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Evaluation of Promising Mung Bean Mutants Against Foot and Root Rot, *Cercospora* Leaf Spot and Yellow Mosaic Diseases

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Abstract

The experiment was conducted to evaluate disease resistant mutants against foot and root rot, *Cercospora* leaf spot and mung bean yellow mosaic disease under natural epiphytotic condition, 9 mutants collecting from the Bangladesh Institute of Nuclear Agriculture were used in this experiment. Among the mutants, MBM-07(S)-2 was found resistant against the foot and root rot disease followed by MBM-347-13, MBM-390-94-Y and MBM-656-51-2. Most of all plants of each plot were attacked by *Cercospora* leaf spot of mung bean. The highest yellow mosaic disease incidence 84.76% was recorded in MBM-80 (LCAL) and the lowest 20.00% in MBM-527-114 followed by MBM-07-Y-2 (30.00%) and MBM-427-87-3 (33.67%). The highest yellow mosaic disease severity 26.84% was observed in MBM-80 (LCAL) and the lowest 0.38% was observed in MBM-527-114 followed by MBM-656-51-2 (1.04%) and MBM-427-87-3 (1.63%). The highest number of seeds per pod was counted in MBM-07-Y-1 and the highest 1000 seed weight was observed in BARI Moog-6 (50.00 gm) followed by MBM-527-114 (45.67 gm). The highest grain yield 204.44 kg was recorded in MBM-07-Y-1 followed by MBM-390-94-Y (186.66 kg). MBM-07(S)-2, MBM-07-Y-2, MBM-07-Y-1 and MBM-527-114 mutants showed less disease incidence and severity for foot and root rot, *Cercospora* leaf spot and mung bean mosaic disease and gave better yield than other mutants.

Keywords: Mung bean mutant; Foot and root rot; *Cercospora* leaf spot, Yellow mosaic disease; Disease resistant

Introduction

Mung bean/green gram (*Vigna radiata*) is one of the important pulse crop as well as an excellent source of cheap cost protein [1]. Considering the nutrients point of view, mung bean is the best of all pulses [2]. It covers 24.18% of the total pulse cultivation area and it also contributes 20.95% of the total pulse production in Bangladesh [3]. Mung bean contains vitamin A, B, C, niacin, and various minerals such as calcium, phosphorus, and potassium which are essential for human body [4]. Mung bean plants can fix atmospheric nitrogen through symbiosis with nitrogen–fixing rhizobia, this crop is valuable both economically as well as nutritionally and is widely used in different cropping systems [5]. The average yield of our mung bean cultivars is poor compared to the cultivar in other countries. There are many constraints responsible for the low yield of mung bean. Among those, diseases are the most important. A total of twenty diseases of mung bean have been recorded in Bangladesh [6]. Foot and root rot, yellow mosaic, *Cercospora* leaf spot and powdery mildew are the major diseases found in the field. Foot and root rot of mung bean is caused by *Fusarium oxysporum* and *Sclerotium rolfsii* cause considerable yield loss by reducing plant population in the field. They are the most destructive soil borne as well as seed borne phytopathogenic fungi Fakir [7]. The host range of the fungus *S. rolfsii* is very extensive [8].

Cercospora leaf spot is also a serious disease of mung bean [9] and causes yield losses of up to 58% [10]. Similarly, mung bean yellow mosaic virus is one of the most important and damaging disease that incurred significant yield reductions every year in Bangladesh [11]. Mung bean yellow mosaic virus (MYMV) may cause 63% yield loss [12]. Yield loss might occur up to 80% in susceptible cultivars which was reported by Ayub et al. [13].

So, cultivation of resistant varieties seems most useful method in disease management. Induced mutations have been used to generate genetic variability and have been successfully utilized to improve yield [14]. Physical and chemical mutagenic agents cause genes to mutate at rates above the spontaneous base line, thus producing a range of novel traits and broadening of the genetic diversity of plants [15]. Resistant response in different crops against disease may be due to decreased level of certain chemicals as compared to susceptible ones [16]. The use of resistant cultivars is widely recognized as the safest, the most economical and the most effective method for protecting crops from disease [17]. So, it is obviously necessary to find out the resistant variety through developing induced mutation.

Materials and Methods

The experiment was conducted at the experimental field and the Plant Disease Clinic laboratory under the Department of Plant pathology, Patuakhali Science, and Technology University (PSTU), Bangladesh. The experiment was carried out during the summer season from April 2015 to June 2015. The experimental field was high land with highly sandy loam texture belonging to the Ganges tidal flood plain (AEZ 13). Seeds of mung bean mutants were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh for conducting the experiment.

List of mung bean mutants

The mung bean mutants were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh which are as follows in Table 1.

