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EVALUATION OF MUNGBEAN GERMPLASM FOR RESISTANCE AGAINST MUNGBEAN YELLOW MOSAIC BEGOMOVIRUS

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Abstract

Mungbean (*Vigna radiata*) germplasm consisting of 254 lines was evaluated against mungbean yellow mosaic begomovirus (MYMV) under natural field conditions conducive for the development of disease and whitefly virus vector population. Majority of the lines were infected within 2-3 weeks and the disease increments monitored over a period of six weeks were 2.36, 18, 48, 74, 83 and 95%. Disease severity followed the similar trend i.e., 0.48, 1.85, 3.82, 4.74, 4.94 and 4.99, respectively. Whitefly population ranged between 1.5-8 adults/plant with an average of 4 adults. MYMV occurred over a wide range of climatic conditions in summer. None of the lines appeared to resistant of any category; 7 lines were classified as susceptible and 247 as highly susceptible indicating that resistance was scarce in mungbean germplasm. Some lines in spite of high disease pressure produced significantly good yield, indicating tolerant reaction to MYMV and selected for breeding purposes.

Introduction

Mungbean (*Vigna radiata* (L.) Wilczek) is an important short duration summer food legume in the tropical and subtropical countries of the world. In Pakistan, the crop is cultivated on about 258 thousand hectares with an annual production of 139 thousand tonnes of grain with yield of 537 kg per hectare. (Anony., 2004). The crop is highly susceptible to yellow mosaic disease caused by mungbean yellow mosaic begomovirus (MYMV). This disease is important, serious, destructive, widespread and inflicts heavy loss annually. It was first identified in India in 1955 and is naturally transmitted by whitefly (*Bemisia tabaci* Genn), but not by mechanical inoculation or by seed (Nariani, I960). It infects mungbean, soybean, mothbean, cowpea and urdbean and some hosts of the family Malvaceae and Solannceae (Dhingra & Chenulu, 1985). Yellow mosaic is reported to be the most destructive viral disease not only in Pakistan, but also in India, Bangladesh, Sri Lanka and adjacent areas of South East Asia (Bakar 1981; Malik 1991).

MYMV belongs to the genus Begomovirus of the family Geminivirideae (Bos, 1999). The virus has geminate particle morphology (20 x 30 nm) and the coat protein encapsulates circular, single stranded DNA genome of approximately 2.8 kb. In Pakistan, the virus has been partially characterized and identified on the basis of Polymerase Chain Reaction (PCR) and epitope profile and DNA sequence (Hussain *et al.*, 2004; Hamid & Robinson 2004).

Use of disease resistant crop varieties is regarded as an economical and durable method of controlling viral diseases. A good deal of research efforts have been directed towards screening mungbean germplasm against MYMV for the identification of resistant sources under diverse environmental conditions and a number of resistant lines have been reported by some workers (Murtza *et al*., 1983; Ghafoor *et al*., 1992; Bashir & Zubair 2002). Inheritance studies with MYMV have also been conducted (Malik 1991; Jayana *et al*., 1991). As a continuity of this approach, 254 lines of mungbean germplasm mainly of local origin were evaluated in this study for resistance under highly epiphytotic conditions of yellow mosaic disease.

Material and Methods

This study was conducted in the Department of Plant Pathology, University of Agriculture, Faisalabad during summer 2004 under field conditions (Green, 1991). Germplasm consisting of 254 mungbean lines were planted in the field in the first week of July, 2004. Each test entry was planted in a row of 3 meter long with 40 cm row to row distance. One row of a most susceptible check was planted after every second test entry. Two rows of the susceptible check were also planted all around the experiment to create more disease. General cultural practices were followed to maintain the experiment except that no insecticide was sprayed to encourage whitefly population for spread of the disease.

