Screening of mulberry accessions for tolerance against major pests of mulberry, *Morus spp.*

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ABSTRACT

Sericulture sector is significantly hampered by the invasion of mulberry by a range of defoliators and sucking pests, which resulted in significant economical loss. With a view of identifying resistant sources of mulberry against insect pests the present study was conducted using forty mulberry germplasm accessions maintained at Department of Sericulture, Forest College and Research Institute, Mettupalayam, during 2021-2022. 13 mulberry accessions *viz.,* MI-0790, MI-0145, R-Local, MI-0615, MI-0497, MI-0174, MI-0783, MI-0065, ME-0025, MI-0252, MI-0034, MI-0675 and MI-0489 recorded significantly lowest defoliation percentage varying from 5.25 to 9.99 for leaf webber. Similarly, for pink mealy bug, shoot damage percentage from 2.95 to 8.26 were recorded in accessions, MI-0835, MI-0252, MI-0669, MI-0812, MI-0818, MI-0637, ME-0174, MI-0029, MI-0012, MI-0665, MI-0300, MI-0145, MI-0675, MI-0632, MI-0790 and ME-0025. Accessions *viz.,* MI-0310, MI-0812, MI-0013, ME-0174, MI-0665, MI-0012, MI-0024, ME-0109, MI-0669, MI-0029, MI-0790, MI-0615, R- Local and MI-0497 recorded thrips of below economic threshold level. Three germplasm accessions, *viz.,* MI-0145, ME-0025 and MI-0252 showed tolerance to both leaf webber and pink mealy bug and ME-0174 and MI-0790 showed multiple

tolerance to leaf webber, pink mealy bug and thrips. Accessions tolerant to insect pests identified in the present study can be utilized in future breeding programme to evolve pest tolerant mulberry varieties.
Keywords: Germplasm accessions, Polyphagous, Defoliators, Tolerance, Mulberry varieties.

INTRODUCTION

Mulberry (*Morus spp.*) is a perennial, deep rooted, fast growing and high biomass producing foliage plant. It is considered as the primary food for the mulberry silkworm, *Bombyx mori L*. Mulberry leaf quality is affected by biotic, abiotic and agronomic factors. As mulberry leaf is available throughout the year, it makes the plant prone to pests and diseases. 300 insect and non insect species of pests are known to occur on mulberry and cause economic yield loss. Major insect pests includes leaf webber, pink mealy bug and thrips. Heavy infestation by them lead to shortages of photosynthesis and thus severely reduce the growth potential of the plant. Govindaiah *et al.* (2005) reported the incidence of mealy bug (19.21 %), thrips (17.18 %), whitefly (12.62 %), jassids (9.08 %) and scale insects (8.24%). Geetha *et al.* (1997) reported leaf roller incidence in Karnataka during 1995 and spread to neighbouring states of Tamil Nadu, Andhra Pradesh and Kerala. Rajadurai *et al.* (1999) 12.8 *per cent* reduction in leaf yield with an average incidence of 21.77 *per cent* resulting in economic loss to sericulturists. Being seasonal in nature, infestation started with onset of monsoon and remained upto Feburary, but the maximum infestation was observed during September to November. Das *et al.* (2021) reported pest incidence at different stages of crop growth, *viz*., thrips (36.67 numbers /leaf) at 23rd week, pink mealy bug (40.50%) at 28th week and whiteflies (32.67 numbers/ leaf) at 35th week.

Mukhopadhyay *et al.,* (2011) reported that thrips caused 20-25% loss in leaf yield. Growth and development of the mulberry silkworm and subsequent cocoon production depended mainly on the nutritional composition of the mulberry leaves. Hence, it is essential to manage insect pests to prevent loss in leaf yield and quality. Ecofriendly management of insect pests is the need of the hour especially for mulberry ecosystem. Varietal resistance is one of the safer management practices. In this context, the present investigation was focused on the screening of the mulberry accessions against insect pests of mulberry, *viz.*, leaf webber, pink mealy bug and thrips.

