INTERNATIONAL JOURNAL OF BIO-RESOURCE, ENVIRONMENT AND AGRICULTURAL SCIENCES (IJBEAS)
Vol. 2(2) :281-286, 2016
www.sbear.in // ISSN 2454-3551

A REVIEW ON POWDERY MILDEW OF MULBERRY AND ITS MANAGEMENT

S. Monir and N. C. Mandal
Department of Plant Protection, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan 731 236, West Bengal, India
Received: April 2016 Revised accepted: May 2016

ABSTRACT

Mulberry is the sole host plant of the silkworm *Bombyx mori* Linn which produces silk. The disease caused by fungus, *Phyllactinia corylia* makes mulberry leaves unsuitable to feed the silkworm. The Disease severity is ranging from a few individual spots to numerous lesions nearly covering entire leaves as a result there decrease in the production of quality leaves by 50% which greatly effects silkworm rearing as well as sericulture industry. With a view of adopting control measures, the incidence of powdery mildew were studied for eight different mulberry varieties namely Tr-10, S-1, S-146, S-13, S-1635, AR-12, AR-14, Br-2 in autumn season.
Key words: Mulberry, management, *Phyllactinia corylia*, Powdery mildew

INTRODUCTION

Powdery mildew of mulberry caused by *Phyllactinia corylea* (Pers.) Karst. was first reported from Ootacamund (Tamil Nadu) by Salmon as early as in 1905. The disease was later reported from all major mulberry growing areas in India. However, its incidence and intensity vary between geographical locations and seasons (Abbas et al., 2010, Chakravorty et al., 2003, Angwar and Thanavelu, 1991, Dikshit et al., 2006). The disease deteriorates the mulberry leaf quality by reducing the protein contents and moisture, and altering the various other leaf constituents (Chanturiya, 1968; Ali *et al.*,1987). Feeding silkworms with infected leaves produces disastrous results, affecting silkworm development and cocoon characters (Noamani et al., 1970; Sullia and Padma, 1987, Umesh Kumar et al., 1993).

Mulberry leaf, the only food for the silkworm (*Bombyx mori*) is deep rooted perennial plant widely distributed in Asia, Europe, Africa and Latin America grown under varied climatic conditions ranging from temperate to tropics. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest. Mulberry leaves are the sole sources of nutrients e.g., protein, carbohydrates, vitamins, minerals etc. for silk worm's growth (Tang et al., 2006).

Powdery mildew is the most common and widespread disease of mulberry. Its occurrence is reported from almost all the mulberry growing areas in both tropical and temperate parts of the world. The quantity and quality of mulberry foliage is often hampered by the infestation of pathogens, parasites and insect pests. It was reported that these pathogens infect mulberry leaves and reduces not only yield but also nutritional values, thus making the leaves unsuitable for silkworm feeding (Bakshi et al., 1972). Moisture, ash, lipid, crude fibre, carbohydrate, vitamins and minerals contents were decreased significantly after infection of mulberry leaves with fungus, *Phyllactinia corylea* (Tang et al., 2006).

Kumaraswamy and Urs (1979) was observed the fungus *P. corylea* manifests in the conidial stage which is known as Ovulariopsis. The disease is characterized by the appearance of white powdery patches on the abaxial surface of leaves the corresponding portion on the others side of leaf develop chlorotic lesions. The patches vary in size from 0.5 to 2.5 cm in diameter and become irregular, and quickly cover the entire lower surface. The leaves become yellow, coarse and less nutritive. Chanturiya (1968) was reported the disease leaves have less moister, and higher starch, cellulose and ash contents than healthy leaves. The disease reduces the protein contents of the leaves by about 33 per cent (Anonymous, 1969). Suryanarayan and Ganesh

(1969), Noamani et al. (1970), Sullia and Padma (1987) were reported feeding silk worm with infected leave affects the growth and development of larvae and cocoon characters.

