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Screening of moth bean (*Vigna aconitifolia*) core collection against yellow mosaic virus

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ABSTRACT

A core collection of moth bean [*Vigna aconitifolia* (Jacq) Marechal] germplasm, consisting of 204 lines identified in NAIP project was evaluated for mung bean yellow mosaic virus (MYMV) resistance; most of the lines were totally destroyed by yellow mosaic virus. Out of 204 accessions, 13 exhibited resistance/tolerance to disease in terms of intensity or level of symptoms appearing on individual plants. The susceptible lines could not bear flowers while resistant plants produced reasonable yield. The response of germplasm to MYMV exposed a distinct variation to the disease reaction. No genetic association between qualitative traits (seed color, leaf shape and plant type) and resistance/susceptibility to MYMV was observed in the present study. However, seed yield was significantly reduced with increased disease intensity.

Key words: Core collection, Legume, Moth bean, Yellow mosaic virus

Mung bean yellow mosaic virus (MYMV) disease in moth bean [*Vigna aconitifolia* (Jacq) Marechal] is tremendous threat to moth bean especially in the arid and semi-arid areas of northern India. MYMV is a species of the Begomovirus genus in the Geminiviridae family which is transmitted by white fly (*Bemisia tabaci*). MYMV disease is characterized by a bright yellow mosaic on the leaves of infected plants and causes significant losses to beans. These yellow mosaics not only reduces the grain and fodder yield, but also affects the quality of fodder crop and seed yield losses may vary from 20-100% (Mathur and Sharma 2002). Report of Yaqoob (2007) and Yaqoob *et al.* (2007) revealed that the available land races in Pakistan are highly susceptible to MYMV.

MYMV infected plants in arid region of Rajasthan produce variety of symptoms ranging from pale-golden yellow mosaic to completely chlorotic symptoms besides stunting of plants and small sized seeds. Moreover, symptoms of MYMV disease have been reported to vary with variety, virus strain, environment, and age of plant at infection (Bhansali 2008). Initially, the symptoms appear on young cotyledonary leaves in the form of mild scattered yellow specs that enlarge. The yellow areas increase rapidly in the new growth in secondary branches and ultimately some of the apical leave turn completely yellow.

MYMV control is often based on limiting the vector population with insecticides, which are ineffective under severe whitefly infestations (Sudha *et al.* 2013). Moreover, management of MYMV through chemical means is not possible directly. Therefore, development and use of YMV resistant varieties is the most desirable strategy to manage the disease in an economical way and to improve the yield of moth bean. Therefore, information on host plant resistance is of a reasonable importance and remains the best approach. In this order, various researchers have demonstrated variable disease reactions in moth bean against MYMV (Bhaskar *et al.* 1990, Bhavsar and Birari 1991, Hakim 1991, Morales *et al.* 1991, Jain 1992). Hence, in order to combat MYMV disease as an initiative towards yellow mosaic resistant breeding, germplasm lines were systematically screened and the results are reported herein.

MATERIALS AND METHODS

A set of 204 accessions of moth bean received from National Agriculture Innovative Project, New Delhi representing collection from various states of India was used for the present investigations. These accessions were sown in fields during rainy season, 2011 at Plant Biotechnology center SKRAU Bikaner with a hand drill. Each accession was sown in 1 m row with two replications and using randomized block design. Plant to plant and row-to-row distances were kept as 10 cm and 30 cm, respectively. Recommended doses of nitrogenous and phosphoric fertilizers were applied. During the experiment, infector

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row was not included as lack of considerable resistance among in moth bean accessions provides ample opportunity for the spread of disease by white fly. Disease incidence was recorded twice during the crop season, i.e. one month after germination and at maturity. The germplasm accessions were evaluated for their response to MYMV disease on the basis of 1-9 rating scale (Park 1978) where "1" indicates resistant and "9" highly susceptible reaction. Same genotypes were evaluated for their yielding ability in disease free season (summer under canal irrigation) keeping the same agronomic practices.

Score	Remarks	Disease rating
1	No symptoms on any plants	HR = Highly Resistant
3	Small necrotic yellow specks with restricted spread covering 0.1-5% leaf area	R = Resistant
5	Yellow mottling and discolouration of leaves, covering 15.10-30% leaf area ; no reduction in plant growth; no yield loss	MR = Moderately Resistant
7	Pronounced yellow mottling and discolouration of leaves, pods and reduction in leaf size and stunting of plants covering 50.10-75% of foliage	S = Susceptible
9	Sever yellowing of entire leaves, stunting of plants and no pod formation covering 85-100% of foliage	HS = Highly Susceptible

Statistical analysis was done for each trait using standard methods given in Chandel (1997). Pearson correlation was used to assess the association between different traits. Disease intensity and disease incidence were calculated by formulas as follow

$$\text{Disease intensity (\%)} = \frac{\text{Total read score} \times 100}{\text{Total number of reading} \times \text{highest score in the scale}}$$

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plant} \times 100}{\text{Total number of (healthy and infected) plant}}$$

$$\text{Plant Disease Index (\%)} = \frac{\Sigma(A \times B) \times 100}{\Sigma B \times 4}$$

where, A, Disease class (1 - 9); B, number of plants showing that disease class per treatment.

