Int. J. Indust. Entomol. Vol. 12, No. 1, 2006, pp. 35~39

[Note]

International Journal of *Industrial Entomology*

Screening of Some Indigenous and Exotic Mulberry Varieties against Major Foliar Fungal and Bacterial Diseases

M. D. Maji*, H. Sau, B. K. Das and S. Raje Urs[1]

Central Sericultural Research and Training Institute, Berhampore - 742101, India.
[1]Seribiotech Research Laboratory, Kodathi, Bangalore - 560 035, India.

(Received 7 October 2005; Accepted 22 January 2006)

Fifty-six indigenous and twenty nine exotic mulberry varieties were screened against powdery mildew, *Myrothecium* leaf spot, *Pseudocercospora* leaf spot, sooty mold and bacterial leaf spot for a period of three years under field condition. The percent disease index (PDI) was recorded during peak season of the foliar diseases. Out of eighty-five varieties studied, ten varieties were highly resistant and eight were resistant to powdery mildew; six varieties were immune and seventy-eight varieties were highly resistant to *Myrothecium* leaf spot; sixty varieties were highly resistant and 21 were resistant to *Pseudocercospora* leaf spot; forty four varieties were highly resistant to sooty mold and two varieties were immune and fifty-eight were highly resistant to bacterial leaf spot. Lowest cumulatative disease index was observed in *M. multicaulis* (7.28) followed by Thailand lobed (7.85) and Italian mulberry (8.06).

Key words: *Morus* spp., Resistance, Susceptible, Powdery mildew, *Myrothecium* leaf spot, *Pseudocercospora* leaf spot, Sooty mold, Bacterial leaf spot

Introduction

Mulberry (*Morus* sp.) is a fast growing perennial tree. It is cultivated as bush, middle bush and tree for its valued leaf for silkworm (*Bombyx mori* L.) rearing. Mulberry is affected by several pathogenic diseases caused by fungi, bacteria, mycoplasma and virus (Yokoyama, 1962; Rangaswami *et al.*, 1978; Sengupta *et al.*, 1990; Yashihiko, 1995). Diseases affect leaf yield (Sikdar and Krishnaswami, 1980, Sengupta *et al.*, 1990) and reduce nutritive value (Chanturia, 1968; Umesh Kumar, 1991). Feeding of diseased leaves prolongs larval period and reduces cocoon yield (Noamani *et al.*, 1970; Umesh Kumar *et al.*, 1993). Foliar diseases, *viz.*, powdery mildew [*Phyllactinia corylea* (Pers) Karst.], *Myrothecium* leaf spot [*Myrothecium roridum* Tode Ex. Fr], *Pseudocercospora* leaf spot [*Pseudocercospora mori* (Hara) Deighton], bacterial leaf spot [*Xanthomonas campestris* pv. *mori* Maji, Qadri and Pal] and sooty mold (Ascomycetes and Deuteromycetes fungi) are important foliar diseases in the Eastern and North Eastern part of India (Maji, 2002, 2003a). Chemical, botanical and biological control against the foliar diseases has been developed (Biswas *et al.*, 1993; Chattopadhyay *et al.*, 2003;Gangwar *et al.*, 2000; Maji *et al.*, 2000, 2003a, b; Pratheesh Kumar *et al.*, 2004). Chemical control has some limitations as the cost for chemical control is high, residual toxicity to silkworm, and hazardous to environment. Repeated use of fungicide/ antibiotics leads to evolve resistant pathogen. Moreover, the purchase of chemicals for crop protection called for some extra economic burden to poor and marginal farmers generally practice sericulture. By far, the best method for control of plant diseases is to raise plants having capacity to remain disease free in presence of pathogens (Pelczar *et al.*, 1977). Plantation of disease resistant mulberry variety is advantageous to farmers, because mulberry is propagate by stem cuttings and once planted, its active growth phase remains for fifteen years. Pelczar *et al.* (1977) opined that wild species which under natural selection are capable of resisting many, perhaps most, infections that occur in nature. Central Sericulture Research and Training Institute, Berhampore - a premier sericultural research organization in the Eastern and North Eastern region of India has rich exotic and indigenous germplasm resources. The present investigation was conducted to screen disease

*To whom correspondence should be addressed.
Mulberry Pathology Laboratory, C. S. R & T.I, Berhampore-742101, West Bengal, India. Tel: 091-3482-53962, Fax: 091-3482-51046, E-mail: mdmaji2000@yahoo.co.in

resistant mulberry varieties for future disease resistance breeding programme.

