Original Research Article

Epidemiology and management of MYMV disease in ~~mungbean~~Mungbean (*Vigna radiata* (L.))

ABSTRACT

Mungbean is a short-duration ancient legume crop that can be grown as a sole or intercrop for grain and green manure in all three crop seasons, including winter, summer, and rainy in various regions of the country. MYMV disease is one of the most destructive diseases transmitted by whitefly (*Bemisia tabaci*Genn) ~~in persistent manner~~persistently. Weather parameters have no direct effect on MYMV~~,~~ but affect the whitefly population. Field experiments were conducted ~~in~~ for three consecutive years from 2019-2021 ~~as~~ to know the effect of weather parameters on the whitefly population. Development of whitefly population and MYMV disease severity were recorded in mungbean ~~crop~~ cropsat 7 days ~~interval~~ intervals~~started~~ startingfrom 20days after sowing (DAS). The present study showed that the whitefly population builds up starting in July and reached ~~to~~ a maximum at end of August to early September. There are various factors influencing the build-up of the whitefly population *viz.*, maximum temperature 36±2°C, minimum temperature 25±2°C, morning relative humidity more than 90 ~~per cent~~percent, more sunshine hours, and no rainfall prevailing during that period. Whitefly population had a positive significant correlation with maximum temperature and bright sunshine hours while evening relative humidity and rainfall were recorded as negatively significant. Three-year data is very helpful in guiding the farmers for timely and preventive sprays based on existing ~~infection~~ infectionsand the population of whitefly in a season.

Keywords: Persistent manner, MYMV Disease, *Bemisia tabaci*, bright sunshine hours, whitefly, and preventive spray.

1. INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) is a very ancient annual crop originated that in India or the Indo- Burmese region, which is commonly known as ~~greengram~~green gram, green bean, moong, mash bean, golden gram, and green soy. Mungbean (*Fabaceae*) is well suited ~~for~~for a large number of cropping systems. More than 90% of the world's mungbean production comes from Asia (Karthikeyan *et al.,* 2015). Mungbean is a ~~short duration~~short-duration legume crop, which can be grown in varying environmental conditions, such as in all three crop seasons viz., kharif, summer, and rabi in different parts of the country, as sole or intercrop for grain and green manure (Dharajiya *et al.,* 2018).The global mungbean area is about. 7.3 million ha with a global output of about 5.3 million tones. The average grain yields (0.73 t/ha) of mungbean are quite low in India. India is the world's largest producer of mungbean cultivated over an area of 3.44 million ha with a production of 1.4 million tones and productivity of 406.98 kg/ha in India. (http://agropedia.iitk.ac.in).

The standard yield of mungbean worldwide is very low (730 kg/ha) and the main reasons are various diseases of mungbean.Out of all diseases ~~of~~ MYMV disease is one of the most prevalent and destructive diseases (Sudha *et al.,* 2013). The most vulnerable stage is from 30 to 45 days of sowing (Sudha *et al.,*2013). MYMV a member of the *Geminiviridae* family, belong to the 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 a persistent manner (Iqbal*et al.,*2011). Mungbean plants are infected at the seeding stage, so it can lead to an 85-100% loss in yield (Sudha *et al.,* 2013). MYMV disease can be recognized by its typical symptoms which start appearing on the young leaves of the plant at a vegetative stage in form of mild yellow spots (John *et al.,* 2015). Gradually, spread all over the upper leaves, which turn ~~to~~ yellow and ultimately, ~~reduces~~ reduceplant size, number of flowers, and pods (Brown *et al.*,1991). Affected plants generate fewer flowers and pods, which also develop mottling and remain small and contain fewer, smaller and shrunken seeds (Patel *et al.*, 2018).

Plant disease emergences have dramatically increased recently as a result of global changes, especially ~~with to respect to~~concerning trade, host genetic uniformity, and climate change (Willocquet *et al.*, 2020).~~Mungbean~~ The mungbeanyellow mosaic virus (MYMV) is prevalent in the major ~~mungbean growing~~mungbean-growing areas in India. A severe outbreak of MYMV in the southern and northern states of India is currently causing serious concern to mungbean growers and ~~to~~ the industrialist in these regions. The most ~~vulnerable.stage~~vulnerable. The stage is from 30 to 45 days (Sudha *et al.*, 2013).In past, different varieties had responded differently ~~to~~. MYMV disease in the field under different ~~temperature~~temperatures, relative humidity, sunshine hours, wind speed, and rainfall. ~~Many weather drive~~Many weather-drivenn epidemiological models have been developed and used to predict plant disease epidemics under variable ~~climate~~ climates(Datta *et al.*, 2010). The present investigation was conducted ~~in order to~~toform ~~a~~an epidemiological model which may direct the farmers toward early and preventive spraying based on the level of disease incidence and whitefly population during the season.