MATERIALS AND METHODS

The experiment was conducted at Department of sericulture, Forest College and Research Institute, Mettupalayam, during 2021-2022 (Latitude 11.20^{0}N, Longitude 76.56^o N and Altitude 320 M). The mulberry accessions were planted in randomized block design (RBD) with five replications/accession. Screening for tolerance to major insect pests *viz.,* leaf webber, pink mealy bug and thrips were done for forty mulberry accessions selected from germplasm bank maintained at Department of Sericulture (Table 2). The mulberry accessions were grown in a plot size of 6x6 feet in row with a plant to plant spacing of 6 x 6 feet. All agronomical practices were followed to raise the crop

excluding plant protection measures. Data on occurrence of insect pests were collected at fortnightly intervals from the selected accessions with five plants for each pest. Direct count of all the developmental stages of the pest was done for thrips. Defoliation percentage for leaf webber determined by number of affected leaves /plant. Top five leaves of upper canopy starting from third to seventh by inverse direction was taken for recording thrips incidence. The percentage infestation for mealy bug was determined infested crumpled shoot and total shoot ratio. Mean scale index of the pests are presented below (Table 1).

Table 1: Mean scale index of recorded insect pests of mulberry.

Insect Pest	ETL
Diaphania pulverulentalis	Defoliation < 10%
Maconellicoccus hirsutus	Shoot damage < 10%
Pseudodendrothrips mori	1-2 nymphs/ adult/leaf

Leaf webber, *D. pulverulentalis*

$$\text{(i)}\quad \text{Defoliation (\%)} = \frac{\text{Number of affected leaves}}{\text{Total number of leaves}} \times 100$$

Pink mealy bug, *M. hirsutus*

$$\text{(i)}\quad \text{Shoot damage (\%)} = \frac{\text{Number of affected shoots / plant}}{\text{Total number of shoots/ plant}} \times 100$$

Thrips, *P. mori*

(i) Number of nymphs and adults on three leaves each at top, middle and bottom (Expressed as number of thrips /leaf)

Table 2. List of mulberry accessions used for the study.

S. No	Name of the accession	Species	S. No	Name of the accession	Species
1.	MI-0012	*M. indica*	21.	MI-0034	*M. alba*
2.	MI-0029	*M. indica*	22.	MI-0615	*M. indica*
3.	MI-0489	*M. indica*	23.	MI- 0024	*M. indica*
4.	MI-0675	*M. indica*	24.	MI- 0065	*M. indica*
5.	MI- 0715	*M. indica*	25.	MI-0310	*M. indica*
6.	MI- 0835	*M. indica*	26.	MI- 0355	*M. indica*
7.	ME- 0058	*M. alba*	27.	MI- 0477	*M. indica*

8.	MI-0145	*M. alba*	28.	MI- 0497	*M. indica*
9.	ME-0247	*M. alba*	29.	MI- 0573	*M. indica*
10.	MI- 0637	*M. alba*	30.	MI- 0669	*M. indica*
11.	MI- 0828	*M. alba*	31.	MI- 0790	*M. indica*
12.	MI- 0252	*M. laevigata*	32.	MI-0827	*M. indica*
13.	ME- 0071	*M. latifolia*	33.	ME-0179	*M. latifolia*
14.	ME- 0109	*M. bombycis*	34.	MI- 0632	*M. latifolia*
15.	ME- 0220	*M. macroura*	35.	MI- 0665	*M. latifolia*
16.	ME- 0006	*M. latifolia*	36.	MI- 0783	*M. latifolia*
17.	MI-0845	*M. latifolia*	37.	MI- 0817	*M. latifolia*
18.	R. local	*M. alba*	38.	ME- 0174	*M. alba*
19.	ME- 0025	*M. alba*	39.	MI- 0300	*M. alba*
20.	MI-0013	*M. indica*	40	MI-0812	*M. alba*