After germination, the crop was regularly monitored for the presence of white fly and development of yellow mosaic disease. Disease severity was recorded at weekly interval using 0-5 arbitrary scale (Bashir, 2005) which is described as follows:

Disease severity	Percent infection	Infection category	Reaction group
0	All plants free of disease symptoms	Highly resistant	HR
1	1 - 10% Infection	Resistant	RR
2	11 -20% infection	Moderately resistant	MR
3	21-30% infection	Moderately susceptible	MS
4	30-50 % infection	Susceptible	S
5	More than 50%	Highly susceptible	HS

Whitefly population was recorded with the help of a wooden split cage (65x35x25 cm) with black sheet from all the sides, except one side which had a transparent glass pan. While taking observations, the glass pan side was kept facing the sun so that whiteflies migrated towards it, being phototactic in behaviour (Chhabra & Kooncr, 1980). The box was kept in such a way that it covered 2-3 plants at random in each plot. The population was assessed at the mid period of the experiment.

Environmental data were collected from the Department of Crop Physiology, University of Agriculture, Faisalabad and related to MYMV infection. At maturity, ripened pods were gradually picked up at appropriate times, sun-dried for 10 days and threshed to record yield/plot.

Results

The progression of MYMV infection and disease severity in mungbean germplasm over a period of six weeks during July and August, 2004 are presented in Figs. 1 and 2.

Progression of MYMV: In the first week (taken 15 days after planting) 112 lines representing 44% of the test entries were infected by yellow mosaic. The number of infected plants ranged between 0 - 13.33% with a mean of 2.36%. Mungbean lines viz., 98-CMG-002, NCM-201, M-197, NM 2003-30, NM 2003-39, NM 2003-41, NM 2003-44, NM 2003-52, NM-92, VC 3960, NCM 251-1 and NCM 258-1 were the first to show disease infection. In the second week, 130 lines were infected with a mean incidence of 18% i.e., 15.5% increase over the first week and the remaining 12 lines were infected in the 3rd week. In the subsequent 4th, 5th and 6th weeks, all the 254 lines (48%) were found infected with mean disease incidence of 74%, 83% and 95%, respectively. The results clearly indicated that the initial period of 2-3 weeks was highly critical for the development and spread of yellow mosaic disease.

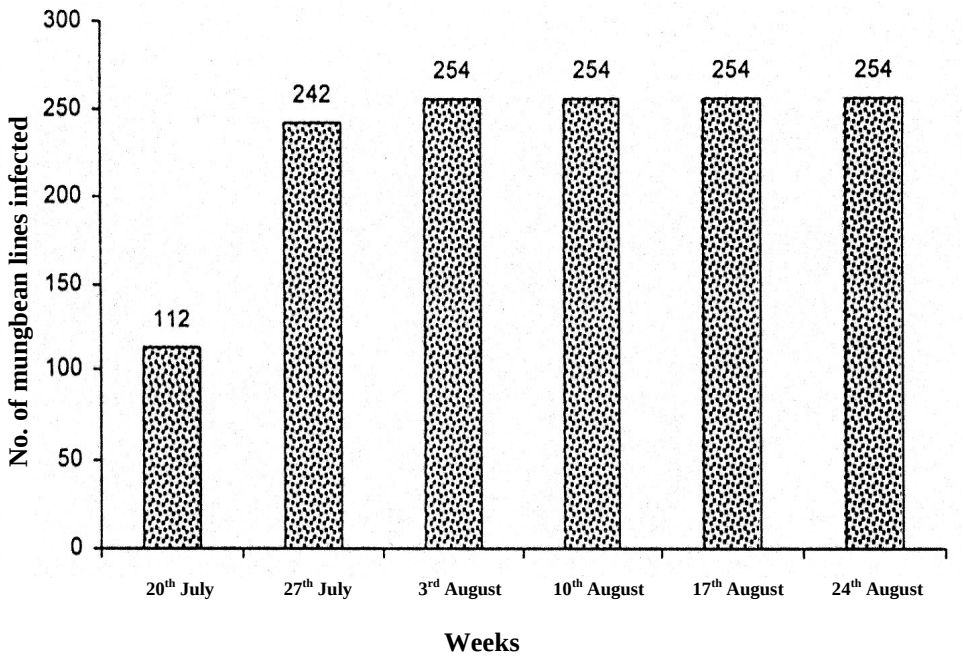

Fig. 1. Number of mungbean cultivars infected in each week.

