



Seasonal effects on outbreak of yellow mosaic disease in released cultivars of mungbean (*Vigna radiata*) and urdbean (*Vigna mungo*)

A K PARIHAR¹, A KUMAR², G P DIXIT³ and SANJEEV GUPTA⁴

ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208 024

Received: 5 October 2016; Accepted: 17 April 2017

ABSTRACT

In India, the diseases like Yellow Mosaic Disease (YMD) have an immense economic significance and addressed as a major impediment against increasing productivity of urdbean [*Vigna mungo* (L.) Hepper] and mungbean [*Vigna radiata* (L.) Wilczek]. The present attempt was made to ascertain the resistance potential of released varieties of mungbean (65) and urdbean (28) during *kharif* 2013 and 2014 under natural conditions against the YMD. There was considerable variability among tested varieties of mungbean and urdbean with respect to disease reaction and average disease score. The weather parameters like temperature and relative humidity showed direct effect on incidence of yellow mosaic virus or white fly population. Three varieties of mungbean, viz. PDM 139, ML 818 and MUM 2 and five varieties of urdbean, viz. LBG 645, IPU 2-43, Uttara, UG 218 and NDU 5-7 witnessed highly resistant reaction against YMD over the years. It was also found that the incidence of yellow mosaic virus was less in the varieties released for North India as compared to central and south India and the varieties released in the recent past have better tolerance. Therefore, these varieties can be used in biotic stress breeding programme and these resistance sources may be used as donor in the future breeding programme for evolving YMD resistant varieties.

Key words: Mungbean, Urdbean, Weather parameters, YMD

Mungbean [*Vigna radiata* (L.) Wilczek] and urdbean [*Vigna mungo* (L.) Hepper] are the important *kharif* season crops of India and considered as a potential source of digestible proteins for human diet. Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Karnataka, Punjab and Rajasthan are the major mungbean and urdbean producing states in the country (Anonymous 2015). Yellow Mosaic Disease (YMD) is a major disease of these crops and may cause up to 100% yield losses (Malik 1991, Bashir *et al.* 2006). This disease is widely distributed throughout the country and attacks not only mungbean and urdbean but also other pulses such as cowpea, moth bean and horsegram. Mungbean and urdbean are grown in both seasons i.e. *kharif* and summer, however, due to more infestation of many pests and diseases in the *kharif* season, their cultivation is being shifted to summer season. In India, YMD was first reported in 1955 at IARI, New Delhi (Nairani 1960). The causal agent of this disease is mungbean yellow mosaic virus (MYMV), which has a wide host range and is transmitted by whitefly (*Bemisia tabaci* Genn) (Nene 1972, 1973). In this disease, the vector

(whitefly), play an important role but may not be essential for all disease development. So, whitefly is involved as fourth casual factors and defines as tetrahedron conditions because it connects the host and pathogen vertices for disease development. The symptomatology of virus is characterized as uneven yellow and green patches on the leaves which eventually turn completely yellow and affected plants produce only fewer flowers, pods and ultimately lead to smaller and shrunken seeds. The Mungbean Yellow Mosaic Virus belongs to genus *Begomovirus* of the family Geminiviridae (Bos 1999). It has been confirmed that at least two virus i.e. MYMV and MYMIV species causing yellow mosaic disease are prevalent in Indian subcontinent. One of these species, Mungbean yellow mosaic India virus is considered to be more predominant in northern, central and eastern India and other MYMV in peninsular region of India (Karthikeyan *et al.* 2004, Malathi *et al.* 2008, Naimuddin 2010). These two species cause major setback to urdbean, mungbean and soybean cultivation and have reported an annual loss of US\$ 300 million (Varma 1992).

