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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 1831-1835
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www.thepharmajournal.com
Received: 02-03-2022
Accepted: 09-04-2022

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Effect of biorational approaches on mungbean yellow mosaic viral disease (MYMV) in mungbean

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Abstract
Mungbean yellow mosaic viral disease is a devastating viral disease causing considerable yield losses in Northern part of India. Mungbean yellow mosaic virus (MYMV) a member of family *Geminiviridae*, transmitted by insect whitefly (*Bemisia tabaci*). The present study showed that whitefly population builds up started in month of July and reached to maximum in first week of September. The minimum whitefly population was observed at end of July, which approached its maximum at end of August to early September. The maximum whitefly population was observed on SML 1082 (8.42) followed by TMB 37 (7.197) and MH 421 (5.087). The percent disease index (PDI) was observed maximum in first week October. The terminal PDI was observed highest in SML 1082 (73.32%) cultivar. The highly significant positive correlation was found between cultivars and disease severity. For the management of MYMV disease biorationals were used and amongst all, salicylic acid @ 150 mg/litre as seed priming and then foliar spray @ 150 mg/L recorded significantly higher yield and less terminal PDI (32.75%) with maximum percent disease control (57.27%) followed by treatment sarpagandha leaves extract @10% as seed priming + spray @100 ml/L with fruit yield 523.38 kg/ha with percent disease control (50.73%) which was statistically at par to the recorded for neem oil @ 5ml/kg as seed treatment + spray @5ml/L with fruit yield 493.03 kg/ha).

Keywords: *Geminiviridae*, percent disease index (PDI), biorationals, sarpagandha and salicylic acid

1. Introduction
Mungbean (*Vigna radiata* (L.) Wilczek) is a very ancient annual crop in. Indian farming which is commonly known as greengram, green bean, moong, mash bean, golden gram and green soy. Mungbean (*Fabaceae*) originated.in India or the Indo- Burmese region, is a vital crop grown throughout Asia. Mungbean is very famous crop with high nutrient value having 20-24% protein, 60-65% carbohydrates, 0.6% fat, 0.5% ash, 2.69-5.80% sugar contents.16.3% fiber and many vitamins like A, B, E, C, and K (Khan *et al.*, 2012) [1]. The standard yield of mungbean worldwide is very low (730 kg/ha) and the mungbean production has not increased yet to the potentials. The main reasons for the low yield were fungus, virus, bacterium, insect, weed etc. Various diseases of mungbean are anthracnose, rust, cercospora leaf spot, powdery mildew, stem necrosis, dry root rot, leaf crinkle and yellow mosaic disease (MYMV). Out of all diseases of mungbean, MYMV disease is one of the most prevalent and destructive diseases (Sudha *et al.*, 2013) [2].
In India, MYMV affects all mungbean-growing states in the country. The most vulnerable stage is from 30 to 45 days (Sudha *et al.*, 2013) [2]. MYMV a member of *Geminiviridae* family, belong to genus *Begomovirus* that was identified in 1955 and it was observed that it is not transmitted mechanically but transmitted by whitefly (*Bemisia tabaci* Genn) in persistent manner (Iqbal *et al.*, 2011) [3]. Mungbean yellow mosaic virus has circular (20 x 30 nm) (Meti *et al.*, 2018) [4], single-stranded (ss) DNA genome (Hull *et al.*, 2004) [5] infecting dicotyledonous plants like urdbean, mungbean and soybean (Haq *et al.*, 2011) [6]. Singh (1980) [7] and. Marimuthu *et al.*, 1981 [8] reported that yield loss in mungbean due to. MYMV disease was about 76-90% in Karanataka. Mungbean plants are infected at the seeding stage, so it can lead to 85-100% loss in yield (Sudha *et al.*, 2013) [2].
MYMV disease can be recognized by its typical symptoms which starts appears on the young leaves of the plant at vegetative stage in form of mild yellow spots (John *et al.*, 2015) [9]. Gradually, spread all over the upper leaves, which turn to yellow and ultimately, reduces plant size, number of flowers and pods (Brown *et al.*, 1991) [10].

