The Pharma Innovation Journal 2022; 11(10): 1539-1542

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(10): 1539-1542

www.thepharmajournal.com
Received: 05-07-2022
Accepted: 28-09-2022

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Preferential behavior of *Mungbean Yellow Mosaic Virus* (MYMV) and its vector (*Bemisia tabaci* Genn.) between mungbean and urdbean

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Abstract
Mungbean Yellow Mosaic Virus (MYMV) is destructive disease, distributed all around the country and causes major damage to pulse crops. Yellow mosaic disease (YMD) of pulses caused by *Mungbean Yellow Mosaic Virus* (MYMV) is transmitted by whiteflies (*Bemisia tabaci.* Genn.) Which causes 10-100 per cent of yield loss in mungbean and urdbean. Experiment was conducted to analyze the preferential behavior of MYMV transmitting vector (*Bemisia tabaci.* Genn.) Between mungbean and urdbean by inoculating the viruliferous whiteflies which were acquired from MYMV infected mungbean and urdbean plants, to the different hosts in different treatments. The results of the preferential studies reported, significant difference in percent disease incidence between mungbean and urdbean plants. The maximum disease incidence of 63.33 per cent was observed in the mungbean plants in treatment T_2 and urdbean plants shown incidence of 43.33 per cent in the treatment T_4, similarly the severity was also maximum in mungbean (83.60 %) than the urdbean (47.88 %) plants in the respective treatments. To confirm the preferential studies both mungbean and urdbean plants were grown together and inoculated by the viruliferous whiteflies acquired from MYMV infected urdbean plants (T_5) and mungbean plants (T_6), in both the treatments disease incidence of mungbean (52.2%) was maximum than compared to the urdbean plants (18.2 %). The studies noticed that mungbean is the most preferred host for the virus and its vector than compared to the urdbean plants.

Keywords: Mungbean, MYMV Urdbean, YMD, Viruliferous whiteflies.

Introduction
The world population is growing rapidly from the present ~ 7.95 billion (in 2022) to ~ 8.9 billion by 2050. Therefore, today's prior importance is to reach the food requirement of the nation by providing quality and nutritional food to this growing population. Globally pulses are produced on ~12 to 15 per cent arable land and it reaches ~ 30 per cent of human dietary protein requirement (Graham and Vance 2003) [2]. Mungbean [(*Vigna radiata* (L.) Wilczek] and urdbean [*Vigna mungo* (L.) Hepper] are the important pulse crops after chickpea and pigeon pea in India, which are regarded a prospective protein source for human daily diet (Parihar *et al.*, 2017) [6] but mungbean and urdbean productivity is hampered by a variety of causes, one among them is diseases. These crops are affected by several fungal and viral diseases which causes a severe reduction in yield loss. Among the disease caused by viruses, Yellow mosaic disease (YMD) is the major viral disease in mungbean and urdbean which lower the yield and it causes up to 100 per cent yield loss (Usharani *et al.*, 2004) [7].
The causal agent for the yellow mosaic disease is *Mungbean Yellow Mosaic Virus* (MYMV) which belongs to the family Geminiviridae, Genus: Begomovirus have characteristic twinned quasi-icosahedral particles (18 × 30 nm) that encapsidate circular single-stranded DNA, bipartite genome (DNA-A and DNA- B compartment) (Fauquet *et al.*, 2005) [1]. It is transmitted by whitefly (*Bemisia tabaci.* Genn) and shows persistent, circulative, and non-propagative type of virus-vector transmission relationship. Hence it is vector transmitted virus, the incidence and severity of YMD and yield loss is directly proportional to the virus- vector population, *i.e., B. tabaci* and Gemini virus complex. The disease incidence and severity of virus depends on different host factors *viz.*, morphological, biochemical and environment factors (Varma and Malathi, 2003) [8]. Management of any vector transmitted virus is either through chemical or else resistant varieties developed, in regard of this some of the investigation reports noticed that, mungbean and urdbean resistant varieties released for MYMV and *Mungbean Yellow Mosaic Indian Virus* (MYMIV) are region specific and also among the mungbean and urdbean varieties screened, the maximum number of mungbean

varieties are highly susceptible than urdbean varieties (Parihar *et al.*, 2017) [6], the resistant and susceptible nature of the varieties is depend on host and environment characters, because some of the host (leaf thickness, trachoma's, and wax) and environment characters (Temperature, Relative humidity and rainfall) have direct relationship with vector which help either to increase or decrease the virus infection. Before characterizing morphological and environmental condition knowing the relative susceptibility of the mungbean and urdbean is having prior importance and this investigation knowledge help to tackle the reason for susceptibility or resistance of the crop those trait may help to develop a new resistant varieties in mungbean and urdbean against MYMV. Keeping the above point's in view present experiment was conducted in the CoA, VC Farm, Mandya during 2020-21 to understand the preferable host for MYMV and whiteflies among the mungbean and urdbean.