RESULTS AND DISCUSSION

Among the various biotic stresses the MYMV is the most important disease of *Vigna* group of pulse crops. It is widespread in the major mung bean and moth bean growing areas in India. It is most important diseases of moth bean and transmitted by white fly (*Bemisia tabaci*). Evolution of resistant varieties is considered to be the most feasible and durable solution of controlling MYMV disease in *Vigna* group (Mohan *et al.* 2014). Screening moth bean germplasm against MYMV disease under natural condition is the first step in identifying the resistant donors for evolving the moth bean varieties with MYMV resistance and yield. In present study, an effort has therefore, been made to screen a set of 204 germplasm lines of moth bean against MYMV that can be further utilized in breeding programme (Fig 1).

Resistance to MYMV was determined by visual symptomatology. Symptomless lines were assumed to be resistant. The germination percentage of seed was found excellent (95%) in all the entries and the crop remained sound and healthy up to seedling stage. No disease (YMV) symptoms were observed till the crop was 12 days old. Afterward the symptoms of YMV disease partially appeared on the leaves of young plants which became more pronounced with time. However, the disease incidence was recorded twice during the crop growth but disease score did not vary. Though, the number of plants infected increased with time and all the plants of a genotype showed similar intensity at maturity. Per cent disease incidence was worked out and it varied from 26.5 to 92.3%. The study revealed that maximum number of entries was grouped under moderately susceptible to highly susceptible categories.

It was observed that accessions in the germplasm varied for plant habit, leaf shape, seed color, grain yield and response to YMV. Out of 204 accessions, only 13 showed resistance/tolerance, 38 moderate resistance, 79 average infection, 63 were moderately susceptible and 11 were highly susceptible against YMV (Table 1). None of the tested genotypes were found immune. Highly susceptible lines even could not bear the flowers and pods. These results are in agreement with Yaqoob (2007) who also observed failure of flowers and pod setting in susceptible entries of Pakistan. However, present results are incongruence with the findings of Bhaskar *et al.* (1990) who reported that resistant lines produced lower yield. These results indicated that the frequency of disease resistance/susceptibility may vary among different accessions, and this difference may be resulted from the genetic background of accessions and environmental/edaphic conditions (Genotype×environment interaction). It is obvious that only few genotypes appeared to be as resistant, which indicated the existence of small amount of resistance in genotypes against MYMV. The results of present screening were in accordance with several previous reports (Khatri *et al.* 2003, Yaqoob *et al*. 2007, Yaqoob 2007).

Fig 1 Field view of moth bean genotypes affected by mung bean yellow mosaic disease

Table 1 Rating of moth bean (*Vigna aconitifolia*) genotypes evaluated against Mung bean Yellow Mosaic Virus Disease