Many efforts have been made for controlling the. MYMV diseases by using the biorationals compounds such as use of leaf extracts of *Mirabilis jalapa*, *Datura metel* and neem (*Azadirachta indica*) oil has provided reduced incidence of MYMV with increased yield (Venkatesan *et al*., 2010) [11]. A variety of mechanisms through which plants defend themselves against pathogens can be either constituted or inducible. The constituted mechanisms include changes in cell wall composition that can inhibit the penetration of pathogen, synthesis of antimicrobial compounds, hypersensitive response and systemic response. The inducible mechanism includes systemic acquired resistance (SAR) and induced systemic resistance (ISR). SAR is very effective against a wide range of viral, bacterial, and fungal pathogens.

Nabila (1999) [14] reported that squash plants gained resistance against. CMV infection after seed treatment with oxalic acid, salicylic acid or hot water that is at 10 mM, salicylic acid and oxalic acid induced resistance by reducing infective virus particles by 83.3 per cent and 37.5 per cent, respectively. Kundu *et al.*, 2011 [15] reported the role of salicylic acid (SA) in inducing resistance to. MYMV infection in *Vigna mungo*, twenty-nine proteins identified that were predicted to be involved in stress responses, metabolism, photosynthesis, transport and signal transduction, showed increased abundance upon SA treatment. Susceptible plants showed characteristic yellow mosaic symptoms upon MYMV infection.

2. Materials and Methods

The present investigation was conducted in the Research Area, Department of Plant Pathology, CCS Haryana Agricultural University, Hisar during kharif 2019. Mungbean cultivars MH 421 as resistant, TMB 37 as moderately resistant and. SML 1082 as susceptible were grown in a randomized block design (RBD) during kharif 2019 in plots (4.5 X 3 m^2) with four replications. The number of whiteflies was recorded at 7 days interval and for this whitefly population (number/ 3 leaves) was counted on three leaves at three different positions, i.e. one at top, one at middle and one at bottom on ten plants selected randomly in a plot started from 20 days and up to 55 days old mungbean crop. All the observations were recorded in the early morning hours because at that time whiteflies were less active. The disease severity was recorded at 7 days interval started from 20 DAS by using 0-6 scale (Ali *et al.*, 2005a). Percent disease index (PDI) was calculated by using the method of McKinney, 1923 [16]. Correlation was analyzed between PDI with the different weather parameters.

Table 1: Disease severity scale (Ali *et al.,* 2005a)

Rating	Category	Severity Range
0	Immune	0%
1	Highly resistant	1-10%
2	Moderately resistant	11-25%
3	Tolerant	26-50%
4	Moderately susceptible	51-60%
5	Susceptible	61-70%
6	Highly susceptible	71-100%

The percent disease index (PDI) was calculated by using the McKinney's (1923) [16] formula:

$$\text{Per cent disease index} = \frac{\text{Sum of all numerical ratings}}{\text{No. of plant examined} \times \text{maximum disease rating}} \times 100$$

For study the effect of plant extracts and few nonconventional chemicals (Biorationals) on plant disease severity (PDI), test weight and yield of mungbean, the experiment was laid out in randomized block design with six treatments (Plot size: 4.5 × 3 m^2) having three replications. The sowing was done on 11^{th}July, 2019 using the seeds of SML 1082 cultivar. Two sprays of chemicals and plant extracts were made at 15 days interval. First spray was done on 25 days after sowing. Data were recorded on disease severity of MYMV on mungbean crop, test weight and yield (kg/ha). The mature pods were harvested and then yield of grains was recorded in g/plot. Later on, grain yield was calculated in kg/ha. The test weight of mature grains was taken by weighing the weight of per 1000 grains of mungbean in gm.

Table 2: Treatment details:

Treatment	Treatment details
T_1	Seed treatment by neem oil @ 5ml/kg and spray @5ml/L of water
T_2	Faba bean seed extract @ 10% as seed priming. and spray @100ml/L
T_3	Sarpagandha leaves extract @10% as seed priming and spray @100ml/L
T_4	Salicylic acid @ 150 mg/litre as seed. priming and spray @ 150 mg/litre water
T_5	Jasmonic acid @ 150 mg/litre as seed priming and spray @ 150 mg/litre water
T_6	Untreated check

For priming seeds are soaked in different solutions for 6 h at 30 ^{0}C.