Materials and Methods

Six month old mulberry saplings of fifty-six indigenous and twenty nine exotic mulberry varieties were planted in micro plot (10' × 10') with 2' × 2' spacing at Central Sericultural Research and Training Institute Berhampore, West Bengal, India [latitude 24° 6'N, longitude 88° 15'E, tropical monsoon climate and altitude 19 m above MSL]. For maintenance of plantation, decomposed farm yard manure was applied at the rate 20 MT/ha/yr during July. Chemical fertilizers, nitrogen, phosphorus and potash were applied at the rate 336:180:112 kg/ha/yr 20 – 25 days after pruning. Nitrogen was applied in five equal split dose during March, May, July, September and December and phosphate and potash in 2 split doses during July and December. Plants were pruned five times during 4th week of February, April, July, September and November. Plantation was irrigated at 20 days interval from November to May.

Powdery mildew, *Myrothecium* leaf spot, *Pseudocercospora* leaf spot, bacterial leaf spot and sooty mold severity were recorded sixty day after pruning during July, September and November for three years. Disease data was recorded by randomly selecting five plants in each variety. In each plant, foliar disease severity was assessed from three randomly selected branches using a 0 – 5 visual rating scale (Maji *et al.*, 2000). In this scale, 0 – healthy leaf, 1 = 1 – 5% leaf area infected, 2 = 6 – 10% leaf area infected, 3 = 11 – 25% leaf area infected, 4 = 26 – 50% leaf area infected, 5 = 51% and above leaf area infected. Percent of disease index (PDI) was calculated according to F. A. O. (1967) formula.

$$\text{Percent disease index} = \frac{\text{Sum of all numerical rating}}{\text{Total no. of leaves counted} \times \text{Maximum grade}} \times 100$$

Mulberry varieties were categorized considering disease severity as 0 = Immune, 0.01 – 5% highly resistant; 5.01 – 10%; resistant; 10.01 – 25% moderately resistant, 25.01 – 50% susceptible; 50.01 – 100% highly susceptible.

Results

Percent disease index (PDI) and cumulatative disease severity (CDI) of eighty five mulberry varieties to powdery mildew, *Myrothecium* leaf spot, *Pseudocercospora* leaf spot, sooty mold and bacterial leaf spot presented in Table 1.

Among the eighty-five varieties screened, ten varieties were highly resistant with less than 5% disease severity, 8 varieties were resistant, 49 varieties were moderately resistant and 18 varieties were susceptible to powdery mildew. Lowest disease index was observed in Thailand lobed (0.22 PDI) followed by M. multicaulis (2.14 PDI). Highest disease severity was observed in Kolitha-3 (33.71 PDI).

Seven varieties *viz.*, Bush Malda-B, Koliakuthai, Calebrasa, Sujanpur, Berhampore-20, Jatinuni, Tollygangue were found immune to Myrothecium leaf spot and seventy-eight varieties disease severity was less than 5%.

Sixty varieties were highly resistant, 21 varieties were resistant and four varieties were moderately resistant to *Pseudocercospora* leaf spot. Lowest disease index was observed in Rotundiloba (0.08 PDI) followed by Thailand lobed (0.14 PDI). Highest disease severity was recorded in Bush Malda - A (13.35 PDI).

Forty-four varieties were highly resistant, 34 varieties resistant and seven were moderately resistant to the sooty mold. Lowest sooty mold severity was observed in *M. indica* black (1.22 PDI) and highest in S_1 variety (18.73 PDI).

Two varieties *viz.*, M. multicaulis and China White were immune to the disease. Fifty-eight varieties were highly resistant, 19 resistant and 6 moderately resistant to the disease. Highest disease severity was observed in KPG-1 (13.22 PDI).

Among the varieties lowest CDI observed in *M. multicaulis* (7.28) followed by Thailand lobed (7.85), Italian (8.06), Australia (10.86). Highest CDI observed on Nagaland local (50.18) and Kolitha-7 (48.91).