Biswas et al. (1992) was observed the disease is more prevalent during the months of September to March with the intensity reaching maximum in January and February. Temperature range of 24 to 28 ºC and higher relative humidity favour the disease development and conidial production. Dispersal of conidia is more during cloudy- rainy day than bright sunny day. Prasad and Siddaramaiah (1979) and Anonymous (1969) were observed the temperature below 12 ºC and above 32 ºC germination of conidia is reported to be low, and at 28 ºC and 100 % RH it is maximum. The pathogen may survive from season to season in infected crop debris and the distribution of the conidia is mainly through air and by movement of infected crop.

Bordeaux mixture was reported to be effective in controlling the disease. Bordeaux mixture sprayed leaves retained residual toxicity even after 15 days and hence its use is not advisable in mulberry. Karathane 0.1% also has residual toxicity for 10 days, while Morestan at 0.25 and 0.05% not only controlled the disease but was also free from any toxicity to silk worms. Spraying of sulphur, Diathane, Sulphur suspension or lime sulphur mixture on the back of leaves for controlling the disease (Pratheesh Kumar et al., 1999). Yellow and spotted lady beetles were also reported as biological controlling agent. The disease can be managed by a hyperparasite, *Cladosporium* sp. (Maji et al., 2006).

CAUSAL ORGANISM

The causal organism of powdery mildew of mulberry has been identified as *Phyllactinia moricola* (P. Henn.) Homma. *Phyllactinia* is an ectoparacite and obtains nutrients by sending haustoria into the leaf tissues. Now, the powdery mildew fungus is known as *Phyllactinia corylea (*Pers.) Karst. Under the Family: Erysiphaceae, Order: Erysiphales, Class: Ascomycetes, Genous: *Phyllactinia*, Speciss: *corylea*

DISEASE SYMPTOMS

The disease first appears as white powdery patches on the lower surface of mulberry leaves (Fig. 1). These patches later spread and cover entire lower surface of the leaves. The corresponding portion of white powdery mildew patches on the other side of leaves develop chlorotic lesion. On severity of disease white powdery patches turn to brownish-black in colour; the leaves become yellow, coarse and less nutritive. Infection on young leaves also causes curling, crinkling, reduction in leaf width and longitudinal folding.

DISEASE CYCLE

The fungus reproduces by both asexual and sexual methods. Asexual reproduction takes place in the initial in the stages during favorable condition and sexual reproduction takes place during adverse condition.

Asexual reproduction

Asexual production takes place by means of conidia. Fungal mycelium is unbranched hyaline and forms a hyphal mat spreading on the leaf surface. Conidia are hyaline, unicellular, club shaped, measuring around 28x70µm**,** each borne terminally on the septets conidiophores. Conidia germinate and produce germ tubes. Germ tubes give rise to several short lateral branches which terminate into lobed adhesion bodies special penetration structures, known as stomatopodia. Lateral branches that are formed near the stomata produce stomatopodia, whereas those are

remote from stomata produce adhesion bodies. Adhesion bodies help fungal mycelium to stick on the leaf surface. The intercellular hyphea produce haustoria which absorb nutrients from the leaf tissues. The liberated conidia disperse through wind current and spread the disease. Dispersal of conidia is more during cloudy rainy days than bright sunny days (Leu and Lee, 1982).

Sexual reproduction

Sexual reproduction takes place by the formation of fruiting body called perithecia (cleistothecia) that develop by the union of antheridium and ascogonium. Perithecia enable the pathogen to survive in field after the crop is harvested. The pathogen may survive from season to season infected crop debris. Perithecia are ball-like swollen structures crowned with cillatecells, whose apics are covered with paste-like granules, and acicular appendages with ballooned bases located on their equatorial line. Perithecia also give rise to a large number of hyphae from near the base, which radiate on the mulberry leaf surface and thus help the perithecia to fix the leaf surface. The disease becomes apparent at conidial stage. The conidiophores were straight at early stages but at appeared spirally coiled when the conidia were matured (Babu et al., 2002). Symptoms included white superficial mycelium with abundant sporulation on the lower surface of leaf.