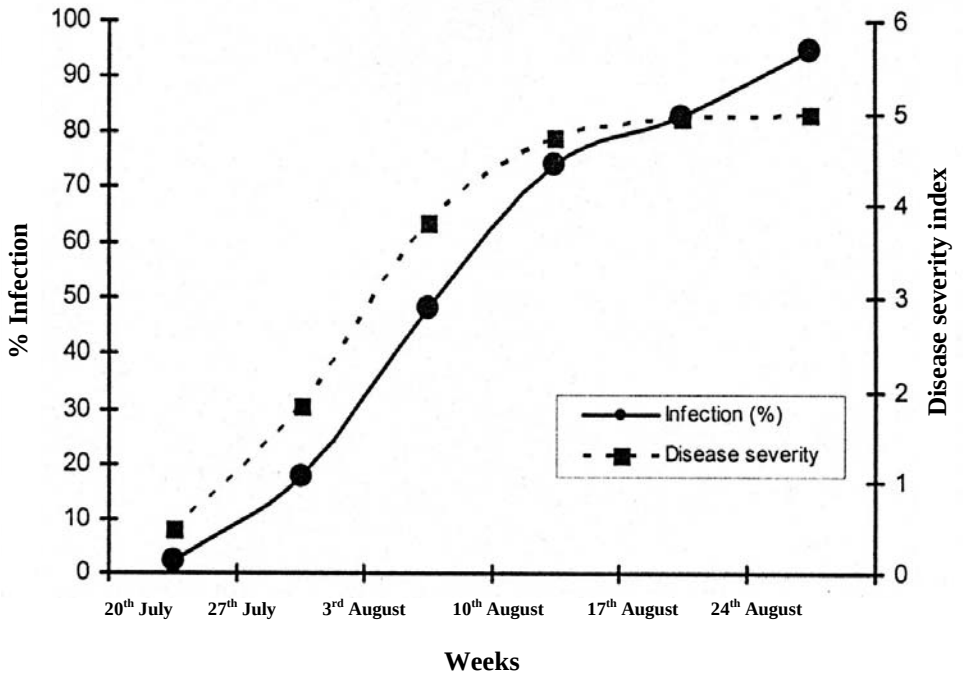

Fig. 2. Weekly progress of infection and severity of MYMV in mungbean lines at Faisalabad.

Incidence of yellow mosaic: All the mungbean lines were invariably infected by yellow mosaic. Disease incidence ranged between 33.3 to 100% with a mean infection of 95%. Two mungbean lines showed the lowest infection (33-35%), 7 lines to the extent of 50%, 12 lines had more than 60%, 16 lines with 70%, 13 lines with 80% and 4 lines having 90% infection. It was amazing to record that 202 mungbean lines were 100% infected with the highest disease severity.

Disease severity: Disease severity generally followed the same trend as that of yellow mosaic infection. It was 0.48 in the first week, and progressed significantly to 1.85, 3.82, 4.74. 4.94 and 4.99 in the subsequent weeks (Fig. 2). As far as the influence of environmental factors was concerned, yellow mosaic caused by MYMV appeared under wide range of conditions and climatic factors seem to be of little value.

Whitefly population: Whitefly was observed on the plants soon after their emergence and subsequent increase in population was recorded during the crop season. Its population ranged between 1.5-8.0 adults/plant with a mean of 4 adults. Low white fly population (1.5 to 2.0 adults/plant) was recorded on six mungbean lines (99.CMG-059, NM 2003-06, NM. 2003-24, NM. 2003-26, NCM. 258 and PDM-54) whereas moderate population (3.1 to 5.2 adults/plant) was observed in majority of the test lines. In general no relationship was found between whitefly population and MYMV-infected mungbean lines.

Grain yield: The response of mungbean lines under MYMV infection towards grain yield was quite variable. Some test lines were good yielder in spite of high disease severity. Eleven lines yielded more than 250 gms/plot, 64 lines with 200-250 gm/plot, 75 lines with 150-199 gm/plot, 67 lines between 100-149 gm/plot and 37 lines yielded less than 100 gm/plot.