Materials and Methods

Two most widely grown and important pulse hosts viz., mungbean and urdbean for *Mungbean Yellow Mosaic Virus* and its vector (*Bemasia tabaci.* Genn) were selected to study their preferential behavior. The susceptible varieties of mungbean (Var. BGS-9) and urdbean (Var. Rashmi) were used for the present studies and the experiment was laid out following the Randomized Complete Block Design (RCBD). The experiment included ten treatments and replicated thrice during summer of 2021 at CoA, VC Farm, Mandya. The details of the treatment are as presented in the Table 1.

The mungbean and urdbean susceptible verities were grown by following the different treatments. Each treatment contains 30 plants, and treatments were covered with polythene mesh to avoid the escape of inoculated viruliferous whiteflies from the treatments. The each treatment were inoculated by viruliferous whiteflies during two leaf stage of the crop. The observations were recorded on disease incidence and severity during the experiment from 15 DAS to 60 DAS at every 15 days interval. The details of the treatments given in below table 1.

Table 1: Treatment details used for the study of preferential behavior of MYMV and its vector (*Bemasia tabaci.* Genn) between mungbean and urdbean

Treatment No	Plants grown in the treatments	Number of Plants in the treatment	Source of Inoculums	Number of viruliferous whiteflies inoculated
T1	Urdbean	30	MYMV infected mungbean	15
T2	Mungbean	30	MYMV infected mungbean	15
T3	Mungbean	30	MYMV infected Urdbean	15
T4	Urdbean	30	MYMV infected Urdbean	15
T5	Mungbean + Urdbean	15+15	MYMV infected Urdbean	15
T6	Mungbean + Urdbean	15+15	MYMV infected mungbean	15
T7	Urdbean	30	Without whiteflies	-
T8	Mungbean	30	Without whiteflies	-
T9	Urdbean	30	Non viruliferous	15
T10	Mungbean	30	Non viruliferous	15

Maintenance of MYMV culture under glass house

Naturally infected mungbean and urdbean plants from the field were used for acquisition by non-viruliferous whiteflies. The non-viruliferous vectors maintained on the cotton plants were allowed for reacquisition starvation of 1 hr. Acquisition access period (AAP) of 12 hours were given to the whiteflies and used for further infection to the mungbean and urdbean for the preferential behavior studies (Muniyappa *et al.*, 2003) [5].

Mungbean yellow mosaic disease incidence

The per cent disease incidence was calculated by counting the number of plants infected and a total number of plants in a treatment at every 15 days interval from fifteen days to sixty days after sowing (DAS).

$$\text{Disease incidence} = \frac{Numberofinfectedplants}{Total\ numberofPlants} \times 100$$

Molecular confirmation of MYMV in mungbean and urdbean through Coat Protein (CP) primers

DNA was extracted from healthy and infected mungbean and urdbean leaf samples using CTAB (Cetyl Trimethyl Ammonium Bromide) (Lodhi *et al.*, 1994) [3] and subjected for the polymerase chain reaction by using Coat Protein gene-specific primers (MYMV CP Fwd 5′ATGGGKTCCGTTGTATGCTTG3 and MYMV CP Rev 5′GGCGTCATTAGC ATAGGCAAT 3′).

Results and Discussion

Relative susceptibility of mungbean and urdbean against MYMV and *B. tabaci*

The present investigation results revealed that, the mean disease incidence of the *Mungbean Yellow Mosaic Virus* ranged from zero to 63.33 per cent. The treatments with mungbean plants were inoculated by MYMV viruliferous whiteflies acquired from MYMV infected mungbean plants (T_2) recorded significantly highest mean disease incidence were followed by mungbean plants were inoculated by MYMV viruliferous whiteflies acquired from MYMV infected urdbean plants (T_3), Urdbean plants were inoculated by MYMV viruliferous whiteflies acquired from MYMV infected urdbean plants (T_1) and Urdbean plants were inoculated by MYMV viruliferous whiteflies acquired from MYMV infected mungbean plants (T_4) with the mean disease incidence of 63.33, 60.00, 43.33 and 33.33 per cent respectively. The significantly lowest mean disease incidence, in the treatments where whiteflies had not inoculated (T_7 and T_8) or inoculated by non-viruliferous whiteflies (T_9 and T_{10}) were recorded zero per cent of disease incidence. Further to know the preference of whiteflies to transmit the MYMV virus among mungbean and urdbean plants, both the crops were grown in single treatment (15:15) and inoculated by MYMV viruliferous whiteflies acquired from MYMV infected urdbean plants and mungbean plants in the treatments T_5 and T_6 respectively, in these two treatments disease incidence of individual crop was recorded. Results reported