RESULTS AND DISCUSSION

Screening of mulberry accessions for tolerance to *D. pulverulentalis*

Mulberry accessions were screened for tolerance against leaf webber based on the defoliation percentage data. Infestation percentage ranged from 5.25 (MI-0790) to 19.98 (MI-0637) *per cent* during September to December, 2021 (Table 3). Among the forty accessions, significantly lowest defoliation percentage was observed in MI-0790 (5.25%) followed by MI-0145 (6.20 %), R-Local (6.82 %), MI-0615 (7.07 %), MI-0497 (7.50%), MI-0174 (7.62 %), MI-0783 (7.87 %), MI-0065 (8.00%), ME-0025 (8.38 %), MI-0252 (8.96 %), MI-0034 (9.15%), MI-0675 (9.54%) and MI-0489 (9.99 %). Highest leaf webber defoliation percentage was recorded in MI-0637 (19.97%) followed by MI-0818 (15.11), ME-0109 (14.63) and MI-0828 (14.19 %) (Table 3). Srinivas *et al.*, (2001) reported the peak incidence of *D. pulverulentalis* in mulberry during January with 91.25 *per cent* infestation. The leaf webber incidence (6.5 %) in mulberry was noticed by Philip and Qadri (2009) during November month. Bhagyamma and Kumari (2016) reported the incidence of leaf webber was 94.5 *per cent*, 89.5 *per cent* and 84.5 *per cent* during November, December and January respectively. Higher infestation might be due to the favorable climatic condition and good quality leaf with high moisture content. In the present study, since the *per cent* incidence was more than 70 *per cent* in all the accessions, in order to identify the resistance source, precise scoring was done by considering the *per cent* defoliation in place of *per cent* infestation.

Table 3. Screening of mulberry accessions against mulberry leaf webber, *D. pulverulentalis*

S No.	Name of the Accession	Defoliation (%)					Mean
		Crop					
		I	II	III	IV	V	

1.	MI-0012	20.83	9.72	9.17	6.08	4.80	**10.12**
2.	MI-0029	21.19	12.79	9.12	8.39	5.45	**11.38**
3.	MI-0489	15.82	10.20	10.38	7.78	5.70	**9.99**
4.	MI-0675	18.67	11.09	7.718	6.658	3.90	**9.54**
5.	MI- 0715	20.07	10.85	10.80	4.98	3.90	**10.12**
6.	MI- 0835	25.74	13.26	7.74	6.58	3.80	**11.42**
7.	ME- 0058	25.69	12.79	9.66	8.55	5.75	**12.49**
8.	MI-0145	12.43	9.15	4.21	3.82	2.00	**6.20**
9.	ME-0247	29.70	16.96	10.56	5.45	4.45	**13.42**
10.	MI- 0637	31.19	15.75	27.20	15.66	10.06	**19.97**
11.	MI- 0828	23.71	15.99	14.61	10.40	6.23	**14.19**
12.	MI- 0252	15.12	9.82	6.50	8.39	5.00	**8.96**
13.	ME- 0071	25.12	17.24	11.70	9.07	5.45	**13.71**
14.	ME- 0109	28.30	18.89	10.99	8.09	6.88	**14.63**
15.	ME- 0220	26.24	13.41	6.85	5.39	3.06	**10.99**
16.	ME- 0006	31.72	13.71	8.99	8.00	5.45	**13.57**
17.	MI-0845	21.98	13.67	10.15	8.89	5.03	**11.94**
18.	R. local	12.35	6.99	5.26	5.26	4.22	**6.82**
19.	ME- 0025	9.06	8.21	9.60	9.07	6.00	**8.38**
20.	MI-0013	13.50	9.76	8.21	9.20	9.20	**9.97**
21.	MI-0034	11.93	10.48	10.50	7.49	5.33	**9.15**
22.	MI-0615	6.42	7.35	6.38	9.12	6.07	**7.07**
23.	MI- 0024	14.56	11.56	17.42	10.45	6.80	**12.15**
24.	MI- 0065	7.86	9.33	8.43	8.89	5.50	**8.00**
25.	MI-0310	23.21	13.99	9.75	6.55	4.75	**11.65**
26.	MI- 0355	20.20	17.20	5.53	10.45	5.80	**11.83**
27.	MI- 0477	20.57	15.47	6.55	11.49	8.00	**12.41**
28.	MI- 0497	8.94	8.13	7.79	8.00	4.65	**7.50**
29.	MI- 0573	13.32	18.97	9.61	5.40	8.89	**11.23**
30.	MI- 0669	13.35	17.02	12.73	10.40	7.49	**12.20**
31.	MI- 0790	5.14	7.18	6.12	4.50	3.32	**5.25**
32.	ME-0179	13.50	13.50	10.47	8.75	6.65	**10.57**
33.	MI- 0632	10.2	16.18	13.24	9.83	6.83	**11.27**
34.	MI- 0665	11.63	15.78	11.39	8.60	3.55	**10.19**
35.	MI- 0783	9.04	9.05	9.14	7.32	4.80	**7.87**
36.	MI- 0817	12.30	17.50	14.99	10.44	6.47	**12.34**