Resistance to MYMV: None of the mungbean lines evaluated under field conditions was found to be highly resistant (HR), resistant (H), moderately resistant (MR) and moderately susceptible (MS). Seven lines were classified as susceptible (S) and 247 lines as highly susceptible (HS) (Table 1).

Environmental factors: The relationships of some environmental factors on the development of yellow mosaic disease during the experimental period are indicated in Table 2. The results, in general clearly suggest that within the experimental period (July to October), which is the optimum growing period of mungbean crop at Faisalabad, environmental factors have no direct influence on disease development. The results, however, indicate that it is the early landing of virurliferous whitefly on the mungbean plants during the first 2-3 weeks rather than number of whitefly. The disease spread during early period is more important as it provides virus inoculum for further spread of the disease. Viruliferous whiteflyare more important than non-viruliferous which are actual source of virus.

Table 1. Distribution of mungbean lines in various infection categories of MYMV.

Infection category	Disease severity	No. of genotypes	Lines involved
Highly resistant (HR)	0	0	0
Resistant (R)	1	0	0
Moderately resistant (MR)	2	0	0
Moderately susceptible (MS)	3	0	0
Susceptible (S)	4	7	NM 2003-21, NM 2003-22, NM 2003-24, NM 2003-25, NM 2003-26, NM 2003-27, NM 2003-28.
Highly susceptible (HS)	5	247	C1/94-4-19, C1/94-4-37, C6/94-4-6, NM 2003-14, NM 2003-15, NM 2003-17, NM 2003-20, NM 2003-23, C6/94-4-2, C1/93-3-49, C10/93-3-21, 99-CMG-058, M-12, 99 CMG-057, NCM-90, 95CM-005, 99CMG-059, NM 2003-03, NM-2003-11, NM2003-16, NM2003-18, NM2003-19, NM2003-31, NM2003-38, NM 2003-39, Mung14/24, NM-98, M-1, M-6, VC 3960(A88), VC3960 (A89), NM-98, NM 12-12, SML-32, 95013, NM-98, C1/95-3-248, C2/94-4-42, C1/95-3-2, C5/95-3-23, C2/94-4-43, NM-98, NM-92, C2/94-4-42, NM-98, NM-92, NM-98, C1/95-3-308, C1/95-3-314, C2/94-4-36, C1/95-3-48, C1/95-3-480, C1/94-4-49, C5/95-3-23, C1/95-3-302, C5/95-3-202, C1/95-3-13, C10/95-3-21, C1/95-3-38, C5/95-3-13, C3/94-4-39, C1/95-3-23, C5/95-3-32, C1/95-3-130, C1/95-3-45, C1/95-3-24, C1/95-3-48, C5/95-3-21, NM-92, C1/95-3-27, C1/94-4-3, NM-92, C1/94-4-19,C1/95-3-49, C10/95-3-25, C6/94-4-18, NM-18-12, C10/95-3-13, C5/95-3-10, NM20-4, C1/94-4-14, NM21-11, C1/95-3-6, NM-92, C1/95-3-10, NM-98, C1/95-3-450, CH/Mung-97, 94CMG-009, M-497, 98-CM-003, BRM-195, NCM-213, 99CMG-060, 99CMG-051, 94CMG-007, 98CMG-005, BRM-48, 95CM-004, VC-2772, M-2997, 98CMG-002, 99CMG-054, NM-98, NM-121-25, M-1497, NCM-226, 98CMG-008, 98CMG-015, 98CMG-018, 98CMG-006, 98CMG-101, 98CMG-013, N-77, NCM-220, M-2597, VC-51161, 98CMG-107, NCM-201, M-119,M-56, 98CMG-009, NM19-19, M-2297, M-91110, 95CMG-001, M-197, M-1397, M-1897, 98CMG-016, M-19, NM 2003-01, NM 2003-02, NM 2003-04, NM 2003-05, NM 2003-06, NM 2003-07, NM 2003-08, NM 2003-09, NM 2003-10, NM 2003-12, NM 2003-13, NM 2003-29, NM 2003-30, NM 2003-32 , NM 2003-33, NM 2003-34, NM 2003-35, NM 2003-36, NM 2003-37, NM 2003-40, NM 2003-41, NM 2003-42, NM 2003-43, NM 2003-44, NM 2003-45, NM 2003-46, NM 2003-47, NM 2003-48, NM 2003-49, NM 2003-50, NM 2003-51, NM 203-52, Mung 1/24, 2/24, 4/24, 5/24, 6/24, 7/24, 8/24, 9/24, 11/24, 13/24, 15/24, 18/24, 19/24, Mung-5, Mung-7, Mung-9, Mung-10, NM-10-12-1, NM-92, 3960-88, NM-2, NM-1, CO-3,NM-49-9, NM 20-4, NM 49-8, NM-15-5, NM-98, NM-92, NCM-209,SWAT Mung, CL94-4-19, 98CMG-003, 98CMG-016, NCM-209, NM-92, NCM257-5, NCM251-12, NCM-257-2, NCM254-1, NCM253-1, NCM251-4, NCM254-3, NCM257-6, NCM251-1, NCM257-10, NCM258-1, NCM255-3, NCM255-3, NCM252-5, NCM255-4, NCM251-13, NCM252-1, NCM255-2, NCM259-2, NCM252-7, NCM254-7, NCM251-16, NCM255-8, Chakwal 97, Basnti,SML-134, PUSA-9072, BARI, Mung-1, VC-6173 B, PDM-54, SMAL-32, NCM-209, AUM-5, AUM-13, AUM-17, AUM-18, AUM-19, AUM-27, AUM-28, AUM-29, AUM-31, AUM-38, AUM-49, AUM-7375-A, NM-54, NM-92, NCM-209