It has been estimated that India's population is increasing by 1.65% per year and would reach from the present level of 121 to 169 million at the end of 2030. Thus, total pulses requirement will be about 32 million metric tonnes with an expected required growth rate of 4.2% (IIPR vision 2011). The extent of losses due to this disease varies across the seasons and locations. Year to year

¹Scientist (e mail: ashoka.parihar@gmail.com), ²Senior Research Fellow, (e mail: ashutoshpnd07@gmail.com), DUS test, ³Project Coordinator (e mail: gpdixit1966@rediffmail.com), AICRP on Chickpea, ⁴ Project Coordinator (e mail: saniipr@rediffmail.com), AICRP on MuLLaRP.

environment variation is more unpredictable than location *per se* (Dia *et al.* 2016, 2016a). Therefore, future studies on multi-location \times year in replicated trials may provide high performing and stable cultivar for specific or widely adapted location (Kumar *et al.* 2016). Hence, sincere efforts must be made for the yellow mosaic disease to bring down the yield losses through identification of resistant cultivars by multi-year screening. Thus, this study was conducted to identify resistant varieties of mungbean and urdbean released in India for different locations.

MATERIALS AND METHODS

The present investigation comprised of 65 released cultivars of mungbean and 28 cultivars of urdbean evaluated at IIPR, Kanpur during *kharif* seasons of 2013 and 2014. The experimental material was planted in 4 rows of 5 meter length at row to row and plant to plant distance of 30 and 10 cm, respectively. The Kanpur location is considered as hot-spot for this disease (Singh and Gurha 1994, Gupta *et al.* 2005). During both the crop seasons, the natural disease pressure of YMD was quite high. The test materials were examined as per the standard rating scale suggested for scoring of YMD in the different group (Singh *et al.* 1988). The susceptibility and resistance to YMD was determined by visual symptomatology in which the susceptible lines were defined as those with more patches/spots on leaves or part of plant while symptomless varieties were assumed to be resistant. Based on Mungbean Yellow Mosaic Disease score, the crop varieties were divided into four subcategories i.e. highly resistant (0), resistant (1-2 scale), moderately susceptible (3) and susceptible (4-5). The mean disease score was calculated for disease rating and frequency.

Weekly data on agro-meteorological parameters, viz. temperature (in degree Celsius, Minimum and Maximum), relative humidity (%) and precipitation (mm) were recorded from the Agro-meteorological Observatory of the Indian Institute of Pulses Research, Kanpur (UP) and weekly values were computed for standard meteorological weeks (SMW). The incidence of this virus and effect of climate were studied at weekly intervals starting from 30th to 37th SMW during *kharif* 2013 and 2014.

RESULTS AND DISCUSSION

Weather condition and disease epidemic

The daily weather was represented as weekly data and mean values were computed from date of sowing to find out relationship of weather parameters with incidence of disease (Table 1). In the present attempt, reaction of the YMD on the varieties recommended for particular region revealed that the incidence of mungbean yellow mosaic disease was less in *kharif* 2014 as compared to *kharif* 2013. In both the crop season, the initiation of disease was observed in third standard meteorological week (32 SMW) after date of sowing. However, the highest incidence of disease was reported during 33th to 36th SMW. The incidence of yellow mosaic disease was higher in 2013 crop season as compared to 2014. During 33rd SMW of 2013 (4th week after sowing) the rainfall was only 8.4 mm while in the correspondence week during 2014 it was 45.2 mm. The temperature and relative humidity during 2013 was also substantially higher than 2014 in the corresponding week. This has resulted in comparatively higher initial incidence of YMD. Low rainfall, high temperature and increased relative humidity helped in buildup of vector population and thus initial YMD incidence increased significantly. Further, the rainfall received during crop growth in 2013 had been quite low (0.6-17.6mm) as compared to 2014(5.5-58.7mm). The higher rainfall might have deterrent effect on buildup of vector population. However, the low rainfall, high temperature and relative humidity caused severity of YMD incidence from 4th-7th week after sowing of both the crops. These finding are in accordance to the earlier results (Seif 1980, Gupta *et al.* 1998, Bashir *et al.* 2001).

Reaction to Yellow Mosaic Disease

The performance of Indian urdbean and mungbean varieties for Yellow Mosaic disease (YMD) has been presented in Table 2 and 3. A significant variation had observed among the tested varieties under investigation. The average disease score of 65 varieties of mungbean and 28 varieties of urdbean, ranged between 0-5 (0= no infection/ highly resistance and 5= highly susceptible).