2. MATERIALS AND METHODS:

The present investigation was conducted in the Research Area, Department of Plant Pathology, CCS Haryana Agricultural University, Hisar during ~~kharif~~Kharif2019-2022. CCS Haryana Agricultural University is situated in the semi-arid climate at 29° 17’ N latitude and. 75° 47’E longitude at an altitude of 215.2 meters above mean sea level in the subtropical climatic zone of India.The mean weekly values of all the weather parameters during the crop-growing season were recorded at the Meteorological Observatory of the Research Farm, CCS Haryana Agricultural University, Haryana, India.

To understand the whitefly population and incidence of MYMV disease, a field experiment was conducted to know the effects of various weather factors on the whitefly population and disease severity for three consecutive years. The correlation analysiswas performed among disease severity, whitefly population and weather parameters. Mungbean cultivars MH 421 as resistant, TMB 37 as moderately resistant and. SML 1082 as susceptible ~~were~~ wasgrown in a randomized block design (RBD) during kharif seasons (2019-2021) in plots. In India, Kharif season lies from May to September.

Disease severity

The disease severity was recorded at 7 days interval ~~started~~ startingfrom 20 DAS (Days after sowing) by using the 0-6 scale in Table 1 (Ali *et al.*, 2005). Percent disease index (PDI) was calculated by using the method of McKinney, 1923. ~~Correlatio~~The correlationn ~~n~~ was ~~analysed~~analyzed between PDI with the different weather parameters.

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

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

~~Mangement~~Management through biorationals and chemicals approaches:

Treatment details:

T_1: Malathion 50 EC @ 450ml/ acre

T_2: Dimethoate EC @ 250ml/ acre

T_3: Neem oil @ 5ml/kg as seed treatment + spray @5ml/L

T_4: Salicylic acid @ 150 mg/litre as seed treatment + spray

T_5:Sarpagandha leaves extract @10% as seed priming + spray @1ooml/L

T_7: Faba bean seed extract @ 10 % as seed priming + spray @100ml/L

3. RESULTS:

A. Whitefly population at weekly interval:

Whitefly population build up on all threecultivars was higher during August as compared to rest of months. It was recorded that in early stages of cropgrowth whitefly population was less and build-upstared with advances in crop growth. Whitefly population was observed first during the monthof July (initial crop growth stages). Thereafter, the whitefly population increased, exceptduring rainfall and high wind speed periods. Whitefly populationwas ranged between 1.5-8 adults/leaf/plant with an average of 4 adults/leaf/plant onmungbean (Table 2, 3 and 4). The whitefly populationincreased up to 45 DAS that might be due to increase in maximum temperature, sunshine hours and decrease in wind speed. The whitefly populationbuilds up started in August. Maximum average whitefly population wasrecorded (8.42) on SML 1082 followed by TMB 37 (7.19) and minimum (5.08) was recorded on MH 421 at 36.4^{0}C, no rainfall (0.00 mm), minimum relativehumidity (53%) and maximum bright sunshine (7.9h) during *kharif* 2019. Among the three cultivarsmaximum average population was recorded on SML 1082 during the course ofdisease development in all the three season.

Whitefly population on all three cultivars exhibited positive significant correlation with bright sunshine hours. SML 1082 exhibited positive significant correlation with bright sunshine hours (0.487) while maximum temperature (0.470) and morning relative humidity (0.417) was recorded as negatively non-significant factor (Table 5). However, evening relative humidity (0.846), wind speed (0.471) and rainfall (0.650) was negatively (non-significant) correlated, while minimumtemperature (0.470) was recorded positively non-significant with whitefly population. Almost similar correlation matrix was found in case of

TMB 37. MH 421 grown as resistant cultivar against MYMV disease also exhibited the same kind of correlation with weather parameters and whitefly population.