Discussion

The occurrence of foliar diseases is one of the limiting factors of production for healthy and nutritious mulberry leaves. Foliar diseases alone reduce 10 – 15% leaf production per unit area of land (Sengupta *et al.*, 1990). To overcome crop loss due to diseases and repeated application of fungicide/agricultural antibiotics, development of resistance mulberry varieties is the best option. Powdery mildew is one of the major diseases in all sericulture practicing country. Our results indicates that ten genotypes *viz.*, Thailand lobed, *M. multicaulis*, *M. australis*, Italian mulberry, Kanva-2, *multicaulis*, Rotundiloba, Australia, MR-1, KPG-2 are highly resistant against p. mildew. Govindaiah *et al.* (1989) reported that Koliakuthai is completely resistant, Punjab local resistant and Shrim – 5

Table 1. Percent disease index, disease response and cumulatative disease index indigenous and exotic mulberry varieties

Mulberry varieties	Origin	Percent disease index/disease response										CDI
		PMLD		MLS		PLS		SMLD		BLS		
		PDI	DR	PDI	DR	PDI	DR	PDI	DR	PDI	DR	
M. multicaulis	Italy	2.14	HR	0.13	HR	0.36	HR	4.64	HR	0.00	I	7.28
Thailand-Lobed	Thailand	0.22	HR	0.07	HR	0.14	HR	3.58	HR	3.84	HR	7.85
Italian	Italy	2.47	HR	0.17	HR	0.19	HR	1.92	HR	3.31	HR	8.06
Australia	Australia	4.85	HR	0.57	HR	0.65	HR	1.25	HR	3.53	HR	10.86
Rotundiloba	France	4.80	HR	0.30	HR	0.08	HR	6.48	R	0.10	HR	11.76
Multicaulis	France	4.77	HR	0.23	HR	5.30	R	0.83	HR	1.87	HR	13.00
MR-1	Karnataka	4.89	HR	0.17	HR	1.12	HR	3.02	HR	4.40	HR	13.61
KPG-2	Kalimpong	4.91	HR	0.19	HR	0.98	HR	5.63	R	2.85	HR	14.56
Almora local	Uttaranchal	6.97	R	0.12	HR	1.80	HR	4.24	HR	2.32	HR	15.46
Okinowaso	Japan	6.65	R	0.67	HR	1.71	HR	6.03	R	1.82	HR	16.88
Kanva-2	Karnataka	4.11	HR	0.32	HR	1.92	HR	4.06	HR	6.48	HR	16.89
Fernandodias	Paraguay	6.45	R	0.04	HR	0.69	HR	4.06	HR	5.76	R	17.00
Cyprus	Cyprus	10.09	MR	0.33	HR	2.18	HR	3.42	HR	2.45	HR	18.47
China (White)	China	10.25	MR	0.67	HR	0.66	HR	7.39	R	0.00	I	18.97
M. australis	Australia	2.38	HR	0.12	HR	2.06	HR	3.3	HR	11.12	MR	18.99
China black-B	China	11.59	MR	0.52	HR	4.53	HR	2.66	HR	0.98	HR	20.28
M. indica (Black)	West Bengal	10.89	MR	0.93	HR	1.70	HR	1.24	HR	6.07	R	20.84
Dudhia White	West Bengal	8.04	R	0.23	HR	3.59	HR	3.15	HR	5.88	R	20.89
Bishnupur-4	West Bengal	15.82	MR	0.38	HR	1.34	HR	1.38	HR	2.31	HR	21.22
Kolitha-8	West Bengal	7.36	R	0.58	HR	8.51	R	2.69	HR	2.40	HR	21.52
CSRS-2	West Bengal	10.35	MR	0.90	HR	2.22	HR	1.25	HR	7.49	R	22.21
MS-8	Karnataka	14.21	MR	0.25	HR	2.03	HR	6.01	R	0.21	HR	22.72
Mandalaya	Burma	10.64	MR	1.13	HR	5.05	R	3.87	HR	2.89	HR	23.58
Surat	Gujrat	5.64	R	0.09	HR	3.91	HR	6.9	R	8.24	R	24.78
Sujanpur-5	Punjab	7.25	R	1.12	HR	6.09	R	7.57	R	2.94	HR	24.97
Assambola	Assam	10.59	MR	0.77	HR	3.30	HR	2.81	HR	8.18	R	25.65
Bogura-1	Bangladesh	10.44	MR	0.22	HR	1.61	HR	5.09	R	8.60	R	25.96
Jodhpur	Rajasthan	18.14	MR	0.71	HR	3.38	HR	3.9	HR	0.17	HR	26.31
Kajli	West Bengal	13.47	MR	0.19	HR	3.25	HR	1.99	HR	8.35	R	27.25
V1	Karnataka	12.52	MR	0.31	HR	3.52	HR	10.09	MR	0.83	HR	27.26
M. indica X	West Bengal	16.68	MR	0.40	HR	4.60	HR	4.23	HR	1.78	HR	27.69
Kurseong	West Bengal	16.14	MR	0.07	HR	2.54	HR	4.92	HR	4.76	HR	28.43
Bush Malda-B	West Bengal	13.13	MR	0.00	I	2.63	HR	3.64	HR	9.10	R	28.50
Koliakuthai	Assam	16.15	MR	0.00	I	1.64	HR	6.11	R	5.00	HR	28.90
Berhampore-B	West Bengal	16.71	MR	0.44	HR	3.24	HR	4.80	HR	3.86	HR	29.04
Calebrasa	Paraguay	17.63	MR	0.00	I	2.46	HR	5.22	R	3.78	HR	29.09
MS-5	Karnataka	15.04	MR	0.92	HR	5.28	R	5.43	R	2.79	HR	29.47
Sujanpur	Punjab	8.07	R	0.00	I	5.57	R	6.01	R	10.07	MR	29.73
Thailand (Unlobed)	Thailand	15.05	MR	0.64	HR	2.02	HR	4.07	HR	8.12	R	29.89
Burma-8	Burma	19.96	MR	0.13	HR	5.07	R	2.84	HR	2.06	HR	30.06
M. indica h.p	West Bengal	23.40	MR	0.50	HR	1.17	HR	4.48	HR	0.59	HR	30.15
Berhampore-20	West Bengal	16.66	MR	0.00	I	3.82	HR	1.94	HR	7.97	R	30.40
Bush Malda-A	West Bengal	12.43	MR	0.04	HR	13.35	MR	1.37	HR	3.49	HR	30.69