Table 1 Observations on agro-meteorological parameters during the crop growth period in *kharif* 2013 and 2014

Week after sowing	Standard Week 2013 and 2014	Rainfall (mm)		Temperature (°C)		Relative humidity (%)	
		2013	2014w	2013 Min.-Max.	2014 Min.-max.	2013	2014
I	30	17.6	5.5	26.7-33.3	26.9-32.1	95.7	83.8
II	31	6.2	7.8	27.1-33.9	27.1-33.0	92.5	91.3
III	32	12.0	12.2	26.2-31.3	26.7-31.4	99.5	92.6
IV	33	8.4	45.2	25.8-32.6	27.9-34.1	97.8	82.1
V	34	0.6	30.1	27.1-33.4	28.6-37.4	93.4	57.8
VI	35	12.2	58.7	25.7-31.7	27.7-33.3	98.0	77.1
VII	36	0.2	32.9	26.7-34.2	26.4-32.0	83.3	90.2
VIII	37	0.8	14.8	25.6-34.4	25.4-30.6	88.1	94.6

In urdbean, five released varieties witnessed highly resistant reaction, i.e. LBG 645, IPU 2-43, Uttara, UG 218 and NDU 5-7, during both the consecutive years, while, in mungbean varieties PDM 139, ML 818 and MUM 2 were observed to be highly resistance during second year. Out of 28 varieties of urdbean, seven varieties, viz. Mash-1, Naveen, NDU-1, Sarla, TPU-4, Pant U-40, and Shekhar U-1 expressed resistant reaction or moderately resistant. Similarly, 12 varieties of mungbean were portrayed resistant or moderately resistant, i.e. Pant M-1, Sujata, Salimar M-1, HUM 1, HUM 2, IPM 99-125, JM-721, ML 131, ML 267,

MH 96-1, HUM 16 and Pusa 672. Two varieties in urdbean and five varieties in mungbean were reported as moderately susceptible. Additionally, three varieties of urdbean and six varieties of mungbean were categorized as susceptible or highly susceptible. The incidence of viral infection was more hazardous to mungbean varieties as compared to urdbean varieties because almost all the varieties were affected by this viral disease and none of these varieties were found symptomless during *kharif* 2013. These findings are congruent to earlier results of variation in mungbean genotypes against MYMIV (Ghafoor *et al.* 1992, Paul *et al.* 2013).

Table 2 Yellow mosaic disease reaction on mungbean released varieties in India during *kharif* 2013 and 2014

Mungbean varieties	YMD score (0-5 scale)			Mungbean varieties	YMD score (0-5 scale)		
	2013	2014	Mean		2013	2014	Mean
PDM 54	4.0	2.0	3.0	CO-4	5.0	2.0	3.5
PDM 139	0.0	0.0	0.0	OUM 11-5	4.0	3.0	3.5
Pant M-1	2.0	1.0	1.5	DHAULI	4.0	4.0	4.0
Pant M-2	4.0	1.0	2.5	GANGA 1	3.0	4.0	3.5
PS 10	5.0	3.0	4.0	GM 4	5.0	3.0	4.0
Pusa 105	3.0	4.0	3.5	HUM 1	2.0	2.0	2.0
OBGG 32	3.0	1.0	2.0	HUM 2	2.0	1.0	1.5
Pusa 9531	3.0	5.0	4.0	HUM 6	3.0	3.0	3.0
Pusa Baisakhi	3.0	1.0	2.0	HUM 12	3.0	5.0	4.0
PS 16	3.0	2.0	2.5	IPM 99-125	2.0	1.0	1.5
Pusa 9072	4.0	2.0	3.0	JM 721	2.0	2.0	2.0
Pusa Patna	4.0	3.0	3.5	K 851	5.0	2.0	3.5
Pratap	4.0	3.0	3.5	LAM M-2	3.0	4.0	3.5
RMG 62	3.0	5.0	4.0	LGG 407	4.0	5.0	4.5
RMG 268	3.0	3.0	3.0	LGG 450	2.0	5.0	3.5
RMG 344	3.0	2.0	2.5	ML 5	2.0	3.0	2.5
Sujata	2.0	1.0	1.5	ML 131	1.0	1.0	1.0
SALIMAR M-1	2.0	1.0	1.5	ML 267	1.0	3.0	2.0
SONA	3.0	3.0	3.0	ML 613	1.0	3.0	2.0
SML 32	5.0	3.0	4.0	ML 818	0.0	0.0	0.0
SML 134	3.0	2.0	2.5	MGG 295/ML 295	3.0	5.0	4.0
SML 668	4.0	3.0	3.5	MH 96-1	2.0	2.0	2.0
TARM 1	4.0	3.0	3.5	MUM 2	0.0	0.0	0.0
TARM 2	4.0	2.0	3.0	NDM -1	1.0	3.0	2.0
TARM 18	3.0	2.0	2.5	IPM 2-03	3.0	2.0	2.5
T 44	3.0	1.0	2.0	KM 2	3.0	3.0	3.0
VAMBAN 1	5.0	3.0	4.0	HUM 16	2.0	2.0	2.0
ASHA	1.0	3.0	2.0	PKU AKM 4	2.0	3.0	2.5
AKM 8803	5.0	3.0	4.0	Pusa 0672	1.0	1.0	1.0
AKM 9911	5.0	2.0	3.5	PAIRY MUNG	4.0	5.0	4.5
BM 4	3.0	1.0	2.0	N 605	5.0	5.0	5.0
BPMP 145	3.0	1.0	2.0	BM 2002-1	4.0	5.0	4.5
BDN 2	4.0	2.0	3.0				