METHOD OF RECORDING DISEASE INCIDENCE

The disease incidence can be recorded using 0-5 scale

Grade	Description
0	No infection
1	0-5% leaf lamina covered by the symptom
2	6-10% leaf lamina covered by the symptom
3	11-25% leaf lamina covered by the symptom
4	26-50% leaf lamina covered by the symptom
5	51% and above leaf lamina covered by the symptom

The per cent disease index (PDI) can be calculated using following formulae

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of all individual rating}}{\text{Total no. of leaves observed X Maximum grade}} \times 100$$

CROPS LOSS

Diseases have been a major limiting factor for cultivation of mulberry. The intensity of disease varies with season, variety and cultivation practices. A number of air and soil borne diseases have been reported in mulberry and their occurrence in different seasons. The fungal diseases are more predominant and cause 10-15% loss in leaf yield besides the deterioration in the quantity. The annual leaf yield loss due to major diseases is estimated to be about 20-30 % (Philip et al., 1994, Qadri et al., 1999a, 1999b).

EPIDEMIOLOGY

Epidemiology is the study of the abiotic and biotic factors which are influencing the outbreak of disease, its intensity and epidemics. Predisposition of the plant may have a tremendous impact on the host parasite relationship. At temperature below 12 ºC and above 32 ºC germination of conidia is reported to be low (Prasad and Siddaramaiah, 1979). Development of weather based forewarning system of mulberry disease in West Bengal in 2006 was conducted by Maji et al. (2007). Foliar disease incidence and severity data of mulberry were collected by them. The simple correlation coefficient between disease severity and metrological factors reveal that

bacterial leaf spot has significant negative correlation with maximum Temperature and positive correlation with minimum R.H., Rainfall and number of rainy days. Powdery mildew and Pseudocercospora leaf spot has significant negative correlation and Myrothecium leaf spot were no significant correlation between metrological factors.

Temperature

The temperature has a profound effect on the development of disease. At lower temperature the disease severity of mulberry is observed less while at higher temperature, the severity becomes more. Temperature in the range of 24-28ºC with higher relative humidity is favourable condition of conidial production and development of powdery mildew disease in mulberry. At bellow 12 ºC and above 32 ºC temperature germination of conidia is reported to be low and in 100 % relative humidity, it is maximum (Prasad and Siddaramaiah, 1979).

Relative humidity

Moisture content of air is usually referred to as relative humidity. Moisture is an important factor for activation of bacterial, fungal and nematode growth and development. Moisture is seen as water on plant surface. The water reduces germination of spores of *Phyllactinea corylea.* Dispersal of conidia is more during cloudy rainy days than bright sunny days (Biswas et al., 1992).

Wind and light

The role of wind in disease development is mainly dissemination of pathogens spores from one plant to another and one place to another place. Rain helps in the release of spores and bacteria from the infected tissues which are carried by wind to healthy plants to cause infection. Light also major role in increase or decrease the susceptibility of plants disease; less intensity of lights more attack to pathogens.

Soil condition

Soil pH also plays a vital role in the occurrence of severity. Mulberry flourishes well in soil that is flat deep, fertile, well drained loamy to clayey and porous with good moisture holding capacity. The ideal range of soil pH is 6.2 to 6.8.

CONTROL MEASURE

1) ***Cultural management***

a. Various cultural practices reduce disease severity. Adoption of wider plant spacing and good ventilation through high bush height.
b. Adoption of wider plants spacing (90cm x 90cm) or paired row spacing (150cm +90cm) x 60cm.
c. Plant is high bushes provide good ventilation to the decrease in humidity in mulberry garden.
d. The growing of unwanted trees in and around the mulberry garden is to avoid (Biswas et al., 1993).

2) ***Chemical management***

i. Bavistin (Carbendazim 50 WP) at 0.2 percent, 1 kg dissolved in 500 litres of water and sprayed to prevent leaf spot and powdery mildew diseases.
ii. Kavach (Chorotholonil WP), 1 kg dissolved in 500 litres of water and sprayed to prevent leaf rust.
iii. Dithane M-45 (Mancozeb 75 WP) 1 kg dissolved in 500 liters of water and sprayed to prevent leaf blight due to fungi and bacteria.
iv. Zinc sulphate (agro grade) 4.4 kg in 440 liters of water to increase leaf quality and quantity.

v. Sulphur fertilizer can also be used for same purpose (Biswas et al., 1993).