Table 1. Continued

Mulberry varieties	Origin	Percent disease index/disease response										CDI
		PMLD		MLS		PLS		SMLD		BLS		
		PDI	DR	PDI	DR	PDI	DR	PDI	DR	PDI	DR	
MS-9	Karnataka	18.83	MR	0.40	HR	2.22	HR	5.78	R	3.57	HR	30.79
MS-7	Karnataka	22.39	MR	0.41	HR	1.22	HR	4.43	HR	2.35	HR	30.81
Matigara-White	West Bengal	13.70	MR	0.42	HR	5.99	R	3.1	HR	7.87	R	31.08
Berhampore-A	West Bengal	23.63	MR	0.42	HR	2.30	HR	4.47	HR	0.61	HR	31.43
Kakpilla	Assam	13.87	MR	1.29	HR	5.12	R	8.57	R	2.60	HR	31.45
MS-1	Karnataka	11.81	MR	1.56	HR	7.16	R	5.26	R	6.47	R	32.26
Bogura-4	Bangladesh	11.76	MR	0.52	HR	4.01	HR	4.28	HR	11.77	MR	32.35
Golaghat	Assam	22.00	MR	0.09	HR	1.72	HR	5.27	R	3.29	HR	32.36
Bishnupur-9	West Bengal	25.54	S	0.38	HR	2.40	HR	3.16	HR	1.18	HR	32.65
Matigara-Black	West Bengal	21.55	MR	0.62	HR	2.93	HR	4.91	HR	2.74	HR	32.74
Philippines	Philippines	22.33	MR	0.26	HR	5.57	R	3.64	HR	1.22	HR	33.03
Berhampore-6	West Bengal	14.64	MR	0.05	HR	5.18	R	4.96	HR	8.80	R	33.63
Jatinuni	Assam	18.51	MR	0.00	I	2.11	HR	7.51	R	5.58	R	33.71
Miuaso	Paraguaya	26.24	S	0.42	HR	3.58	HR	3.31	HR	0.28	HR	33.83
Black cherry	Karnataka	22.40	MR	0.88	HR	1.54	HR	7.79	R	1.55	HR	34.16
Dudhia red	West Bengal	24.32	MR	0.32	HR	5.61	R	3.29	HR	0.70	HR	34.24
Shrim-2	Bangladesh	21.84	MR	0.25	HR	0.89	HR	10.72	MR	0.80	HR	34.50
M. cathyana	Indonesia	23.39	MR	0.10	HR	0.91	HR	3.97	HR	6.45	R	34.82
Kokusa-13	Japan	26.88	S	0.36	HR	1.42	HR	7.61	R	0.58	HR	36.85
Tista Valley	West Bengal	26.87	S	0.51	HR	3.03	HR	6.36	R	1.39	HR	38.16
Punjab local	Punjab	27.37	S	0.07	HR	2.81	HR	6.39	R	1.67	HR	38.30
RFS-175	Karnataka	17.89	MR	1.81	HR	6.89	R	9.08	R	2.90	HR	38.57
FGDTR-9	Karnataka	24.68	MR	0.42	HR	3.22	HR	10.62	MR	0.15	HR	39.09
Molai	Assam	26.59	S	0.09	HR	1.70	HR	7.71	R	3.07	HR	39.16
Monlai	Burma	25.48	S	0.22	HR	2.65	HR	7.7	R	3.54	HR	39.59
Mysore local	Karnataka	18.46	MR	0.66	HR	3.43	HR	6.81	R	11.01	MR	40.38
KPG-1	West Bengal	14.90	MR	0.55	HR	9.15	R	3.16	HR	13.22	MR	40.98
ACC165	Karnataka	23.02	MR	0.39	HR	2.89	HR	13.8	MR	1.01	HR	41.10
Kolitha-9	West Bengal	31.20	S	0.34	HR	4.41	HR	4.84	HR	0.59	HR	41.37
M. nigra	Indonesia	17.23	MR	0.41	HR	13.00	MR	6.94	R	5.15	R	42.72
Tollygangue	West Bengal	27.84	S	0.00	I	8.11	R	3.23	HR	3.86	HR	43.04
MS-6	Karnataka	32.62	S	0.39	HR	3.52	HR	6.09	R	0.60	HR	43.21
S1	West Bengal	25.54	S	1.85	HR	1.88	HR	10.5	MR	3.73	HR	43.50
Kollitha-3	West Bengal	33.71	S	0.22	HR	4.02	HR	5.33	R	0.34	HR	43.62
Shrim-5	Bangladesh	26.06	S	0.62	HR	6.76	R	9.97	R	0.28	HR	43.69
Sultanpur	U.P.	29.50	S	0.36	HR	6.78	R	7.11	R	1.95	HR	45.71
OPH-1	Karnataka	16.50	MR	0.83	HR	10.83	MR	11.15	MR	6.85	R	46.16
Shrim-8	Bangladesh	33.39	S	0.29	HR	5.88	R	7.12	R	0.78	HR	47.46
Monla-1	Burma	28.68	S	0.27	HR	8.89	R	7.03	R	3.57	HR	48.44
S1635	West Bengal	15.16	MR	1.00	HR	9.82	R	18.73	MR	4.03	HR	48.73
Kolitha-7	West Bengal	30.64	S	0.21	HR	10.23	MR	6.76	R	1.07	HR	48.91
Nagaland local	Nagaland	25.98	S	0.67	HR	4.87	HR	5.83	R	12.83	MR	50.18