Table 3 Yellow mosaic disease reaction on urdbean released varieties in India during *khariif* 2013 and 2014

Urdbean varieties	YMD score(0-5 scale)		
	2013	2014	Mean
Azad U-1	3.0	5.0	4.0
Azad U 2	0.0	3.0	1.5
KU 96-3	3.0	0.0	1.5
LBG 611	5.0	2.0	3.5
LBG 645	0.0	0.0	0.0
LBG 685	4.0	5.0	4.5
Manikya	1.0	2.0	1.5
Mash 1	1.0	2.0	1.5
Naveen	2.0	2.0	2.0
NDU 1	2.0	2.0	2.0
Pant U 30	4.0	3.0	3.5
Shekhar U 1	2.0	2.0	2.0
Shekhar U 3	3.0	1.0	2.0
Sarla	2.0	1.0	1.5
TU 94-2	5.0	3.0	4.0
TPU 4	2.0	2.0	2.0
Uttara	0.0	0.0	0.0
WBU 108	3.0	3.0	3.0
UG 338	1.0	2.0	1.5
Mash 414	5.0	3.0	4.0
Pant U 40	2.0	1.0	1.5
IPU 2-43	0.0	0.0	0.0
GU-1	4.0	3.0	3.5
RUG -10	4.0	3.0	3.5
Vallabh U-1	5.0	2.0	3.5
UG 218	0.0	0.0	0.0
NDU 5-7	0.0	0.0	0.0
Mash 4-4	2.0	0.0	1.0

Yellow Mosaic Disease reaction exhibited vast variability among tested mungbean and urdbean varieties. The urdbean and mungbean varieties released over different decades showed different infection level against Mungbean Yellow Mosaic Disease as depicted in Table 4. In *khariif* 2013, 20 varieties of mungbean and six varieties of urdbean which were developed before 1990, showed moderately resistance (2.8, 2.7) to moderately susceptibility (3.0) reaction.

Besides, 12 varieties in urdbean and 23 varieties in mungbean developed between 1991-2000 had average YMD score of 2.8 and 2.7, respectively. On the basis of two years study, it may be concluded that varieties of urdbean (10 varieties) evolved after 2000 showed resistance with average YMD score of 1.7, whereas 22 varieties mungbean evolved after 2000 AD showed moderately resistance with average YMD score of 2.6.