that among these two crops mungbean plants showed the maximum disease incidence of 43.33 and 40.00 per cent and urdbean plants showed disease incidence of 13.33 and 13.00 per cent in the treatments T_6 and T_5.

The results of the present investigation confirmed that among the mungbean and urdbean crops mungbean is the most preferable host for the whiteflies to transmit the MYMV virus and the rate of increase of disease incidence increased exponentially in mungbean and urdbean plants during early growth stage of the crops. The results of the studies confirmed by Parihar *et al*. (2017) [6] revealed that the disease incidence of MYMV infection was more severe in mungbean varieties as compare to urdbean varieties.

Molecular detection of MYMV through CP gene-specific primer

To confirm the presence of *Mungbean Yellow Mosaic Virus* in infected and healthy mungbean and urdbean plants, the leaf samples were collected from the field at 30 DAS from each treatment and the genomic DNA was extracted by using the CTAB method and subjected to a polymerase chain reaction by using Coat-protein mediated MYMV specific primer. ~ 900bp band was visualized when exposed to UV-rays through gel documentation unit. Our present results were also confirmed by Mantesh *et al.* (2020) [4] they reported that eighteen genotypes infected by MYMV visualized band at 900 bp.

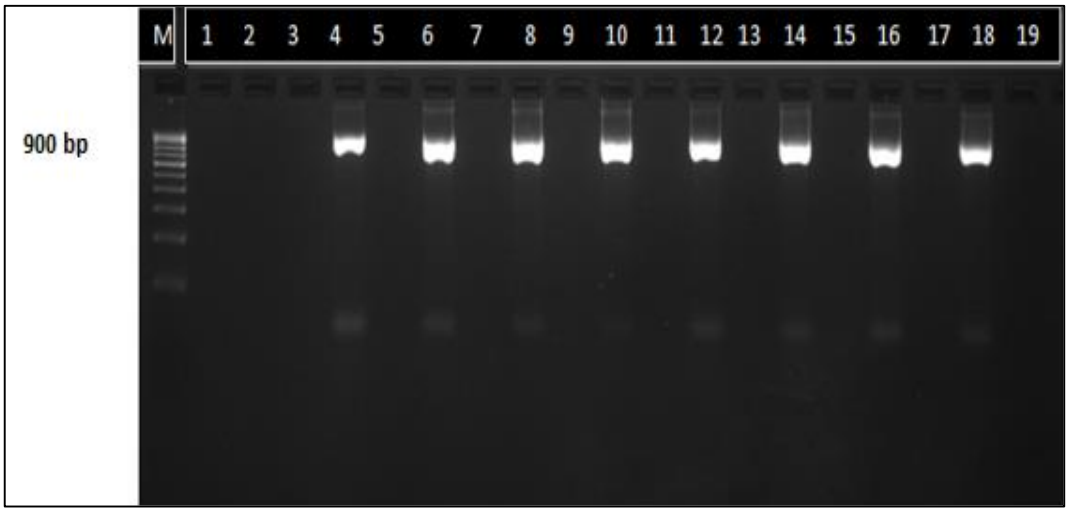

Plate 1: Molecular detections of MYMV in mungbean and urdbean through Coat protein gene-specific primer from first season experiment

M-100 bp ladder Lane 1: Mungbean healthy plant from T8, Lane 2: Urdbean healthy plant from T_7, Lane 3: Mungbean from T_{10}, Lane 4: MYMV infected Urdbean from T_1, Lane 5: Healthy Urdbean from T_1 Lane: 6 MYMV infected mungbean from T_2, Lane: 7 Healthy mungbean from T_2, Lane: 8 MYMV infected mungbean from T_3, Lane: 9 Healthy mungbean from T_3, Lane: 10 MYMV infected urdbean from T_4, Lane: 11 Healthy urdbean from T_4, Lane: 12 MYMV infected mungbean from T_5, Lane: 13 Healthy mungbean from T_5, Lane: 14 MYMV infected urdbean from T_5, Lane: 15 Healthy urdbean from T_5, Lane: 16 MYMV infected mungbean from T_6, Lane: 17 Healthy mungbean from T_6.