37.	MI-0818	18.85	17.97	18.47	12.73	7.56	**15.11**
38.	ME- 0174	16.06	11.84	3.33	3.56	3.33	**7.62**
39.	MI- 0300	10.27	19.14	15.91	12.09	8.666	**13.21**
40.	MI-0812	13.56	16.71	10.66	6.59	6.77	**10.86**
	S.Ed	3.057	2.374	2.060	0.894	0.877	**2.319**
	CD (=0.05)	6.040	4.686	4.070	1.767	1.733	**4.585**

Screening of mulberry accessions for tolerance to *M. hirsutus*

Screening of mulberry accessions for tolerance against pink mealy bug was done based on shoot damage percentage. The data were recorded for five crops and it ranged from 2.95 (MI-0835) to 25.96 (MI-0783) *per cent* (Table 4). Among the 40 accessions screened significantly lowest shoot damage percentage was recorded in MI-0832 (2.95 %) followed by MI-0252 (3.50%), MI-0669 (4.28 %), MI-0812 (5.18 %), MI-0818 (5.40 %), MI-0637 (5.49 %), ME-0174 (5.63%), MI-0029 (5.86 %), MI-0012 (6.05%), MI-0665 (6.89 %), MI-0300 (7.00 %), MI-0145 (7.37%), MI-0675 (8.02 %), MI-0632 (8.18 %), MI-0790 (8.23%) and ME-0025 (8.26%) while highest pink mealy bug shoot damage percentage was recorded in MI- 0783 (25.96%), R-Local (20.40%) and MI- 0024 (18.40%). Prabhakar *et al.,* (2015) screened mulberry germplasm for pink mealy bug and reported that the incidence ranged from 3.67 to 26.18 *per cent*. Hendawy *et al.,* (2022) reported that the mealy bug population in mulberry raised during June to September with the peak incidence during second fortnight of June. Sakthivel *et al.,* (2019) reported that the pink mealy bug high incidence was during summer season and almost negligible during rainy season.

Table 4. Screening of mulberry accessions against pink mealy bug, *M. hirsutus*

S No.	Name of the Accession	Shoot damage (%)					Mean
		Crop					
		I	II	III	IV	V	
1.	MI-0012	1.33	4.48	6.57	8.84	9.03	**6.05**
2.	MI-0029	1.33	3.90	5.65	9.30	9.14	**5.86**
3.	MI-0489	5.01	11.85	13.61	13.31	13.85	**11.53**
4.	MI-0675	4.35	11.25	7.93	8.29	8.29	**8.02**
5.	MI- 0715	4.56	11.12	12.47	14.88	13.32	**11.27**
6.	MI- 0835	0.00	2.00	3.33	4.01	5.41	**2.95**
7.	ME- 0058	5.55	12.52	17.90	19.88	17.88	**14.74**
8.	MI-0145	3.32	8.17	7.61	8.98	8.79	**7.37**
9.	ME-0247	5.66	14.93	13.26	14.24	14.96	**12.61**
10.	MI- 0637	2.90	5.68	5.08	6.80	6.98	**5.49**