3) *Biological Management*

a. Yellow Lady bird beetles, *Illeis indica* Timb and *Illeis cinta* Fab are known to be the natural predators of powdery mildew. These coccinellied insects feed voraciously of the conidia of the fungi (Gupta, 2001, Maji, 2003, Biswas et al., 1993, Maji et al., 2003).

b. Gangwar et al. (2000) and Pratheesh Kumar et al. (2000) also reported the efficacy of some fresh leaf extract and composted extract for the controlling of powdery mildew of mulberry.

4) *Use of resistant varieties*

a. Few verities viz. Kaliakuttai, Mandalaya and MR-2 can be used as resistant varieties (Teotia et al, 1994).

REFERENCES

Abbas, S. Q., Ali. I., Niaz, M., Ayesha, R. and Iftikhar, T. 2010. New fungal records on *Morus alba* from Faisalabad, Pakistan, I. *Pakistan Journal of Botany* 42(1) : 583- 592.

Ali, R. and Ahmed, S. U. 1987. New record of mulberry wilt in Bangladesh. *Bangladesh Journal of Botany* 16: 207-208.

Angwar, S. K. and Thanavelu, K. 1991. Occurrence of mulberry disease in Tamil Nadu. *Indian Phytopathology* 44: 545-549.

Anonymous. 1996. Annual Report 1995-1996, Central Sericultural Research & Training Institute, Berhampore, West Bengal.

Babu, A.M., Vineet Kumar and Govindaiah. 2002. Surface ultrastructural studies on the infection process of *Pseudocercospora mori* causing grey leaf spot disease in mulberry. *Sericologia* 106(8): 938-945.

Bakshi B. K., Reddy Ram, M.A., Puri, Y. N. and Singh, S. 1972. Survey of the disease of important FRIC, Dehradun, India. pp. 93-98.

Biswas, S., Rao, A., Mondal, S. K. Roy, B. N. 1992. Influence of diurnal variations and climatic conditions on conidial dispersal of *Phyllactinia corylea*. *Indian Journal of Sericulture* 31(2): 135-139.

Biswas, S., Sen, S. K., and Pavan Kumar, T. 1993. Integrated disease management system in mulberry. *Sericologia* 33(3):401-415.

Chakravorty, R., Neo, K., Das, R. and Dutta P. K. 2003. Seasonal incidence of majore foliar fungal diseses of mulberry in North East India. *Indain Journal of Sericulture* 42(2). 122-127.

Chanturiya, N. N. 1968. Biochemical characteristics of mulberry leaves damaged by powdery mildew. *Sobshch. Akad Nauk Gruz. SSR* 52: 799-804.

Dikshit, B. K., Dash, B. D. and Purohit, K. M. 2006. Studies on the incidence of mulberry foliar diseases in agro-climatic conditions of Koraput district in Orissa. Proceeding, RSRS, CSB, Dehradun: pp. 109-111.

Gangwar, S. K., Qadri, S. M. H., Maji, M. D., Pratheesh Kumar, P.M., and Saratchadra, B. 2000. Evaluation of fresh plant extracts for the control mulberry powdery mildew. *Indian Journal of Sericulture* 39(1): 76-78.

Gupta, S. K. 1991. The mites of agricultural importance in India with remarks on their economic status. In : Modern Acarology (Eds. Dusbabek & Bukva). Academic Pub., Vol. 1, pp. 509 - 522. .

Kumarswamy, S. and Urs, S. D. 1979. Occurrence of *Ovulariopsis* sp. Pat. and har. on *Morus alba*, L., a new host record in India. *Current Research* 8:15.

Leu, L. S. and Lee, C. C. 1982. Morphology and conidial germination of Powdery mildew of mulberry. *Plant Protection Bulletin* 24: 27 – 36.

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

Maji, M. D., Banerjee, R., Das, N. K., Chakraborty, S. and Bajpai, A. K. 2007. Role of meteorological factors on mulberry diseases development. *International Symposium on Agrometeoorolgy and Food Security (INSAFS) held on 18-21 February 2008 at Central Research Institute for Dryland Agriculture, Hydrabad, 500059, India*. Abstr. No. AS9-P12. PP. 208.