Plant extract preparation: First the tender leaves/green seeds of plant species were collected in paper bag. Then after drying them, the plant extract was prepared by grinding the plant leaves with equal amount of double distilled water in grinder. After grinding the leaves, they were squeezed through a fine muslin cloth. The prepared extracts were filtered and then poured in flask, which were covered by cotton plugs and then put in refrigerator.

3. Results and Discussion

Development and spread of MYMV depends upon sustaining whitefly population, host plant condition and various weather parameters like maximum temperature, minimum temperature, rainfall, wind velocity, relative humidity and sunshine hours etc. prevailing during the crop season in field conditions. Incidence of the whitefly population on mungbean was recorded from July to September on all three cultivars. The results are presented in Table 1. Whitefly population build up on all three cultivars were higher during August as compared to rest of months. Whitefly population increased, except during rainfall and high wind speed periods. It was recorded that the whitefly population was ranged between 1.5-8 adults/leaf/plant with an average of 4 adults/leaf/plant on mungbean.

3.1 Whitefly population and PDI: The positive relationship was found between whitefly population and disease severity. At initial stages of crop growth, whitefly population and disease incidence were found to be lower but later due to favourable weather conditions increase in whitefly population led to increase in MYMV disease. The incidence started at 20 DAS with varying whitefly population on all three cultivars. The maximum whitefly population (8.42 adults/leaf) was noticed on SML 1082 with higher PDI (73.32%) whereas minimum whitefly population (4.83 adult/leaf) with lower PDI (10.55%) was noticed on MH 421 after 55 DAS in first week of September.

Table 1: Whitefly population and percent disease index on three mungbean varieties during kharif 2019

Time of observation (DAS)	MH 421		TMB 37		SML 1082	
	Whitefly population /3 leaf	Per cent disease index	Whitefly population /3 leaf	Per cent disease index	Whitefly population /3 leaf	Per cent disease index
20	1.443	1.66 (7.40)	2.083	6.10 (14.27)	2.593	20(26.55)
27	1.140	1.98 (8.07)	1.570	8.88 (17.32)	2.083	33.33(35.24)
34	2.217	4.21(11.39)	3.891	17.73(24.91)	4.590	42.77(40.81)
41	3.797	6.11(13.95)	6.007	26.10(30.65)	6.897	49.44(44.66)
48	5.087	8.33 (16.42)	7.197	32.77(34.88)	8.420	57.77(49.45)
55	4.830	10.55(18.86)	5.817	41.66(40.16)	6.900	73.32(59.14)
CD(p=0.05)	1.117	(3.95)	1.029	(5.57)	0.704	(8.93)
SE(m)±	0.35	(1.23)	0.32	(1.74)	0.22	(2.80)

The correlation between whitefly population and MYMV disease severity was found positively significant. The correlation matrix of whitefly population and PDI was also worked out. It was found that there was highly significant positive correlation in case of MH421, whereas with SML1082 and TMB 37 it was positively significant. Similarly, Patel and Mahatma (2016) [17] observed the pattern of increase in the disease incidence was almost similar to the whitefly population. Similarly, Nath (1994) [18] studied the effect of the weather parameters on the population of whitefly and the incidence of yellow mosaic virus on green gram. He reported a simple positive significant correlation between the disease incidence and the population of the whitefly.

Table 2: Correlation matrix of whitefly population and PDI on three mungbean varieties