11.	MI- 0828	3.88	9.44	8.61	11.86	12.62	**9.28**
12.	MI- 0252	0.00	0.00	4.81	6.03	6.65	**3.50**
13.	ME- 0071	3.33	9.77	13.88	15.86	15.84	**11.74**
14.	ME- 0109	5.88	14.89	15.78	18.66	18.60	**14.76**
15.	ME- 0220	3.22	8.32	9.67	14.56	14.30	**10.01**
16.	ME- 0006	4.26	10.47	10.89	17.89	17.83	**12.27**
17.	MI-0845	4.25	7.68	9.60	15.55	15.92	**10.60**
18.	R. local	5.24	21.53	24.22	26.19	24.84	**20.40**
19.	ME- 0025	0.00	3.80	8.56	14.37	14.58	**8.26**
20.	MI-0013	3.81	9.40	11.52	14.06	13.72	**10.50**
21.	MI-0034	6.24	9.67	15.89	20.74	19.94	**14.50**
22.	MI-0615	8.47	14.31	18.25	11.88	11.88	**12.96**
23.	MI- 0024	7.57	14.79	19.21	25.84	24.61	**18.40**
24.	MI- 0065	7.20	17.54	20.56	22.92	21.07	**17.86**
25.	MI-0310	3.63	9.00	20.25	12.54	12.02	**11.49**
26.	MI- 0355	4.55	10.33	11.56	12.11	12.89	**10.28**
27.	MI- 0477	0.00	4.67	3.84	31.36	29.23	**13.82**
28.	MI- 0497	5.33	8.79	21.40	23.40	23.80	**16.54**
29.	MI- 0573	6.00	10.23	10.89	11.45	12.77	**10.26**
30.	MI- 0669	0.00	0.00	5.10	8.15	8.15	**4.28**
31.	MI- 0790	2.76	7.40	9.36	10.83	10.83	**8.23**
32.	ME-0179	6.33	8.88	17.55	18.34	19.67	**14.15**
33.	MI- 0632	3.03	7.63	10.91	9.77	9.60	**8.18**
34.	MI- 0665	0.00	4.16	11.14	9.60	9.60	**6.89**
35.	MI- 0783	6.86	15.73	33.22	37.28	36.71	**25.96**
36.	MI- 0817	8.22	13.99	8.99	16.80	16.80	**12.96**
37.	MI-0818	0.00	2.80	6.41	8.90	8.90	**5.40**
38.	ME- 0174	0.00	1.66	5.58	10.25	10.65	**5.63**
39.	MI- 0300	1.33	4.00	9.50	10.53	9.67	**7.00**
40.	MI-0812	2.22	2.40	4.27	8.38	8.64	**5.18**
	S.Ed	3.226	9.95	12.60	15.85	16.64	**4.259**
	CD (=0.05)	N/A	5.03	6.37	8.01	7.91	**2.154**

Screening of mulberry accessions for tolerance to *P. mori*

The thrips population in forty mulberry accessions ranged from 0.32 to

1.82 thrips /leaf. (Table 5). Among the accessions, significantly lowest population of thrips was observed in MI-0310 (0.32 thrips /leaf) followed by MI-0812 (0.64 thrips /leaf), MI-0013 (0.68 thrips /leaf), ME-0174 (0.76 thrips /leaf), MI-0665 (0.80 thrips /leaf), MI-0012 (0.82 thrips /leaf), MI-0024 (0.82 thrips /leaf), ME-0109 (0.84 thrips /leaf), MI-0669 (0.84 thrips /leaf), MI-0029 (0.85 thrips /leaf), MI-0790 (0.88 thrips /leaf), MI-0615 (0.90 thrips /leaf), R-Local (0.92 thrips /leaf) and MI-0497 (0.94 thrips /leaf). Highest density of thrips population was recorded from MI- 0477 (1.82 thrips /leaf) ME- 0006 (1.62 thrips /leaf) and MI-0675 (1.49 thrips /leaf). Prabhakar *et al.,* (2015) reported that the incidence of thrips was higher (11.25 %) in pre-monsoon compared to others seasons (monsoon, 3.75 % and post monsoon 3.00 %). Totally, thirty eight mulberry genotypes showed thrips infestation in pre-monsoon season. Baidya and Chatterjee (2020) reported that the highest population was recorded on 2nd week of November (7.94 no. of insects/leaves). Das *et al.,* (2021) reported that maximum incidence was observed during third week of May to second week of June (30.70 to 36.67 / leaf)