Table 4 YMD reactions in Indian urdbean and mungbean varieties developed over a period

Year of release	Number of varieties		Average YMD Score		Range of Score of YMD	
	Mung-bean	Urd-bean	Mung-bean	Urd-bean	Mung-bean	Urd-bean
<1990 AD	20	6	2.7	2.6	1-5	1-5
1991-2000 AD	23	12	2.7	2.8	0-5	0-5
>2000 AD	22	10	2.6	1.7	0-5	0-3

Table 5 Reaction of Indian mungbean and urdbean varieties to YMD

Recommended region	YMD score		Range	
	Mungbean	Urdbean	Mungbean	Urdbean
Northern India	2.4	2.1	0-5	0-4
Centre India	3.0	2.7	1-5	2-3
South India	3.2	2.5	1-5	0-4

An attempt was also made to categorize the varieties released in different zones and the incidence of disease during the period (Table 5). On the basis of two seasonal studies on urdbean and mungbean, the average incidence of yellow mosaic disease was less in the varieties released for north India as compared to those released for central and south India. In urdbean average YMD score was 2.1 in North India and it was quite low as compared to those varieties released for central (2.7) and south India (2.5). Similarly in mungbean, North Indian varieties (2.4) showed less YMD incidence like urdbean varieties as compared to those for central India (3.0) and south India (3.2). In this study, almost all the varieties of urdbean released for different zones as well as 39 varieties of mungbean released for north India showed moderate resistance while, varieties released for Central and South India were found moderately susceptible (Kumar *et al.* 2014a, 2014 b).

In the last 15 years in Indian urdbean and mungbean breeding programme, it has been the main focus to develop new plant cultivars with high degree of resistance against yellow mosaic disease (YMD). As a result, the newly released varieties of urdbean like IPU 2-43, LBG 645, NDU5-7 and Uttara and mungbean varieties, viz. PDM 139, ML 818 and MUM 2 were reported to have high degree and durable resistance against mungbean yellow mosaic disease. However, it is also to be noted that most of the released varieties of mungbean have not revealed high degree of resistance. Therefore, it is essentially required to be more concentrate on the strengthening of research programme for this very important aspect to fulfil the coming year requirement of mungbean for alarmingly increasing population.

In the present study, the tetrahedron conditions of disease development showed that weather parameters like temperature and relative humidity of 4-7 weeks after sowing have direct effect on incidence of yellow mosaic virus or whitefly population. The incidence of yellow mosaic

disease virus was less in the varieties released for north India as compared to central and south India. As results, three varieties of mungbean, viz. PDM 139, ML 818 and MUM 2 and five varieties of urdbean viz. LBG 645, IPU 2-43, Uttara, UG 218 and NDU 5-7 were witnessed highly resistant against MYMD over the years.