Table 2. Relationship between some environmental factors and occurrence of Mungbean Yellow Mosaic Virus (MYMV).

Period	Temperature °C			R.H. %	Rain-fall (in mm.)	% Incidence of MYMV (Total)	Percent age weekly increase	Remarks Observations
	Max.	Min.	Av.					
July 1-13, 2004	39.36	29.43	34.41	53.71	0	-	-	Planting, germination & landing of whitefly
July 14-20, 2004	39.93	26.79	33.51	53.70	1.03	2.36	-	Base line, appearance of MYMV
July 20-27, 2004	40.5	28.07	43.3	50.71	0.59	18.00	15.64	Fast Spread of MYMV
July 28 to August 03, 2004	37.93	28.57	33.27	64.57	3.57	48.00	30.00	Fast Spread of MYMV
August 04-10, 2004	37.36	28.14	32.77	68.43	1.71	74.00	26.00	Fast Spread of MYMV
August 11-17, 2004	38.36	28.57	33.49	67.86	2.37	83.00	9.00	Slow Spread of MYMV
August 18-24, 2004	35.79	29.0	31.69	71.43	4.66	95.00	12.00	Slow Spread of MYMV
August 25-31, 2004	38.21	26.93	31.59	57.71	0.81	"	"	Maturity of Crop

Discussion

Mungbean germplasm has been extensively screened for resistance against yellow mosaic disease caused by MYMV (Bashir, 2005), but substantially with little success. Naqvi *et al*., (1995) found no immunity in several mungbean lines tested, whereas partial resistance was reported by Singh *et al*., (1996). Earlier, Gill *et al*., (1983) have clearly demonstrated that resistance against MYMV was rare in mungbean, but was found in urdbean (*Vigna mungo*) and soybean (*Glycine max*), which led them to successful hybridization and inter-specific transfer of resistance. In the present study, none of the 254 mungbean genotypes showed any remarkable degree of resistance to MYMV. Our results agree at large with Pandya *et al*., (1977) and Singh *et al*., (1996). Out of 254 mungbean genotypes, 7 appeared to be susceptible and 247 as highly susceptible. It was interesting to note that some lines viz., NM-92, NM-93, ML-5. M-19-19, NM-92, NM-54, NM 15-5, previously reported to be resistant to yellow mosaic disease (Malik 1991; Saleem *et al*., 1998; Khattak *et al*., 1999) proved to be highly susceptible in this study. Location disease pressure and virus strain seem to be important factors in this respect. Therefore, environment-genotype interactions as well as MYMV strains need to be identified in future. These results suggest that initial period of 2-3 weeks is highly critical due to early landing of viruliferous whitefly, development and spread of yellow mosaic disease.