B. Disease severity at weekly interval

The MYMV disease occurred throughoutthe growing season of mungbean crop. The disease initiated in thefield at 20 days after sowing in the form of vein clearing of leaves on 2 to 3 young leavesfollowed by yellowingof leaves. The higher terminal PDI was observedon SML 1082 (73.32%) cultivar as compared to TMB 37 (41.66%) and MH 421 (10.55) (Table 6, 7 and 8). At the time of initiation ofdisease, the maximum temperature was 38±2^{0}C with more than 85 percent morningrelative humidity. As the crop growth advances, the PDI increase significantly. Slow progress in disease was observed in the weeks whichhad lower whitefly population due to unfavourable weather conditions, i.e. highwind speed (7.21 km/h), less bright sunshine hours (3.82 h)and less total rainfall (83.7mm). They thrive best under hot and humid conditions and the population also towers with higher temperatures. The progress in diseasewas also noticed during post rainfall periods. The maximum PDI was observed inlast week of August and first week of September. The highest PDI (73.32) was recordedon SML 1082 at 55 DAS during first week of September.

PDI on three cultivars SML 1082 exhibited positive non-significant correlation with minimum temperature, morning relative humidity and bright sunshine hours. However, maximum temperature,wind speed and rainfall werenegatively (non-significant) correlated (Table 9). The evening relative humidity is the only factor that has significant effect on PDI that is highlysignificant (negative) for all the three cultivars.

Positive relationship was foundbetween 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 inwhitefly population led to increase in MYMV disease. The incidencestarted at 20 DAS with varying whitefly populationon all three cultivars. The correlation between whiteflypopulation and MYMV PDI was found positively significant. Table 10 showing that MH 421 (0.958) was positively highly significant and SML 1082 (0.831) and TMB 37 (0.888) were found positivelysignificant which clearly indicated that vector population directlyaffected the MYMV disease on mungbean crop.

C. Management of MYMV disease in mungbean:

The result revealed that all the treatments hadsignificant effect in increased theyield aswell as test weight. Test weight of all treatments was significantly higher than the control. In all treated plots significantlylower PDI was recorded during all the periods of observations. Amongst the chemicals, Dimethoate EC recorded significantly less terminal PDI with maximum increase in yield (58.68) followed by Melathion 50 EC @ 450ml/ acre (Table 11). Faba bean seed extractas seed treatment + spray @5ml/L shows maximum percent increase in yield (54.68)followed by the use of Neem oil as seed treatment + spray @5ml/L which is at par with the use of salicylic acid as seed treatment + spray @5ml/L.

In order to guide farmers toward early and preventive spraying based on the degree of disease incidence and whitefly population throughout the season, a biorational approaches in mungbean is very helpful.

4. DISCUSSION:

For the sake of epidemiological studies temperature, relative humidity, rainfall, wind velocity and sunshine hours were considered as most important factors. The whitefly population and percent disease index (PDI) was observed throughout the growing season on three mungbean cultivars. The disease initiated at 20 DAS and maximum progress in PDI was noticed on SML 1082 followed by TMB 37 and MH 421. The highest terminal PDI (75.8%) and whitefly population (7.50) was observed on SML 1082. The maximum whitefly population and PDI were observed during last week of August and early September. This might be due to more favourable weather conditions, i.e. maximum temperature 36±2 °C and low evening relative humidity (<54%) with more sunshine hours during this period. No rainfall prevailing during that period.In previous studies, Khan*et al.*, 2018 observed maximum whitefly population at higher temperature (38^0C) and relative humidity (66%), which were congenial for prevalence of the mungbean yellow mosaic disease. Similarly, Singh & Gurah (1994) found that hot weather with little or no rainfall was conducive for multiplication of MYMV and *Bemisia tabaci*. Meti *et al.*, 2018 observed that decrease in whitefly population was mainly due to higher rainfall and lower minimum temperature, whereas increase in whitefly population was due to higher maximum temperature and no rainfall. Cooler weather and high relative humidity are detrimental to whitefly population (Sharma *et al.*, 2014) and present study is in agreement with his findings.