REFERENCES

- Bashir M, Jamali A R and Ahmed Z. 2006. Genetic resistance in mungbean and mashbean germplasm against mungbean yellow mosaic *begomovirus*. *Mycopathology* **4**: 1–4.
- Bashir M H, Afzal M, Sabir M A and Raza A B M. 2001. Relationship between sucking insect-pests and physico-morphic plant characters towards resistant/susceptibility in some new genotypes of cotton. *Pakistan Entomologist* **23**: 75–8.
- Bos L. 1999. *Plant Viruses: Unique and Intriguing Pathogens. A Text Book of Plant Virology*, pp: 305–6. Backhuys Publishers, the Netherlands.
- Dia M, Wehner T C, Hassell R, Price, D S, Boyhan, G E, Olson, S, King, S, Davis, A R and Tolla G E. 2016. Genotype x environment interaction and stability analysis for watermelon fruit yield in the US. *Crop Science* **56**: 1 645–61 doi: 10.2135/cropsci2015.10.0625.
- Dia M, Wehner, T C and Arellano C. 2016a. Analysis of genotype x environment interaction (GxE) using SAS programming. *Agronomy Journal* **108**(5): 1–15. doi: 10.2134/agronj2016.02.0085.
- Ghafoor A, Zubir M, Malik B A and Iqbal S M. 1992. Evaluation of selected germplasm of mungbean [*Vigna radiata* (L.) Wilczek]. *Pakistan Journal of Botany* **24**: 112–8.
- Ghafoor A, Ahmad Z and Sharif A. 2000. Cluster analysis and correlation in blackgram germplasm. *Pakistan Journal of Biological Sciences* **3**: 836–9.
- Gupta G P, Mahapatra G K, Kundu S K and Roshan L. 1998. Impact of abiotic factors on the population dynamics of whitefly in cotton. *Indian Journal of Entomology* **60**: 207–96.
- Gupta S, Kumar S, Singh R A and Chandra S. 2005. Identification of a single dominant gene for resistance to mungbean yellow mosaic virus in blackgram (*Vigna mungo* L.). *SABRO Journal of Breeding and Genetics* **37**(2): 85–9.
- IIPR. 2011. IIPR Vision 2030. Indian Institute of Pulses Research (ICAR), Kanpur.
- Karthykeyan A S, Vanitharani R, Balaji V, Anuradha S, Thillaichidambaram P, Shivaprasad P V, Parameswari C, Balamani V, Saminathan M and Veluthambi K. 2004. Analysis of an isolate of Mungbean yellow mosaic virus (MYMV) with a highly variable DNA B component. *Archives of Virology* **149**: 1 643–52.
- Kumar A, Parihar A K, Dixit G P and Gupta S. 2014a. Resistance potential of newly released urdbean genotypes against *Mungbean yellow mosaic India virus*. *Indian Phytopathology* **67**: 314–5.
- Kumar A, Parihar A K, Dixit G P and Gupta S. 2014b. Zonal occurrence of mungbean yellow mosaic disease in mungbean cultivars released for different zones in India. *The Ecoscan* **6**: 111–4.
- Kumar B, Guleria S K, Khanorkar S M, Dubey R B, Patel J M, Kumar V, Parihar C M, Jat S L, Singh V, Yathish K R, Das A, Sekhar J C, Bhati P, Kaur H, Kumar M, Singh A K, Varghese E and Yadav O P. 2016. Selection indices to identify maize (*Zea mays* L.) hybrids adapted under drought stress and normal ecologies in tropical climate. *Crop and Pasture Science* DOI: <http://dx.doi.org/10.1071/CP16141>.
- Malathi V G and John P. 2008. Gemini viruses infecting legumes. (In) Rao GP, Lava Kumar P and Holguin-Pena R J (Eds) *Characterization, Diagnosis and Management of Plant Viruses* pp 97–123. Stadium Press, Houston.
- Malik I A. 1991. Breeding for resistance to MYMV and its vector in Pakistan. (In) *Mung-bean Yellow Mosaic Disease: Proceedings of an Inter-national Workshop*. Green S K and Kim D (Eds). Bangkok, Thailand, July 2-3, 1991, AVRDC, Taiwan, 79 p.
- Naimuddin and Akram M. 2010. Detection of mixed infection of *begomoviruses* in cowpea and their molecular characterization based on CP gene sequences. *Journal of Food Legume* **23**: 191–5.
- Nairani I K. 1960. Yellow mosaic of mungbean (*Phaseolous aureus* L.). *Indian Phytopathology* **13**: 24–9.
- Nene Y L. 1972. A survey of viral diseases of pulse crops in Uttar Pradesh. *Pantnagar Research Bulletin* **4**: 191.
- Nene Y L. 1973. Viral diseases of some warm weather pulse crops in India. *Plant Disease Report* **5**: 463–7.
- Pathak A K and Jhamaria S L. 2004. Evaluation of mungbean (*Vigna radiata* L.) varieties to yellow mosaic virus. *Journal of Mycology and Plant Pathology* **34**: 64–5.
- Paul P C, Biswas M K, Mandal D and Pal P. 2013. Studies of host resistance of mungbean against Mungbean Yellow Mosaic Virus in the agro-ecological condition of lateritic zone of West Bengal. *The Bioscan* **8**: 583–7.
- Seif AA. 1980. Seasonal fluctuation of adult population of whitefly, *Bemisia tabaci* on cotton and its relationship with weather parameter. *Journal of Cotton Research and Development* **5**: 181–9.
- Singh G, Kapoor S and Singh K. 1988. Multiple disease resistance in mungbean with special emphasis on Mungbean yellow mosaic India virus. *Proc. of Second Int'l. Mungbean Symp*, AVRDC, Shanhu, Tainan, Taiwan, pp 289–96.
- Singh R A and Gurha S N. 1994. Influence of cropping season on the incidence of yellow mosaic virus in mungbean genotypes. *Indian Journal of Pulses Research* **7**: 206–8.
- Varma A, Dhar A K, Mandal B, Gocen S K and Kim D. 1993. MYMV transmission and control in India. *Mungbean Yellow Mosaic Disease*. Proceeding of and International Workshop, Bangkok, 92-373.