S. No.	Variety	Disease severity
1	MH 421	0.958^{**}
2	TMB 37	0.888^{*}
3	SML 1082	0.831^{*}

** = Highly significant, * = Significant

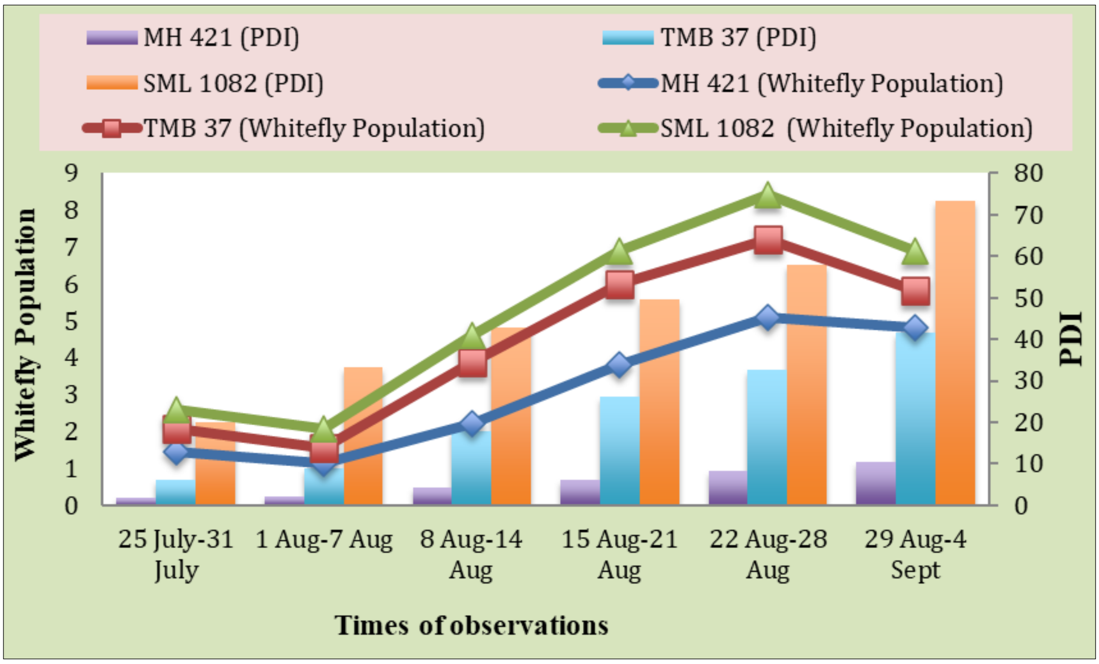

Fig 1: Percent disease index (PDI) recorded on different cultivars and whitefly population at weekly intervals

Plate 1: Infected pods of mungbean (SML 1082)

3.2 Effect of biorational approaches on mungbean : Biorationals compounds such as neem oil, fababean seed extract, sarpagandha leaves extract and nonconventional chemical such as salicylic acid and jasmonic acid were used to study their effect on PDI, fruit yield and test weight. The result revealed that all the treatments had significant effect in reducing. PDI and also increased the yield as compared to control. Amongst the treatments, salicylic acid @150 mg/litre as seed priming and then foliar spray @ 150 mg/L recorded significantly less terminal PDI (32.75%) with maximum percent disease control (50.27%). Farooq *et al*., 2018 reported that resistance to MYMV infection could be induced in mungbean plants by activating the salicylic acid (SA) pathway.

The fruit yield was recorded highest (543.60 kg/ha) in treatment salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/litre as compared to other treatments as well as per cent increase in yield was also maximum (45.18%). This was followed by treatment sarpagandha leaves extract @10% as seed priming + spray @100 ml/L with fruit yield 523.38 kg/ha which was statistically at par to the recorded for neem oil @ 5ml/kg as seed treatment + spray @5ml/L (493.03 kg/ha). Test weight was also recorded highest in salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/litre (35.41gm) as compared to other treatments and control (30.18gm). Maximum percent increase in test weight (13.78) was also recorded in this treatment. Therefore, it is clear that out of all treatments, salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/litre recorded lowest PDI with highest seed yield and test weight.