Both the whitefly population and PDI were found negatively significant with evening relative humidity, whereas all other factors were reported having no significant effect. Earlier, Khan *et al.*,(2012) and Ansar *et al.*, (2014) have reported negative correlation between maximum temperature and whitefly population. There was positive significant correlation between whitefly population and sunshine hours, which was also observed by Meti *et al.*, (2018). The high wind speed and more total rainfall have detrimental effect on whitefly population. In present findings, the lesser number of whiteflies were observed in the weeks, which have high wind speed and more rainfall, and a negative correlation was found with wind speed and rainfall. Similarly, Marabi *et al.*, (2017) has also recorded significant negative correlation with wind speed and rainfall. Present findings were corroborative with the findings of Ali *et al.*, (2015) and Suman *et al.*, (2016) who reported that the maximum temperature has a significant negative correlation with MYMV disease incidence and Khan *et al.*, (2018) who established negative correlation of the disease with rainfall and wind speed but there was positive correlation of MYMV disease with maximum temperature.

Management of MYMV disease by controlling its vector *Bemisia tabaci*, through use of resistance inducers and biorationals was tried. The present result revealed that suppression of MYMV disease could be achieved through use of biorational approaches and nonconventional chemicals. Dubey *et al.,* (2011) observed that application of neem seed kernel extract and foliar spray of neem oil is effective. Reang *et al.,* 2018 also used different botanicals and out of them, neem @ 0.2% showed lowest disease incidence (10.49%) and severity (9.58%) in the case of virus disease.

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Studies conducted in tropical agricultural areas of Latin America such as Venezuela (Olivares et al. 2018; Hernandez et al. 2018; Orlando et al. 2018) and Panama have shown that MYMV disease is also a major constraint to mungbean production in these regions (Montenegro et al. 2021a; 2021b; Bertorelli and Olivares, 2020;Olivares and Hernández, 2019). The disease is transmitted by the same vector, Bemisia tabaci, and causes similar symptoms in infected plants as in India.

In Venezuela, MYMV disease has been reported to cause yield losses ranging from 20% to 80%, depending on the severity of the infection (Demey et al. 2016). The disease is more prevalent during the rainy season (May to October) (Rey et al. 2019; Parra et al. 2012; Cortez et al. 2018), and the whitefly population is high (Hernandez et al. 2017; Hernandez et al. 2020). Management of MYMV disease in Venezuela involves the use of similar strategies as in India, such as cultural practices, chemical control, and host resistance (Guevara et al. 2012; Olivares, 2017).

In Panama, MYMV disease is also a major constraint to mungbean production, especially in the central and western regions of the country (the disease is more prevalent during the dry season (December to April) (Pitti et al. 2021), and the whitefly population is low. Management of MYMV disease in Panama involves the use of similar strategies as in India

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and Venezuela, but the focus is on host resistance.

MYMV disease is a major viral disease that affects mungbean production in India and other tropical regions around the world, including Latin America. Management of MYMV disease in these regions involves the use of several strategies such as cultural practices, chemical control, and host resistance. Host resistance is considered the most effective and sustainable approach for managing MYMV disease in mungbean.

5. CONCLUSION: ~~Whitefly~~ The whiteflypopulation builds ~~up~~ started in ~~month of July and reached to maximum at~~July and reached maximum at the end of August to early September. There ~~are~~ isvarious reason for the build-up of whitefly population *viz.*, maximum temperature 36±2°C, minimum temperature 25±2°C, morning relative humidity more than 90 percent, more sunshine hours, and no rainfall prevailing during that period. For the management of MYMV disease biorationals were used and amongst all Faba bean seed extract @ 150 mg/~~litre~~ literas seed priming and then foliar spray @ 150 mg/L recorded significantly less terminal PDI with maximum percent disease control (54.68%).

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

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%

Table 2: Effect of weather parameters on whitefly population on three cultivars of mungbean during *kharif* 2019

Time of observation	Whitefly population/ leaf			Temperature (ºC)		Relative Humidity (%)		Average wind velocity (km/h)	Bright sunshine hours (h)	Total Rainfall (mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	7.21	3.81	23.3
25-07-2020	1.443	2.083	2.593	38.6	24.2	89	74	5.02	4.4	83.7
1-08-2020	1.140	1.570	2.083	35.4	20	89	72	7.5	7.1	1.1
8-08-2020	2.217	3.891	4.590	36.6	26	83	63	4.97	3.2	14.4
15-08-2020	3.797	6.007	6.897	34.4	23.2	91	68	5.18	7.9	0.0
22-08-2020	5.087	7.197	8.420	36.4	25	83	54	4.7	6.2	27.7
29-08-2020	4.830	5.817	6.900	33.5	25.5	85	57			
CD (P=0.05)	1.117	1.029	0.704							
SE±	0.35	0.32	0.22							

