiments at Chai Nat Field Crops Research Center, Phitsanulok Field Crops Experiment Station, Sri Samrong Field Crops Experiment Station, Ban Mai Samrong Field Crops Experiment Station, Phetchabun Field Crops Experiment Station, Suranaree University of Technology and Rajamangala Institute of Technology, Ayutthaya Campus^{4/} Average from dry and rainy seasons of 1998 experiments, 7 locations/10 experimental plots^{5/} Visual rating score (average from dry and rainy seasons of 1998 experiments) : 1 = no infection 5 = severe infection^{6/} Disease index, DI. (Wongpiyasatid *et al.*, 1999)

Table 2 Yield and visual rating score of cercospora leaf spot and powdery mildew in mungbean mutant lines tested in the dry and rainy seasons of 1999.

Line/variety	Yield (kg/rai)				Cercospora leaf spot ^{5/}	Powdery mildew ^{5/}
	Dry ^{1/}	Early rainy ^{2/}	Late rainy ^{3/}	Average ^{4/}		
M 4-2	253	299	222	240	2.0	2.0
M 5-1	246	321	205	231	2.0	2.5
M 5-5	246	326	210	236	2.0	2.0
M 5-8	-	309	202	223	1.8	2.5
M 5-10	278	302	215	240	2.2	3.0
M 5-15	271	268	202	225	2.0	2.7
M 5-16	282	271	172	207	2.1	2.2
M 5-22	242	339	203	232	2.0	2.0
M 5-25	214	288	210	224	2.0	2.6
M 5-28	238	292	200	221	2.2	1.8
M 5-29	258	274	211	229	2.1	2.3
9-5	-	278	207	221	2.2	3.1
KPS 1	272	272	205	227	2.1	2.3
CN 36	252	271	217	232	2.1	2.6
Mean	254	294	206	228	2.1	2.4

^{1/} Dry season of 1999 experiment at Chai Nat Field Crops Research Center

^{2/} Early rainy season of 1999 experiment at Chai Nat Field Crops Research Center

^{3/} Average from late rainy season of 1999 experiment at Chai Nat Field Crops Research Center, Sri Samrong Field Crops Experiment Station, Phetchabun Field Crops Experiment Station

^{4/} Average from dry and rainy seasons of 1999 experiment, 4 locations/6 experimental plots

^{5/} Visual rating score (average from dry and rainy seasons of 1999 experiments) : 1 = no infection 5 = severe infection

mildew compared to the standards, KPS1 and CN36. Even though the incidences of disease resistance of the three mutant lines were not that low, the mechanism of resistance might be indicated as tolerance whose part of definition according to Painter (1951) was a basis of resistance in which the plants showed an ability to grow and reproduce itself or to repair injury. The term is mostly applied to insect plant resistance, but could be well explained in this case in spite of unknown resistant source.

Disease infection under both natural and artificial conditions were considered in line selection. However, when the results were contradictory to each other, the one from the artificial inoculation would then be determined, since under natural condition, the plants either might have a chance to escape or the infection is too low for the plants to express optimum resistance. In the inoculated condition, all plants are supposed to be equally infected. It could be said that the lines

Table 3 Yield, regression coefficient, deviation from regression and disease visual rating score of mungbean mutant lines tested in the dry and rainy seasons of 1998 and 1999.

Line/variety	Yield ^{1/} (kg/rai)	Regression coefficient (b _i)	Deviation from regression	Cercospora leaf spot ^{2/}	Powdery mildew ^{2/}
M 4-2	237 ab ^{3/}	1.05 ns	356 ns	2.4	2.5
M 5-1	240 a	0.98 ns	488 ns	2.4	2.8
M 5-5	240 a	1.19 ns	67 ns	2.5	2.3
M 5-8	227 abc	1.29 *	172 ns	2.4	2.8
M 5-15	223 bcd	1.10 ns	374 ns	2.3	2.8
M 5-16	211 d	0.81 ns	1421 **	2.8	2.4
M 5-22	225 a-d	1.02 ns	563 *	2.5	2.4
M 5-28	217 cd	0.88 ns	258 ns	2.5	2.3
M 5-29	222 bcd	0.98 ns	291 ns	2.3	2.7
KPS 1	217 cd	0.87 ns	150 ns	2.5	2.5
CN36	228 abc	0.83 ns	216 ns	2.3	2.7
F-test	**	-	-	-	-
Mean	226	-	-	-	-
CV (%)	15.6	-	-	-	-

^{1/} Average from 7 locations and 14 experimental plots (experiments of late rainy season, 1998 at Phitsanulok FCES and dry season 1999 at Chai Nat FCRC were not included)

^{2/} Visual rating score (average from dry and rainy seasons of 1999) : 1 = no infection 5 = severe infection

^{3/} Data within columns, means followed by a common letter are not significantly different at the 5% level by DMRT

ns = non-significant

* = significant at 5% level

** = significant at 1% level

selected for further investigation, both yield and disease resistance were brought into consideration under logic mentioned.

CONCLUSION

Comparison of mungbean lines conducted in 10 experiments at 7 locations during 1998 and 6 experiments at 4 locations in 1999 should be further studied for yield in the farmers' fields. The 3 lines, M5-5, M5-1 and M4-2, revealed that they had better yield stability than the standard checks. Yet artificial inoculation showed that they

were more resistant to cercospora leaf spot than the checks.

ACKNOWLEDGEMENT

The authors would like to express their appreciation in the assistance on new line testing to all research centers, experimental stations and institutions mentioned above. The experiments leading to this publication was funded by Kasetsart University Research and Development Institute (KURDI).

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Received date : 1/08/00
Accepted date : 20/11/00