PMLD: Powdery mildew, CDI: Cumulatative disease index, MLS: *Myrothecium* leaf spot, I: Immune, PLS: *Pseudocercospora* leaf spot, HR: Highly resistant, SMLD: Sooty mold, R: Resistant, BLS: Bacterial leaf spot, MR: Moderately resistant.

moderately resistant to powdery mildew but our results indicate that the Koliakuthai moderately resistant, Punjab local and Shrim – 5 are susceptible to the disease. However, disease response of Almora local, Shrim – 2, Kakpilla, Assambola, Jatinuni and RFS_{175} corroborate with their finding. Variation of disease response may be due to different agroclimatic condition as well as and cultural practices of the two different regions.

Fungal leaf spot *viz., Myrothecium* leaf spot and *Pseudocercospora* leaf spot are a major problem during monsoon in the Eastern and North Eastern region of India. Our study indicates that seven mulberry genotypes *viz.,* Tollygunge, Bush Malda-B, Sujanpur, Calabrasa, Koliakuthai, Jatinuni and Berhampore-20 are immune to *Myrothecium* leaf spot. But none of the varieties were immune to *Pseudocercospora* leaf spot.

Sooty mold causing fungi grows profusely on the upper surface the mulberry leaf on the secretion honeydew of white fly as a result leaves are unfit for silkworm rearing. Severity of sooty mold causing fungi was > 5 PDI in forty-four genotypes.

Bacterial leaf spot is another major foliar disease of mulberry during monsoon in the Eastern and North Eastern region of India. Two genotypes *viz.,* China White and *M. multicaulis* were found disease free through out study period. Besides, fifty-eight genotypes were found highly resistance to the disease with > 5% disease severity.