Table 3: Effect of biorationals (nonconventional) chemicals and plant extracts on MYMV of mungbean (SML 1082)

Tr. No.	Treatments	Per cent disease index at different time periods (DAS)						Per cent disease control
		20	27	34	41	48	55	
T1	Neem oil @ 5ml/kg as seed treatment + spray @5ml/L	11.77	15.84	18.55	27.65	31.10	40.33	47.39
T2	Faba bean seed extract @ 10% as seed priming + spray @100ml/L	16.63	24.44	26.66	33.33	36.66	51.21	33.19
T3	Sarpagandha leaves extract @10% as seed priming + spray @1ooml/L	12.73	17.22	23.88	25.73	31.10	37.77	50.73
T4	Salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/L	9.44	14.07	18.77	23.32	29.05	32.75	57.27
T5	Jasmonic acid @150mg/l as seed priming + spray @150mg/L	16.11	21.10	27.77	31.66	40.53	48.33	36.95
T6	Untreated check	17.77	29.44	36.773	49.44	58.33	76.66	--
CD(p=0.05)		(2.97)	(4.41)	(2.82)	(3.13)	(3.12)	(3.64)	
SE(m)±		(0.93)	(1.38)	(0.88)	(0.98)	(0.97)	(1.14)	

Table 4: Effect of nonconventional chemicals and plant extracts on mungbean (SML 1082) fruit yield and test weight

Tr. No.	Treatments	Fruit yield (Kg/ha)	Test Weight (gm)	Per cent increase in yield	Per cent increase in test weight
T1	Neem oil @ 5ml/kg as seed treatment + spray @5ml/L	493.03	33.67	36.76	11.56
T2	Faba bean seed extract @ 10% as seed priming + spray @100ml/L	431.72	31.96	19.75	05.89
T3	Sarpagandha leaves extract @10% as seed priming + spray @1ooml/L	523.38	34.34	45.18	13.78
T4	Salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/L	543.60	35.41	50.77	17.32
T5	Jasmonic acid @150mg/l as seed priming + spray @150mg/L	436.71	32.60	21.14	08.01
T6	Untreated check	360.49	30.18		
CD(p=0.05)		(3.64)	(3.21)		
SE(m)±		(1.14)	(1.07)		

Similarly Srivastava *et al.*, 2010 [19] observed that All treatments were helpful in reducing plant infection but the most effective treatment was the combination of SA@5mM and BTH@150mg/L as compared to virus inoculated control as well as medicinal plant extracts including sarpagandha were inhibitory for all the three strains of virus up to 75 days. All the botanicals used as a control raised increase the grain yield significantly and reduce this spot blog score up to the range of 12 to 36 as compared to the 79 score of untreated control as well as cost of treatments (Malik *et al.*, 2008) [12]. Several reports are also available on induction of resistance against plant viruses by using chemicals and one among them is salicylic acid which is natural messenger used to control tobacco mosaic virus (Murphy and Carr, 2002) [13]. Dubey *et al.*, (2011) [20] observed that application of neem seed kernel extract and foliar spray of neem oil is effective. Reang *et al.*, 2018 [21] also used different botanicals and out of them, neem @ 0.2% showed lowest disease incidence (10.49%) and severity (9.58%) in case of virus disease.

4. Conclusion

The present study showed that whitefly population builds up started in month of July and reached to maximum in first week of September. The minimum whitefly population was observed at end of July, which approached its maximum at end of August to early September. Biorationals compounds such as neem oil, fababean seed extract, sarpagandha leaves extract and nonconventional chemical such as salicylic acid and jasmonic acid were used to study their effect on PDI, fruit yield and test weight. Amongst the treatments, salicylic acid

@150 mg/litre as seed priming and then foliar spray @ 150 mg/L recorded significantly less terminal PDI (32.75%) with maximum percent disease control (50.27%). The fruit yield (543.60 kg/ha) and test weight (35.41gm) were recorded highest in treatment salicylic acid @ 150 mg/litre as seed priming and spray @ 150 mg/litre as compared to other treatments as well as per cent increase in yield was also maximum (45.18%). This was followed by treatment sarpagandha leaves extract @10% as seed priming + spray @100 ml/L with fruit yield 523.38 kg/ha which was statistically at par to the recorded for neem oil @ 5ml/kg as seed treatment + spray @5ml/L (493.03 kg/ha). Salicylic acid spray is very helpful in managing the disease by the mechanism of SAR (Systemic Acquired Resistance).

5. Acknowledgment
The authors acknowledge the infrastructure and support of Department of Plant Pathology, CCS Haryana Agricultural University, Hisar without whom this work wouldn't have reached its completion.

6. Conflict of Interest: None.

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