Rating scale	Genotypes
'1' YMV rating	PLMO 12, IC 36096, IC 415152, IC 129177, IC 129177, IC 472217, IC 36392, IC 36649, IC 129208, IC 36467, IC 129194, PLMO 30, IC 36573, RMO 40
'3' YMV rating	IC 36486, IC 121025, IC 402283, IC 36011, PLMO 23, IC 36114, IC 140725, IC 129196, IC 36157, IC 405139, IC 36523, IC 120986, IC 120973, IC 39653, IC 39839, JADIA, IC 472232, IC 121051, IC 39706, IC 311396, IC 20992, IC 52159, IC 472214, IC 36562, IC 36468, IC 39777, IC 36189, IC 36620, IC 36568, IC 415155, IC 140730, IC 121015, IC 103016, IC 472196, 225-9-9-17-1-2, IC 402285, IC 129216, VDV 6172
'5' YMV rating	IC 311415, PLMO 121, IC 140678, IC 311423, IC 472257, IC 36454, IC 140616, IC 140605, IC 129179, IC 472239, IC 35937, IC 140707, PLMO 51, IC 472202, IC 36192, IC 36096, IC 121073, IC 39809, VDV 6119, IC 415139, IC 472173, IC 36150, IC 36499, PLMO 6, PLMO 5, IC 39704, IC 129197, IC 36643, IC 140660, IC 140716, IC 39693, IC 36392, IC 472185, IC 30639, IC 140677, IC 140707, IC 39742, 39776, IC 36366, PLMO 7, IC 39728, IC 39689, MARUMOTH, IC 472158, IC 39808, IC 36394, IC 39848, IC 36081, IC 36496, IC 35934, VDV 6175, IC 35850, PLMO 26, PLMO 41, IC 10141, IC 16219, IC 285166, IC 39846, IC 39840, IC 9100, IC 36498, PLMO 207, PLMO 69, IC 474145, IC 36562, 36376, IC 129243, IC 472189, IC 140635, IC 120986, PLMO 132, IC 472236, IC 472177, IC 129190, IC 39648, IC 35841, PLMO 134, IC 39799, PLMO 57
'7' YMV rating	IC 39703, IC 10144, RMO 3, IC 472243, IC 39754, PLMO 87, IC 103016, PLMO 14, IC 52150, IC 36539, IC 8283, PLMO 82, IC 36082, IC 39713, PLMO 211, PLMO 238, IC 36477, IC 39702, IC 39626, IC 39800, IC 39633, IC 52147, IC 140727, PLMO 245, PLMO 40, IC 140635, PLMO 132, IC 472147, PLMO 15, IC 36449, IC 472162, PLMO 78, PLMO 44, IC 36648, IC 36017, IC 36482, IC 36557, IC 36487, IC 9083, IC 36161, IC 36537, IC 140622, IC 11463, JAWALA, IC 121039, VDV 6170, IC 36161, IC 39749, IC 36521, IC 39694, IC 333212, IC 415103, IC 16218, IC 121005, PLMO 190, IC 16220, IC 121015, IC 5863, PLMO 8, IC 35864, IC 39678, IC 472179, PLMO 65
'9' YMV rating	IC 129248, PLMO 2, IC 285159, PLMO 89, IC 333125, PLMO 198, IC 35874, IC 121016, IC 36592, IC 39735, IC 39796

In general yield was reduced (70.25%) under the influence of disease drastically taken over all the genotypes. The range of yield was from 2.34 g to 48.54 g/10 plants under disease free condition, whereas it was from 0.22 g to 32.34 g/10 plants under disease. Though, comparison of yield level between control and treatment was not in same season but it gave a clue on percent yield reduction. This comparison revealed that the yield showed a more skewed distribution towards lower yield for mosaic infected plants (Fig 2a and b).

However, the distribution was not normal and was more flat for non-infected plants but was not much skewed. Disease thus affects yielding ability of most of the susceptible genotypes. It was also observed that disease appears with more intensity under high rainfall conditions in monsoon. The disease free control trial was taken during summer as crop remains mostly disease free .The genotypes were normally distributed for their reaction to disease based on score and PDI (Fig 3a and b).

Hence, the population (core group) used is perfect for MYMV studies and tagging comprising of diverse genotypes. The IC 36573 with disease rating 1 produced the highest yield of 32.3 g/10 plant and remaining 12 genotypes give higher yield also (Table 2). The 11 accessions were found highly susceptible to Yellow mosaic virus and were totally destroyed by the disease with rating scale 9 give low yield, lowest being IC 129248 0.27g/10 plants (Table 2). Similar results have also been reported by Jain (1992) and Khatri *et*

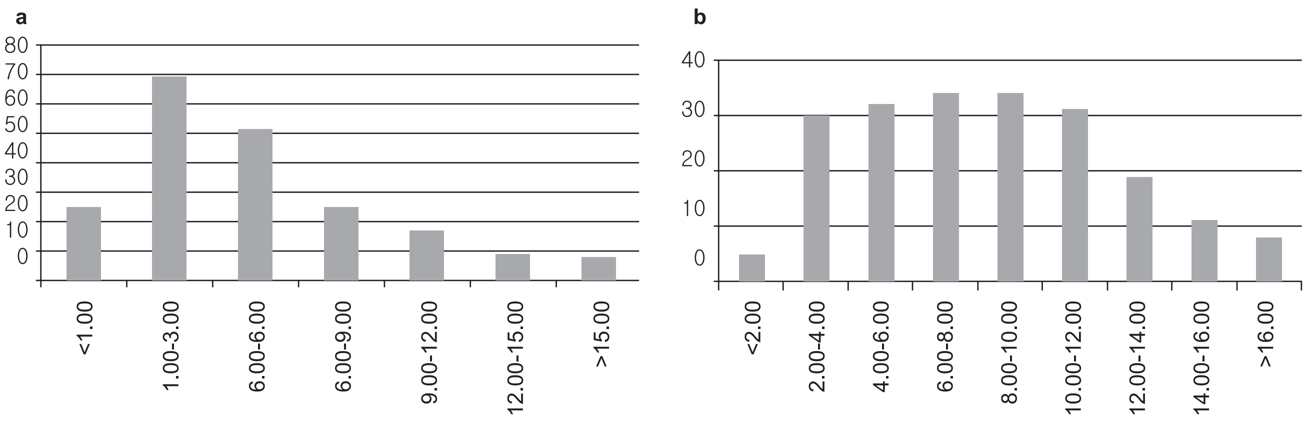

Fig 2 Distribution of 204 genotypes moth bean yield under a) under Mung bean Yellow Mosaic disease and b) disease free environment