The present study indicates that both exotic and indigenous varieties having different level of resistance to different foliar diseases. The immune and resistance genotypes identified can be utilized for future disease resistance breeding programme to evolve disease resistant mulberry varieties.

Reference

Biswas, S., S. K. Mandal and P. K. Chinya (1993). Development of powdery mildew disease in mulberry and its control. *Sericologia* **33**, 653-662.

Chanturia, N. N. (1968) Biochemical characteristics of mulberry leaves damaged by powdery mildew. *Soobsch Akad Nauk Gruz SSR.* **52**, 799-804.

Chattopadhayay, S., M. D. Maji, P. M. Pratheesh Kumar, K. K. Das and B. Saratchandra (2002) Response of mulberry brown leaf spot fungus *Myrothecium roridum* to different plant extracts. *Int. J. Indust. Entomol.* **5**, 183-188.

F.A.O. (1967) Crop losses due to diseases and pest. Food and Agricultural Organization, Rome.

Gangwar, S. K., S. M. H. Qadri, M. D. Maji, P. M. Pratheesh Kumar and B. Saratchadra (2000) Evaluation of fresh plant extracts for the control mulberry powdery mildew. *Indian J. Seric.* **39**, 76-78.

Govindaiah, D. D. Sharma, K. Sengupta, V. Gunasekhar, N. Suryanarayana and Y. R. Madhava Rao (1989) Screening of Mulberry varieties against major fungal diseases. *Indian J. Seric.* **28**, 207-213.

Maji, M. D., S. M. H. Qadri and S. C. Pal (2000) Control of bacterial leaf spot of mulberry caused by *Xanthomonas campestris pv. mori. Indian J. Seric.* **38**, 81-83.

Maji, M. D. (2002) Mulberry diseases of the Gangetic plain of West Bengal and their control. *Indian Silk* **41**, 11-15.

Maji, M. D. (2003) North Eastern states: Mulberry diseases and their management. *Indian Silk* **42**, 7-10.

Maji, M. D., S. Chattopadhyay, P. M. Pratheesh Kumar and S. Raje Urs (2003a) Evaluation of mulberry phylloplane bacteria for biological control of powdery mildew of mulberry caused by *Phyllactinia corylea. J. Mycopathol. Res.* **41**, 197-200.

Maji, M. D., S. M. H. Qadri and S. C. Pal (2003b) Evaluation of mulberry phylloplane microorganisms for biological control of bacterial leaf spot of mulberry caused by *Xanthomonas campestris* pv. *mori. Indian J. Agric. Res.* **37**, 307-309.

Noamani, M. K. R., P. K. Mukherjee and S. Krishnawswami (1970) Studies on the effect of feeding multivoltine Silkworm (*Bombyx mori* L.) larvae with mildew effected leaves. *Indian J. Seric.* **9**, 4-52.

Pelczar, Jr. M. J., R. D. Roger and E. C. S. Chan (1977) Microbiology. Mc Graw - Hill Pub. Co. Ltd., New Delhi.

Pratheesh Kumar, P. M., M. D. Maji, S. Chattopadhayay and S. Raje Urs (2004) Isolation and evaluation of bacterial biocontrol agents for management of leaf spot (*Myrothecium roridum*) in mulberry. *J. Mycopathol. Res.* **42**, 43-47.

Rangaswami, G., M. N. Narasimhana, K. Kashiviswanathan, C. R. Sastry and M. S. Jolly (1978) Sericulture Manual I. Mulberry cultivation. FAO Agric. Bull., Rome.

Sengupta, K., Pradip Kumar, M. Baig and Govidaiah (1990) Hand Book on Pest and Disease Control of Mulberry and Silkworm. United Nations, ESCAP, Bangkok.

Sikdar, A. K. and S. Krishnawswami (1980) Assessment of leaf yield loss of two mulberry varieties due to leaf spot. *Indian J. Seric.* **19**, 9-12.

Umesh Kumar, N. N. (1991) Physiological studies of mulberry varieties infected by foliar pathogens. Ph. D. Thesis, Bangalore University, India.

Umesh Kumar, N. N., D. D. Sharma and M. P. Shree (1993) Effect of feeding fungus infected leaves on commercial characters of silkworm (*Bombyx mori* L.). *Indian J. Seric.* **32**, 107-109.

Yashihiko, A. (1995) Sericulture in Tropics. AICAF, Tokyo, Japan .

Yokoyama, T. (1962) Synthesised Science of Sericulture. Central Silk Board, Bangalore.