Post emergence mortality due to foot and root rot

Data on post emergence mortality due to foot and root rot disease of mung bean was recorded at 15 and 30 DAS on the basis of 0 to 6 scales [18].

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Assessment of disease severity for *Cercospora* leaf spot

Disease severity was recorded from each plot by using (0-9) disease severity scale according to Mehta and Mondal [19] as follows in Table 2.

Assessment of disease severity for yellow mosaic disease

Severity of mung bean yellow mosaic disease was recorded from each plot on the basis of 0 to 8 scale according to Malik [20] as follows in Table 3.

Growth and yield contributing characters

Fifteen plants of each unit plots were randomly selected at maximum growth stage for recording of the data on number of pod per plant, length of pod, number of seed per pod and 1000 seed weight. Yield of mung bean mutants were recorded in individual plot.

Analysis of data

The experiment was conducted in Randomized Complete Block Design (RCBD). Data were analyzed using ANOVA with the Web Agri Stat Package 2.0 (WASP). Means were compared by the Duncan's multiple tests and statistical significance was determined at 5% level using WASP.

Results and Discussion

Post emergence mortality

Percent post emergence mortality of mung bean mutants were recorded at 15 and 30 days after sowing (DAS) and data are presented in Table 4. Mung bean mutants were evaluated for their reaction to foot and root rot disease caused by *S. rolfsii*. The tested mutants showed significant variation in respect of post emergence mortality at 15 and 30 DAS. At 15 DAS, the highest 13.38% seedling mortality was observed in the plot of MBM-07-Y-1 followed by the plot of MBM-527-114 (12.21%) and the lowest 6.32% seedling mortality in MBM-07(S)-2 followed by MBM-347-13 (7.52%). But in the contrary, MBM-347-13 showed the highest 14.72% post emergence mortality followed by MBM-07(S)-2 (14.00%) at 30 DAS. The sensitivity to post emergence mortality decreased with the increase in age of the plants. Similar findings were reported in case of barley seedling by Singh et al. [21]. They found that barley seedlings were most susceptible to attack of *S. rolfsii* during first fifteen days of the growth and the percent infection of the plant reduced with aging. Similarly, in case of groundnut diseases, Kulkarni et al. [22] also found similar findings.

Sl No.	Name of the mutants
1	MBM-07-Y-1
2	MBM-07-Y-2
3	MBM-656-51-2
4	MBM-527-114
5	MBM-07(S)-2
6	MBM-347-13
7	MBM-390-94-Y
8	MBM-80 (LCAL)
9	MBM-427-87-3
10	BARI Moog-6 (check variety)

Table 1: The mung bean mutants were collected from Bangladesh Institute of Nuclear Agriculture (BINA).

Scales	Description	Categories
0	No visible symptoms	Immune
1	1% to 10% leaf area infected	Highly resistant
3	11% to 30% leaf area infected	Resistant
5	31% to 50% leaf area infected	Moderately resistant
7	51% to 80% leaf area infected	Susceptible
9	81% to 100% leaf area infected	Highly susceptible

Table 2: Disease severity was recorded from each plot by using (0-9) disease severity scale.

Scale	Description	Categories
0	No infection	Immune
1	1% to 5% plant parts infected	Immune
2	6% to 10% plant parts infected	Highly resistant
3	11% to 20% plant parts infected	Resistant
4	21% to 30% plant parts infected	Moderately resistant
5	31% to 40% plant parts infected	Tolerant
6	41% to 50% plant parts infected	Moderately tolerant
7	51% to 80% plant parts infected	Susceptible
8	81% to 100% plant parts infected	Highly susceptible

Table 3: Severity of mung bean yellow mosaic disease was recorded from each plot on the basis of 0 to 8 scale.

Mung bean mutants	Seedling mortality (%)	
	15 DAS	30 DAS
MBM-07-Y-1	13.38^{a}	10.92^{cd}
MBM-07-Y-2	11.76^{b}	10.65^{d}
MBM-656-51-2	8.34^{de}	12. 54^{bc}
MBM-527-114	12.21^{ab}	12.27^{bcd}
MBM-07(S)-2	6.32^{f}	14.00^{ab}
MBM-347-13	7.57^{ef}	14.72^{a}
MBM-390-94-Y	8.26^{de}	12.48^{bc}
MBM-80 (LCAL)	11.37^{b}	12.37^{bcd}
MBM-427-87-3	9.63^{cd}	11.67^{cd}
BARI Moog-6 (check variety)	11.08^{bc}	12.33^{bcd}
$LSD_{0.05}$	1.493	1.574
CV (%)	8.71	7.40

$^{(a-f)}$Means of the mutants and variety were compared by DMRT. There is no significant variation having same letter(s) among the mutants and variety.