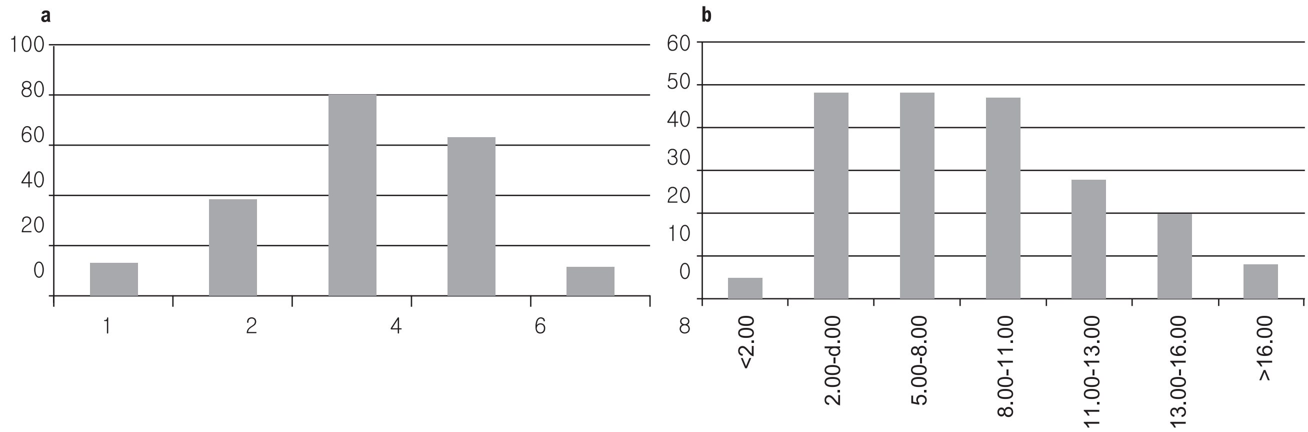

Fig 3 Distribution of 204 moth bean genotypes based on a) disease score (1 to 9) and b) plant disease index (PDI)

Table 2 Seed yield, leaf shape and seed colour of highly resistance (13 genotypes) and highly susceptible genotypes (11 genotypes) of moth bean evaluated against mung bean yellow mosaic virus disease

Genotype	Tolerant genotype against YMV disease				Genotype	Susceptible genotype against YMV disease			
	Seed yield (g)/10 plants	MYMV rating	Leaf shape*	Seed colour*		Seed yield (g)/10 plants	MYMV rating	Leaf shape*	Seed colour*
PLMO-12	1.18	1	B	BR	IC-129248	0.27	8	N	BR
IC-36096	0.93	1	B	BR	PLMO-2	1.74	8	N	BR
IC-415152	5.64	1	B	BR	IC-285159	2.37	8	B	BL
RMO-40	9.74	1	B	BR	PLMO-89	1.67	8	B	BR
IC-129177	6.02	1	B	BR	IC-333125	5.65	8	B	BR
IC-472217	15.67	1	N	BR	PLMO-198	2.33	8	N	BL
IC-36392	3.63	1	B	BR	IC-35874	3.49	8	B	BR
IC-36573	32.34	1	B	BR	IC-36592	2.6	9	B	BR
IC-36649	10.23	1	B	BR	IC-121016	1.82	8	N	BR
IC-129208	20.18	1	B	BR	IC-39735	6.57	9	B	BL
IC-36467	6.44	1	B	BR	IC-39796	2.76	9	N	BR
IC-129194	9.26	1	B	BR					
PLMO-30	8.53	1	B	BR					

*B, Broad leaf shape; N, narrow leaf shape; BR, brown coloured seed; BL, black coloured seed

al. (2003) who indicated variable response of various moth bean lines to MYMV. The low incidence of MYMV in resistant genotypes may be due to less metabolic derangements in resistant as compared to susceptible genotype (Mali *et al*. 2000). Subsequently two types of leaf shape (narrow and broad lobs) and seed color (yellow and brown) were observed in both resistant and susceptible plants, Yellow mosaic virus was not genetically linked with characters. The present results are in line with those Yaqoob (2007) where phenotypic traits were not linked with resistance.

The yield of all the genotypes and rating scale of MYMV disease are negatively correlated on the basis of correlation coefficient (r) that was -0.29 and Plant Disease Index and yield data are negatively correlated on the basis of correlation coefficient (r) that was -0.27.

Though immune response to yellow mosaic virus is lacking however resistance response was observed in core collection against yellow mosaic virus. These can possibly be exploited either directly and/or through hybridization for evolving high yielding resistant moth bean varieties.

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