Increasing incidence and epiphytotic conditions of MYMV, encountered every year in the country, may be attributed to a combination of factors such as high population of viruliferous whitefly, build up of inoculum potential in some hosts and wide range of favourable environmental conditions. Under this complex ecosystem, there are chances of breakdown of resistance to MYMV. In fact, some begomoviruses have emerged as a serious and potential threat to many crops in Pakistan (Hamid, 1999). These viruses attack a number of hosts of the family Solanaceae, Fabaceae and Malvaceae, and some of the hosts preferred by the vector, might be serving as a bridge for the perpetuation of MYMV. In recent years, diverse isolates, variants and virulent mutants of tomato yellow leaf cure virus (TYLCV) and cotton leaf curl virus (CLCuV) have emerged, which are responsible for breakdown of resistance and resurgence of diseases. It is possible that MYMV consists of many variants, which need to be differentiated, identified and characterized on biological and molecular basis (Hamid & Robinson, 2004).

Indigenous mungbean germplasm is reported to carry better resistance than the exotic material (Jayana *et al*., 1991, Saleem *et al*., 1998). The germplasm evaluated under this study seems to have very narrow genetic base. It would be desirable to broaden the genetic base of local germplasm for resistance to MYMV through breeding, genetic engineering and biotechnological approaches (Biswas & Verma 2001). Mode of inheritance of MYMV in mungbean has been studied by several workers (Reddy & Singh, 1993; Saleem *et al*., 1998; Sadiq *et al*., 1999). It is unanimously reported that susceptibility to MYMV is dominant over resistance and was conditioned by a single recessive gene (Malik, 1991), this factor needs to be utilized till the resistant sources become available.

Based on surveys conducted in major mungbean and mash growing areas of Punjab such as Bhakkar, Layyah, Minawali, Narowal and Sialkot districts, yellow mosaic disease in mungbean is not as serious as on mash crop and this may be due to introduction of resistant cultivars of mungbean or possibly prevalence of mild strains of MYMV (Bashir, 2005). Therefore, yellow mosaic disease can be managed with the introduction of resistant or tolerant cultivars, management of whitefly population and modification of

field environment and agronomic practices. Moreover, disease tolerant mungbean lines giving appreciable high yield should be preferred over resistant lines with low yield potential. The yellow mosaic tolerant lines of mungbean identified in this study are of high value and must be used in breeding program to develop new desirable cultivars.

References

Anonymous. 2004. *Agricultural Statistics of Pakistan*. Ministry of Food, Agriculture and Livestock. Economies Wing. Govt. Pakistan. Islamabad.

Bakar, A.K. 1981. Pest and disease problems of mungbean in West Malaysia. *Malaysian Agric. Jour*., 53: 29-33.

Bashir, M. and M. Zubair. 2002. Identification of resistance in urdbean (*Vigna mungo*) against two different viral diseases. *Pak. J. Botany*, 34(1): 49-51.

Bashir, M. 2005. Studies on viral diseases of major pulse crops and identification of resistant sources. Technical Annual Report (April, 2004 to June, 2005) of ALP Project. Crop Sciences Institute, National Agricultural Research Centre, Islamabad. pp: 169.

Biswas, K.K. and A. Verma. 2001. Agro-inoculation as a method of screening germplasm for resistance to mungbean yellow mosaic *Geminivirus. Indian J. Phytopathology*, 54: 240-245.

Bos, L. 1999. Plant Viruses: Unique and Intriguing Pathogens: *Text Book of Plant Virology*. Backhuys publishers, The Netherlands: 305-306 pp.