Table 3: Effect of weather parameters on whitefly population on three cultivars of mungbean during *kharif* 2020

Time of observation	Whitefly population/ leaf			Temperature (ºC)		Relative Humidity (%)		Average wind velocity (km/h)	Bright sunshine hours (h)	Total Rainfall (mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	6.7	8.0	38.4
16-07-2020	0.00	0.00	0.00	36.0	26.5	89	64	8.7	5.7	111.1
23-07-2020	1.21	3.17	3.32	34.6	25.9	92	75	4.8	7.3	14.7
30-07-2020	3.43	3.48	4.53	34.5	26.8	87	60	5.9	6.6	0.0
06-08-2020	3.76	3.46	4.82	36.4	27.0	84	66	6.9	6.6	32.8
13-08-2020	4.84	4.53	5.67	35.3	27.5	88	62	6.5	6.7	17.5
20-08-2020	5.13	5.34	6.12	35.3	26.9	90	77	7.7	6.4	11.7
27-08-2020	5.28	5.67	6.28	32.6	25.4	91	76	7.5	6.8	0.0
3-09-2020	5.89	5.91	7.50	33.9	25.6	90	64			

Table 4: Effect of weather parameters on whitefly population on three cultivars of mungbean during *kharif* 2021

Time of observation	Whitefly population/ leaf			Temperature (ºC)		Relative Humidity (%)		Average wind velocity (km/h)	Bright sunshine hours (h)	Total Rainfall (mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	6.7	8.0	38.4
22-07-2020	0.00	0.00	0.00	26.9	35.9	63	86	4.8	8.2	9.0
29-07-2020	1.24	3.34	3.76	27.4	33.7	76	92	8.4	5.9	56.0
5-08-2020	3.78	3.87	4.53	26.5	31.9	79	94	7.6	6.9	149.9

12-08-2020	4.21	4.21	5.22	26.6	35.6	58	88	4.7	7.2	0.0
19-08-2020	4.99	4.78	5.78	26.3	37.1	54	80	4.9	8.4	0.0
26-08-2020	5.65	5.78	6.58	26.7	34.7	69	86	5.9	3.6	0.5
2-09-2022	5.67	6.21	7.32	25.9	35.9	65	88	7.8	5.8	15.7
9-09-2022	5.93	6.43	5.48	25.8	32.7	75	95	6.9	7.4	100.2

Table 5: Correlation matrix of weatherparameters and whitefly population on different varieties ofmungbean during kharif 2019

S. No	Variety	Temperature (°C)		Relative humidity (%)		Wind speed (km/h)	Sunshine hours (h)	Rainfall (mm)
		Maximum	Minimum	Morning	Evening			
1	MH421	-0.477^{NS}	0.507^{NS}	-0.450^{NS}	-0.884^{*}	-0.549^{NS}	0.525^{S}	-0.548^{NS}
2	TMB37	-0.469^{NS}	0.535^{NS}	-0.393^{NS}	-0.827^{*}	-0.462^{NS}	0.462^{S}	-0.661^{NS}
3	SML1082	-0.470^{NS}	0.539^{NS}	-0.417^{NS}	-0.846^{*}	-0.471^{NS}	0.487^{S}	-0.650^{NS}

NS = Non significant, * = Significant

Table 6: Effect of weather parameters on percent disease index (PDI) on three cultivars of mungbean during *kharif* 2019

Time of observation	Percentage disease index (PDI)			Temperature (°C)		Relative Humidity (%)		Average wind velocity (km/h)	Bright sunshine hours (h)	Total Rainfall (mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	7.21	3.81	23.3
25-07-2020	1.66	6.10	20.02	38.6	24.2	89	74	5.02	4.4	83.7
1-08-2020	1.98	8.88	33.33	35.4	20	89	72	7.5	7.1	1.1
8-08-2020	4.21	17.73	42.77	36.6	26	83	63	4.97	3.2	14.4

15-08-2020	6.11	26.10	49.44	34.4	23.2	91	68	5.18	7.9	0.0
22-08-2020	8.33	32.77	57.77	36.4	25	83	54	4.7	6.2	27.7
29-08-2020	10.55	41.66	73.32	33.5	25.5	85	57			
CD (P=0.05)	3.95	5.57	8.93							
SE±	(1.23)	(1.74)	(2.80)							