Table 2: MYMV Disease severity (PDI) in mungbean and urdbean at different intervals

Disease severity (PDI %) at different interval				
Treatments	**15 DAS**	**30 DAS**	**45 DAS**	**60 DAS**
T_1	0 (0.00)	12.33 (20.56)	36.93 (37.43)	47.88(43.79)
T_2	12.33(20.56)	40.29(39.40)	64.78(53.60)	83.60(66.12)
T_3	10.90(19.28)	38.35(38.26)	62.33(52.14)	81.41(62.66)
T_4	0.00(0.00)	9.00(17.46)	33.62(35.44)	46.65(43.52)
T_5**	11.67(19.28)	35.77(36.74)	53.67(47.11)	76.30(60.87)
T_6**	14.17(22.11)	38.37(38.28)	58.11(49.67)	78.90(64.47)
T_7	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
T_8	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
T_9	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
T_{10}	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
S.E.M ±	0.54	0.84	1.27	1.36
CD @ 5 %	1.62	2.50	3.78	4.05
F	*	*	*	*

Table 3: MYMV Disease incidence in mungbean and urdbean at different intervals

Disease incidence (DI %) at different intervals				
Treatment	**15 DAS**	**30 DAS**	**45 DAS**	**60 DAS**
T_1	00.0(00.0)	26.77(31.10)	33.3(35.28)	43.33(41.18)
T_2	6.66(14.96)	46.67(43.10)	56.67(48.85)	63.33(54.24)
T_3	6.66(14.96)	43.34(41.19)	53.34(46.93)	60.00(50.89)
T_4	00.0(00.0)	16.67(24.12)	30.00(33.27)	33.3(35.25)

T_5**	3.33(10.51)	36.33(37.08)	50.0(45.02)	53.33(46.93)
T_6**	3.35(10.56)	40.00(39.25)	53.34(46.93)	56.67(48.85)
T_7	00.0(00.0)	00.0(00.0)	00.0(00.0)	00.0(00.0)
T_8	00.0(00.0)	00.0(00.0)	00.0(00.0)	00.0(00.0)
T_9	00.0(00.0)	00.0(00.0)	00.0(00.0)	00.0(00.0)
T_{10}	00.0(00.0)	00.0(00.0)	00.0(00.0)	00.0(00.0)
S.E.M ±	0.91	1.36	1.93	1.01
CD @ 5 %	2.76	2.70	5.90	3.09
F	*	*	*	*

Note: * Significant at ($p \leq 0.05$) level, DAS: Days after sowing, Values in parenthesis: indicates Arc sine transformation value.
** Per cent disease incidence of both mungbean and urdbean, Treatment details are given in table 1.

Table 4: Disease incidence and disease severity in mungbean and urdbean grown in single cage upon inoculated with MYMV viruliferous whiteflies during summer of 2021

Treatment		Disease incidence (%)		Disease severity (%)	
	Interval	Mungbean	Urdbean	Mungbean	Urdbean
T_5	15 DAS	3.30	0.00	10.90	0.00
	30 DAS	26.66	10.00	44.44	38.32
	45 DAS	36.66	13.33	61.11	58.32
	60 DAS	40.00	13.33	72.4	68.43
T_6	15 DAS	3.35	0.00	11.67	0.00
	30 DAS	30.00	10.00	38.64	34.44
	45 DAS	40.00	13.33	58.34	52.22
	60 DAS	43.33	13.33	80.34	78.8

Conclusion

The present experiment conducted in controlled field conditions, reports revealed that mungbean plants are more susceptible and disease incidence (64.9 %) and severity (83.72 %) was maximum than the urdbean plants (44.99 and 47.41 %) irrespective of the source of inoculum. Its concluded that mungbean is more potential and preferable host for the whiteflies and MYMV which may be due to morphological and biochemical properties by applying this preferential behavioral studies of MYMV and whiteflies based on these reports further the morphological and biochemical variation studies should be conducted by confirming that we can able to develop the resistant varieties against whiteflies, along with these this idea can be used in the management strategies of urdbean, by growing mungbean either as border crop or mixed crop which results in the escape the MYMV infection**.** To validate the row ratios of mungbean and urdbean to control the whiteflies or escape the urdbean plants from the MYMV loss further research has to conduct in natural conditions.

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