Maji, M. D., Chattopadhayay, S., Pratheesh Kumar, P. M and Raje Urs, S. 2003. Evaluation of mulberry phylloplane bacteria for biological control of Powdery mildew of mulberry caused by *Phyllactinia corylea. Journal of Mycopathological Research* 41:197-200.

Maji, M. D., Banerjee, S., Chattopadhyay, A. B., Saha, P. K. and Ghosh, P. L. 2006. Eco-friendly management of major foliar diseases of mulberry through botanicals and bio-control agent. Proc. on Workshop on Regional Seminar on Prospect & Problems of Sericulture as an Economic Enterprise in North West India on 11^{th} -12^{th} November, 2006 at Central Sericultural Research and Training Institute, Berhampore, PP. 152-156**.**

Maji, M. D. Qadri, S. M. H, Das, N. K. and Pal S. C. 2002. Meteorological factors in relation to development and prediction of bacterial leaf spot disease of mulberry (*Morus* sp.). *Indian Academy of Sericulture* 6 (2): 107-114.

Noamani, K. R., Mukherjee, P. K. and Krishnaswami, S. 1970. Studies on the effect of feeding multivoltine silk worm (*Bombyx mori* L.) Larvae with mildew affected mulberry leaves. *Indian Journal of Sericulture* 9: 49-52.

Phillip T., Gupta, V., Govindaiah Bajpai, A. K. and Datta R. K. 1994. Disease of mulberry in India-Research priorities and management strategies. *International Journal of Tropical Plant Disease* 12: 1-21

Prasad, K. S. K. and Siddaramaiah, A. L. 1979. Studies on development of powdery mildew disease of mulberry in Karnataka. *Indian Journal of Sericulture* 18: 9-13

Pratheesh Kumar, P. M., Qadri, S. M. H., Pal, S. C., Saratchandra, B. 1999. Evaluation of few fungicides against two leaf spot diseases of mulberry (*Morus* spp.). *Bulletin of Sericulture Research* 10:9-15

Pratheesh Kumar, P. M., Qadri, S. M. H., Maji, M. D., Gangwar, S. K. and Saratchadra, B. 2000. Biological control *Phyllactinia corylea* (Pers) Karst using composted extracts. *Indian Journal Sericulture* 39(1): 81-83.

Qadri, S. M. H., Gangwar, S. K., Pratheesh Kumar, P. M., Elangavon, C., Maji, M. D and Saratchadra, B. 1999a. Crop loss assessment due to leaf spot disease of mulberry. *Indian Journal of Sericulture* 38(1): 35-39.

Qadri, S. M. H., Pratheesh Kumar, P. M., Gangwar, S. K., Elangavon, C., Das, N. K., Maji, M. D. and Saratchadra, B. 1999b. Crop loss assessment due to powdery mildew in mulberry. *Bulletin of Sericulture Research* 9: 31-35

Salmon, E. S. 1905. On the variation shown by conidial stage *Phyllactinia corylea* (Pers.) Karst. *Annals of Mycology* 2: 18-26.

Sullia, S. B. and Padma, S. D. 1987. Acceptance of mildew affected mulberry leaves by silk worm (*Bombyx mori* L.) and its effects on cocoon characteristics. *Sericologia* 27: 693-696

Suryanarayan , S. K. and Ganesh, N. K. 1969. Preliminary observation on the effect of silk worms with mildew affected leaves. *Silk worm Information Bulletin* 1: 62-70.

Tang Kahem, Abul Samed, M. A., Akand Haque Anyul, Azhar Sabina Bably and Absar, N. 2006. Nutritional changes of four varieties of mulberry leaves infected with fungus

(*Phyllactinia corylea*). Pakistan *Journal of Biological Science* 9(3): 355-359.

Teotia, R. S., Sen, S .K., Mandal, S. K. and Sinha, S. S. 1994. Varietal resistance in mulberry to leaf rust (*Aecidium mori*, Barklay). *Sericologia* 34(4): 759-763.

Umesh Kumar , N. N., Sharma, D. D. and Shree, M. P. 1993. Effect of feeding fungus infected leaves on commercial characters of silkworm (*Bombyx mori. L*.). *Indian Journal of Sericulture* 32 (1):107 – 109.