Table 4: Post-emergence mortality of mungbean mutants' due to foot and root rot at 15 days and 30 days after sowing.

Mungbean mutants	Disease severity (%)
MBM-07-Y-1	5.32^{f}
MBM-07-Y-2	5.31^{f}
MBM-656-51-2	9.04^{e}
MBM-527-114	11.88^{d}
MBM-07(S)-2	12.40^{d}
MBM-347-13	26.95^{a}
MBM-390-94-Y	12.73^{d}
MBM-80 (LCAL)	19.87^{b}
MBM-427-87-3	17.83^{c}
BARI Moog-6 (check variety)	17.44^{c}
$LSD_{0.05}$	1.156
CV (%)	4.86

$^{(a-f)}$Means of the mutants and variety were compared by DMRT. There is no significant variation having same letter(s) among the mutants and variety.

Table 5: Disease severity of mung bean mutants for *Cercospora* leaf spot at pod formation stage (60 DAS).

Disease severity of mung bean mutants for *Cercospora* leaf spot at pod formation stage (60 DAS)

Disease severity of mung bean mutants for *Cercospora* leaf spot at pod formation stage (60 DAS) was estimated and presented in Table 5.

Cercospora leaf spot disease severity showed significant differences to one another. The severity ranged from 5.31% to 26.95%, where the

highest percent disease severity was observed in MBM-347-13 followed by MBM-80 (LCAL) (19.87%) and the lowest 5.31% percent of severity was observed in MBM-07-Y-2 followed by MBM-07-Y-1 5.32%. Iqbal et al. [23] evaluated fifty-eight mung bean genotypes for resistance against *Cercospora* leaf spot diseases under artificially inoculated disease condition in the field.

Disease incidence and severity of mung bean mutants for yellow mosaic at pod formation stage (90 days after sowing)

The tested mutants were showed significant differences to each other for disease incidence and severity of mung bean mutants for yellow mosaic disease at pod formation stage (90 DAS) (Table 6). The disease incidence was ranged from 20.00% to 84.76% where the highest 84.76% was recorded in MBM-80 (LCAL) followed by MBM-07(S)-2 (78.67%) and the lowest 20.00% of disease incidence was recorded in MBM-527-114 followed by MBM-07-Y-2 (30.00%). This is in accordance with the findings of Khattak et al. [24].

On the other hand, the disease severity for yellow mosaic of mung bean among the mutants ranged from 0.38% to 26.84%. The highest disease severity was observed in MBM-80 (LCAL) (26.84%) followed by MBM-07(S)-2 (15.53%) and the lowest disease severity was observed in MBM-527-114 (0.38%) followed by MBM-656-51-2 (1.04%). Iqbal et al. [25] found resistant mung bean mutants by screening 100 mung bean germplasms and they reported that four genotypes/lines i.e., 014043, 014133, 014249, 014250 were found as resistant.

Mungbean mutants	Disease incidence (%)	Disease severity (%)
MBM-07-Y-1	66.00^{c}	7.16^{c}
MBM-07-Y-2	30.00^{g}	4.55^{e}
MBM-656-51-2	36.33^{f}	1.04^{fg}
MBM-527-114	20.00^{h}	0.38^{g}
MBM-07(S)-2	78.67^{b}	15.53^{b}
MBM-347-13	56.67^{d}	6.19^{cd}
MBM-390-94-Y	42.67^{e}	5.86^{d}
MBM-80 (LCAL)	84.76^{a}	26.84^{a}
MBM-427-87-3	33.67^{fg}	1.63^{f}
BARI Moog-6 (check variety)	45.33^{e}	3.59^{e}
$LSD_{0.05}$	4.953	1.135
CV (%)	5.84	9.09

$^{(a-h)}$Means of the mutants and variety were compared by DMRT. There is no significant variation having same letter(s) among the mutants and variety.

Table 6: Disease incidence and severity of mung bean mutants for yellow mosaic at pod formation stage (90 days after sowing).

Mung bean yield and yield contributing characters

Number of pods per plant: Number of pods per plant was recorded after harvesting of plants (Table 7). Number of pods ranged from 3.03 to 4.90, where the minimum number of pods (3.03) was recorded in MBM-527-114 and maximum number of pods (4.90) was recorded in BARI Moog-6. The present findings similar to those of Dharmalingam and Basu [26] and Akhtar [27]. They studied with mung bean mutants and observed that the entries $BMXK_2$-03005-4 gave higher number of pods per plant.