Chhabra, S.K. and S. Kooner. 1980. Sources of whitefly, *Bemisia tabaci* G. and yellow mosaic virus resistance in *Vigna radiata* Wilczek. *Tropical Grain Legume Bulletin*, 19: 20-29.

Dhingra, K.L., and V.V. Chenulu. 1985. Effect of yellow mosaic on yield and nodulalion of soybean. *Indian Phytopathology*, 38(2): 248-251.

Ghafoor, A., M. Zubair and S.M. Iqbal. 1992. Evaluation of selected germplasm of mungbean. *Pak. J. Botany*, 24: 112-118.

Gill, A. S., M.M. Verma, H.S. Dhaliwal and T. Sandhu. 1983. Inter specific transfer of resistance to mungbean yellow mosaic virus from *Vigna mungo* to *V. radiata*. *Current Science*, 52: 31-33

Green, S.K. 1991. Guide lines for diagnostic work in plant virology. *Technical Bulletin* No. 15: AVRDC, Taiwan.

Hamid, S. 1999. *Molecular Diversity of Begomoviruses of Legumes and Cucurbits in Pakistan. Ph.D. Thesis*. University of Dundee, UK. pp. 232.

Hamid, S. and D.J. Robinson. 2004. Begomoviruses from mungbeans in Pakistan: Epitope profiles, DNA A sequences and phytogentic relationships. *Archives of Virology*, 149: 809-819.

Hussain, M., J. Qazi, S. Mansoor, S. Irum, M. Bashir and Y. Zafar. 2004. First report of mungbean yellow mosaic virus on mungbean in Pakistan. *Plant Pathology*, 53(4): 518.

Jayana, M.K., T. Rangaswamy, T.R. Kumar and K.C. Shambulingappa. 1991. Resistance to yellow mosaic virus in mungbean genotypes. *Plant Protection Bulletin*, 43: 9-10.

Khattak, G.S.S., M.A. Haq, S.A. Rana, P. Srinivas and M. Ashraf. 1999. Inheritance of resistance to mungbean yellow mosaic virus in mungbean. *Thai Jour. Agric. Sci*., 32: 49-54.

Malik, J.A. 1991. Breeding for resistance to MYMV and its vector in Pakistan. Pp: 41-53. Mungbean Yellow Mosaic Disease. *Proceedings of an International Workshop*. Bangkok, Thailand, 23 July, 1991. AVRDC. (Eds.): S.K. Green and D. Kim.

Murtaza, M.A., M.A. Bhatti and H.A. Qayyum. 1983. Susceptibility of mungbean lines to whitefly and yellow mosaic. *Pak. Entomol*., 5:51-56.

Naqvi, S.M., M.A. Rustamani, T. Hussain and M.A. Talpur. 1995. Relative resistance of mungbean varieties to whitefly and yellow mosaic. *Proc. Pak. Zool. Conf*., 15: 247-251.

Nariani, T.K. 1960. Yellow mosaic of mungbean. *Indian. Phytopath*., 13: 24-29.

Pandya, B.P., D.P. Singh and B.L. Sharma. 1977. Screening of mungbean germplasm for field resistance to yellow mosaic virus. *Trop. Grain Legumes Bulletin*, 7: 13-14.

Reddy, K.R. and D.P. Singh. 1993. Inheritance of resistance to mungbean yellow mosaic virus. *Jour. Madras Agric*., 80: 199-201.

Sadiq, M.S., G.S.S. Khattak, M. Saleem and G. Sarwar. 1999, Exotic mungbean germplasm: its utilization through conventional breeding approach. *Trop. Agric. Res*., 2: 4-6.

Saleem, M., W.A. Haris and I.A. Malik. 1998. Inheritance of yellow mosaic virus resistance in mungbean. *Pak. J. Phytopathology*, 10: 30-32.

Singh, K., S. Singh and R.K. Kumar. 1996. Inheritance to mungbean yellow mosaic in mungbean. *Indian J. Pulses Research*, 9: 90.

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