- M: Morning Relative Humidity, E: Evening Relative Humidity

Table 7: Effect of weather parameters on percent disease index (PDI) on three cultivars of mungbean during *kharif* 2020

Time of observation	Percentage disease index (PDI)			Temperature (ºC)		Relative Humidity (%)		Average wind velocity (km/h)	Bright sunshine hours (h)	Total Rainfall (mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	6.7	8.0	38.4
16-07-2020	0	0	0	36.0	26.5	89	64	8.7	5.7	111.1
23-07-2020	0	0	2.14	34.6	25.9	92	75	4.8	7.3	14.7
30-07-2020	5.83	4.17	6.7	34.5	26.8	87	60	5.9	6.6	0.0
06-08-2020	6.67	9.17	13.3	36.4	27.0	84	66	6.9	6.6	32.8
13-08-2020	9.17	16.67	26.7	35.3	27.5	88	62	6.5	6.7	17.5
20-08-2020	13.33	22.50	50.0	35.3	26.9	90	77	7.7	6.4	11.7
27-08-2020	15.00	26.67	70.8	32.6	25.4	91	76	7.5	6.8	0.0
3-09-2020	18.33	29.17	75.8	33.9	25.6	90	64			

- M: Morning Relative Humidity, E: Evening Relative Humidity

Table 8: Effect of weather parameters on percent disease index (PDI) on three cultivars of mungbean during *kharif* 2021

Time of observation	Percentage disease index (PDI)	Temperature (ºC)	Relative Humidity	Average wind	Bright sunshine	Total Rainfall

						(%)		velocity (km/h)	hours (h)	(mm)
	MH 421	TMB 37	SML 1082	Max.	Min.	M	E	6.7	8.0	38.4
22-07-2020	0	0	2.88	26.9	35.9	63	86	4.8	8.2	9.0
29-07-2020	0	4.15	5.77	27.4	33.7	76	92	8.4	5.9	56.0
5-08-2020	4.72	9.57	7.88	26.5	31.9	79	94	7.6	6.9	149.9
12-08-2020	5.87	12.45	15.66	26.6	35.6	58	88	4.7	7.2	0.0
19-08-2020	10.12	19.64	36.99	26.3	37.1	54	80	4.9	8.4	0.0
26-08-2020	14.77	24.58	48.97	26.7	34.7	69	86	5.9	3.6	0.5
2-09-2022	17.88	28.69	67.74	25.9	35.9	65	88	7.8	5.8	15.7
9-09-2022	19.66	32.19	74.89	25.8	32.7	75	95	6.9	7.4	100.2

- M: Morning Relative Humidity, E: Evening Relative Humidity

Table 9: Correlation of weather parameters and PDI on different varieties of Mungbean

S.No	Variety	Temperature (°C)		Relative humidity (%)		Wind speed	Sunshine hours	Rainfall
		Maximum	Minimum	Morning	Evening			
1	MH421	0.763*	0.533^{NS}	0.469^{NS}	-0.882^{*}	-0.575^{NS}	0.510*	-0.426^{NS}
2	TMB37	0.797*	0.612^{NS}	0.446^{NS}	-0.872^{*}	-0.591^{NS}	0.490*	-0.421^{NS}
3	SML1082	0.878*	0.436^{NS}	0.473^{NS}	-0.865^{*}	-0.622^{NS}	0.619*	-0.306^{NS}

NS = Non significant, * = Significant

Table 10: 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

Table 11: Management of MYMV disease in mungbean

Treatment No.	Treatments	Percent increase in yield	Percent increase in test weight	B:C Ratio
T1	Malathion 50 EC @ 450ml/ acre	58.68	17.98	1.96
T2	Dimethoate EC @ 250ml/ acre	52.77	16.32	1.84
T3	Neem oil @ 5ml/kg as seed treatment + spray @5ml/L	46.76	13.56	1.69
T4	Salicylic acid @ 150 mg/litre as seed treatment + spray	44.69	12.87	1.56
T5	Sarpagandha leaves extract as seed treatment + spray @5ml/L	38.76	12.37	1.52
T6	Faba bean seed extract as seed treatment + spray @5ml/L	54.68	16.78	1.86
T7	Control	--	--	1.26