Length of pod: Pod length was recorded just after harvesting of plants from 15 plants in selected mutants. There were non-significant variations among the mutants. Pod length ranged from 4.79 cm to 6.23 cm, where the highest (6.23 cm) pod length was counted in MBM-07-Y-1 and the lowest (4.79 cm) pod length was counted in MBM-80 (LCAL). The findings of the study are related with the study of Vanderberg [28]. He reported that the lines differed significantly in respect of agronomic traits and yield parameters.

Number of seeds per pod: The seeds per pod were counted from the selected plants after harvesting of the plant (100 DAS). There were significant variations among the mutants. The number of seeds ranged from 4.84 to 8.23, where the highest number of seeds (8.23) per pod was recorded in MBM-07-Y-1 and the lowest number of seeds (4.84) per pod was recorded in MBM-390-94-Y. Vohra and Beniwal [29] reported that mung bean yellow mosaic virus infection affects grain yield and reduction in yield contributing characters.

Thousand seed weight: The thousand-seed weight ranged from 42.00 gm to 50.00 gm and there were non-significant variations among them. The highest 50.00 gm seed weight was observed in BARI Moog-6 followed by (45.67 gm) MBM-527-114 and the lowest (42.00 gm) seed weight was observed in MBM-347-13 followed by (42.00 gm) MBM-07-Y-2. Babu et al. [30] also reported that infection of *Vignaradiata* plants by MYMV caused significant reduction in number of pods per plant, seed yield and 1000 seed weight.

Seed yield: The seed yield per hectare differs significantly from one to another. The highest (204.44) grain yield was recorded in MBM-07-Y-1 followed by (186.66) MBM-390-94-Y and the lowest (120.44) yield observed in MBM-427-87-3 followed by (157.33) the MBM-80 (LCAL). Khattak et al. [24] conducted an experiment of fourteen MYMV susceptible F3 progenies from a cross NM 92 X VC 1560D showed significant differences for MYMV disease infection, yield and yield components.

Name of the mutants	No. of pods per plant	Length of pod	No. of seeds per pod	1000 seed weight	Yield (gm)	Yield (kg/ha)
MBM-07-Y-1	4.54^{ab}	6.23^{a}	8.23^{a}	44.67^{ab}	153.33^{a}	204.44^{a}
MBM-07-Y-2	4.13^{bc}	5.75^{ab}	7.76^{ab}	42.00^{b}	124.67^{d}	166.23^{d}
MBM-656-51-2	3.66^{c}	4.86^{ab}	5.52^{de}	44.67^{ab}	130.33^{c}	173.77^{c}
MBM-527-114	3.03^{d}	5.37^{ab}	7.43^{ab}	45.67^{ab}	140.00^{b}	186.66^{b}
MBM-07(S)-2	4.00^{bc}	5.42^{ab}	6.83^{bc}	44.33^{b}	124.00^{cd}	165.33^{cd}
MBM-347-13	4.87^{a}	4.80^{b}	5.37^{de}	42.00^{b}	130.00^{cd}	173.33^{cd}
MBM-390-94-Y	3.81^{c}	5.78^{ab}	4.84^{e}	45.67^{ab}	140.00^{b}	186.66^{b}
MBM-80 (LCAL)	4.20^{bc}	4.79^{b}	5.93^{cde}	45.00^{ab}	118.00^{d}	157.33^{d}
MBM-427-87-3	4.88^{a}	5.50^{ab}	7.16^{abc}	44.00^{b}	90.33^{e}	120.44^{e}
BARI Moog-6 (check variety)	4.90^{a}	5.80^{ab}	6.18^{cd}	50.00^{a}	122.67^{cd}	163.56^{cd}
$LSD_{0.05}$	0.5715	1.209	1.142	4.854	5.653	5.653
CV (%)	6.35	12.98	10.20	6.32	9.67	9.67

$^{(a-e)}$Means of the mutants and variety were compared by DMRT. There is no significant variation having same letter(s) among the mutants and variety.

Table 7: Yield and yield attributes of different mutants at harvesting stage (100 DAS).

Conclusion

The experiment was conducted to evaluate disease resistant mutants against foot and root rot, *Cercospora* leaf spot and mung bean yellow mosaic disease under natural epiphytotic condition. The post emergence mortality by foot and root rot was recorded at 15, 30 DAS. Among the mutants, MBM-07(S)-2 was found resistant against the foot and root rot disease. Most of all plants of each plot were attacked by *Cercospora* leaf spot. The highest number of seeds per pod was counted in MBM-07-Y-1 and the highest 1000 seed weight was observed in BARI Moog-6. The highest grain yield was recorded in MBM-07-Y-1 followed by MBM-390-94-Y (186.66 kg). It was observed that the mutants MBM-07(S)-2, MBM-07-Y-2, MBM-07-Y-1 and MBM-527-114 showed less disease incidence and severity for foot and root rot gave better yield than that of other mutants.

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