Table 5. Screening of mulberry accessions for tolerance against *P. mori*

S No.	Name of the Accession	No. of nymphs/adults/leaf					Mean
		Crop					
		I	II	III	IV	V	
1	MI-0012	2.10	1.00	0.80	0.20	0.00	**0.82**
2	MI-0029	1.40	1.00	0.77	0.65	0.45	**0.85**
3	MI-0489	2.01	1.25	0.80	0.50	0.20	**0.95**
4	MI-0675	3.40	2.20	1.00	0.65	0.20	**1.49**
5	MI- 0715	1.80	1.80	1.40	1.00	0.80	**1.36**
6	MI- 0835	2.20	1.60	0.80	0.80	0.20	**1.12**
7	ME- 0058	2.40	1.20	1.20	0.40	0.20	**1.08**
8	MI-0145	3.20	1.00	1.60	0.80	0.20	**1.36**
9	ME-0247	2.17	1.60	0.80	0.20	0.20	**0.99**
10	MI- 0637	2.20	1.80	1.40	0.60	0.00	**1.20**
11	MI- 0828	2.00	1.80	0.75	0.40	0.20	**1.03**
12	MI- 0252	2.90	1.00	0.60	0.20	0.20	**0.98**
13	ME- 0071	2.50	1.60	1.80	0.40	0.20	**1.30**
14	ME- 0109	2.00	1.00	1.00	0.20	0.00	**0.84**
15	ME- 0220	2.00	1.80	0.80	0.60	0.40	**1.12**
16	ME- 0006	3.50	2.50	1.00	0.70	0.40	**1.62**
17	MI-0845	2.80	2.01	1.50	0.80	0.30	**1.48**
18	R. local	2.00	1.00	1.00	0.40	0.20	**0.92**
19	ME- 0025	1.80	1.20	1.80	1.20	0.80	**1.36**

20	MI-0013	1.00	0.80	1.00	0.60	0.00	**0.68**
21	MI-0034	1.80	1.00	1.00	0.80	0.20	**0.96**
22	MI-0615	1.90	0.80	1.00	0.80	0.00	**0.90**
23	MI- 0024	1.50	1.00	0.80	0.50	0.30	**0.82**
24	MI- 0065	2.00	1.00	1.00	0.80	0.20	**1.00**
25	MI-0310	0.80	0.80	0.00	0.00	0.00	**0.32**
26	MI- 0355	0.00	0.60	0.60	0.00	0.00	**0.24**
27	MI- 0477	2.80	2.50	2.00	1.00	0.80	**1.82**
28	MI- 0497	2.50	1.20	0.80	0.20	0.00	**0.94**
29	MI- 0573	0.00	0.20	0.00	0.00	0.00	**0.40**
30	MI- 0669	2.00	1.00	0.80	0.40	0.00	**0.84**
31	MI- 0790	2.00	1.00	0.80	0.40	0.23	**0.88**
32	ME-0179	0.60	0.40	0.00	0.00	0.00	**0.20**
33	MI- 0632	2.80	1.80	1.00	1.00	0.80	**1.48**
34	MI- 0665	2.00	1.00	0.60	0.40	0.00	**0.80**
35	MI- 0783	2.50	1.00	1.00	0.80	0.60	**1.18**
36	MI- 0817	2.00	1.00	1.00	0.80	0.20	**1.00**
37	MI-0818	2.30	1.00	1.00	1.00	0.00	**1.06**
38	ME- 0174	1.80	1.20	0.60	0.20	0.00	**0.76**
39	MI- 0300	2.00	1.00	1.00	0.80	0.40	**1.04**
40	MI-0812	1.80	0.90	0.40	0.10	0.00	**0.64**
	S.Ed	0.063	0.215	0.198	0.209	0.196	**0.226**
	CD (=0.05)	0.178	0.304	0.407	0.433	0.397	**0.448**

CONCLUSION

Pest infestation in mulberry resulted in deterioration of leaf quality through depletion of nutrients in addition to reduction in leaf yield. The varied nutritive status of the mulberry leaves influenced the growth and development of silkworm in turn affecting silk production. It is necessary to adopt proper crop protection practices at the right time during the mulberry crop production to overcome the loss due to feeding by insects. Among the several management approaches, varietal resistance has good advantage in terms of its ecofriendly nature to the environment and compatibility with the natural enemies of insect pests. The mulberry accessions MI-0145, ME-0025 and MI-0252 were found to be tolerant to both leaf webber and pink mealy bug. ME-0174 and MI-0790 were tolerant to leaf webber, pink mealy bug and thrips. Hence, the mulberry accessions identified for tolerance to Leaf webber, Pink mealy bug and Thrips can be further utilized for mulberry crop improvement programme.

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