
Diseases of ber (*Zizyphus jujube*) in Eastern India

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Ber (*Zizyphus mauritiana* Lamk - Rhamnaceae) is one of the important fruit crops of arid and semi arid zones of the world. In India though it is a minor fruit but recently the ber become an important cash crop in some areas and its acreage and production are increased. Due to rapid spread of commercial cultivation, the crop is also affected by different biotic and abiotic factors including pathogens causing many serious diseases. Not much attention to the diseases of ber has been given so far and remained under-estimated the problems. The ber, a tropical fruit crop is prevalent in arid and semi-arid region of the world. The crop considered as minor fruit in this country on the basis of its production in restricted area, popularity and awareness although it is a very important crop and contributes a good share of economy in many localities. Several biotic and abiotic stresses have been responsible for causing diseases, related to loss of crop. As the importance of the crop generally continue in a locality or a particular state thus it overlooks the national importance particularly researches on protection technology, leading to limited knowledge for management of different diseases both in pre-harvest as well as post-harvest stage. Ber is affected by many serious diseases like powdery mildew, sooty mold, leaf spots (*Alternaria*, *Cercospora*, *Septoria*, *Cladosporium*, *Pestalot-*

tiopsis etc.) and rust among the fungal infections and witches broom caused by MLOs as reported by Jamader *et al.* (3). Seven diseases on ber were identified by Yuan *et al.* (7) in China mostly grown in the southern provinces of the country and also grown in India. While many diseases originated in the orchards, fruit rot may initiates from the field and may express in storage due to lack of proper handling and storage conditions. The amount of loss caused by fruit diseases is tremendous and has not yet been documented properly and thus adoption of suitable remedial measure is needed. The present investigation was carried during 2010-11 to identify the diseases prevalent in ber and also to find out seasonal variation of different diseases.

Extensive survey was carried out in the different districts of West Bengal and adjoining areas of neighbouring states *viz.* Jharkhand, Bihar and Assam. Fixed plot survey was done within the institutional orchard for close supervision throughout the year. Diseased samples including infected leaf, fruit and twigs were collected regularly from different localities and from different cultivars in different seasons. Causal organisms were isolated and identified following standard laboratory techniques. Common laboratory media *viz.* potato dextrose agar (PDA), oat meal agar and V-8

agar were used for isolation and purification of causal pathogens for different diseases. Both macroscopic and microscopic observations were followed in the laboratory for proper identification. The present investigation was done in the Gangetic alluvial zone in Eastern India considering some important high yielding as well as local cultivars e.g. Gola, Banarasi Kadke, Narkeli, Umran, Madhu Kul etc. During two years of investigations, six different diseases recorded and their pathogens were also isolated and identified. Seasonal variations of all the diseases were also assessed. Pathogenicity of all the isolated microorganisms was also confirmed. The different diseases/disorders of ber identified were powdery mildew, black leaf spot, anthracnose, rust, cladosporium leaf spot, algal leaf spot, fruit rot and black fruit spot (unidentified causal agent). All the maladies in ber were studied with different aspects and cited below with important information.

Powdery Mildew

This is one of the most prominent diseases and caused significant losses due to its infection on fruits (4). The disease appears by the end of October and prevails up to April. The disease first appears on young leaves in the form of white floury patches and later spreads to the young shoots and developing fruits. With the passage of time, the infected area becomes slightly raised and rough. The infected fruit often becomes malformed and may shed from the tree. The disease caused by the fungus *Oidium erysipoides* f. sp. *zizyphi* Yen and Wang and air-borne in nature.

The fungal mycelium become external on the host while conidiophore are upright single, measuring 75.8-139.4 × 12.6 mm. Conidia are cylindrical, hyaline, measuring about 25.2 - 37.8 × 16.8 - 21.0 mm. Conidia of this fungus germinates and form appressoria after 2-4 hours at 20 ± 2° C in most saturated atmosphere, where sporulation starts 96 hours after inoculation on susceptible ber leaves. Temperature range from 10-30° C and relative humidity of 32 percent and above, favour the diseases development.

Black leaf spot

It was first reported from Haryana (1). Sooty tuft like circular to irregular black spot develop on leaf surface. When infection advances, it covers a large area on the lower surface of the leaves and corresponding upper surface shows brownish discoloration. The disease is caused by *Isariopsis indica* var. *zizyphi*. The pathogen produces multi-septate, long, dark brown conidiophore having prominent scars. Conidia were light brown, multi-cellular (3-4 celled) broader at middle while tapering towards the both ends, straight or sometimes bent, measuring 17-42×8.5-10.2µm in size. The conidia germinating from the tip cell were also recorded. The same observation was also described by Gupta and Madan (1). The fungus survives in plant debris and soil which serve as primary source of infection. Secondary infection occurs through spores present in the air. Climatic factors like temperature and humidity largely influenced the disease development. Black leaf spot disease of ber was recorded during post rainy

season in the month of November to May. Severity of the disease was found to be 32.5% during November and increases during the month of March (47.0 %) and then decreased in the month of May (20%) indicated that low to moderate temperature and low atmospheric humidity favours the disease development

Anthraco nose of ber

Symptom of the disease on leaf was recorded as appearance of irregular, rough or corky reddish brown spots with yellowish margin, having the size of 2 to 3 mm in diameter. The spots generally appear on the upper surface of leaves and are not restricted by veins. Initially these spots were isolated but at later stage they may coalesced to form large patches on the infected leaves. On the fruit surface symptoms were small, circular to roughly circular, brown to black colored spots with depressed sporulating zone at the center. Size of spots quickly enlarges during color change of fruit peel from green to yellow and on each fruit usually 3-4 spots were recorded. The anthracnose disease of ber is caused by the fungus *Colletotrichum gloeosporioides*. Pathogen produces numerous unicellular spores on the host surface. The conidia are almost hyaline; bullets shaped and are produced on short, upright conidiophores from acervullus without any special hyphae called setae. Upon inoculation with pure culture or spore suspension the pathogen produced dark spots with whitish center on fruit surface at six days after inoculation. Anthracnose of ber was observed during the summer season. The disease severity was higher during the month of May

(17%) as compare to the month of April (15.5%) and March (10%).

Rust of ber

The disease first appeared on the lower surface of leaves as small, irregular, reddish brown uredopustules which later advances to cover the whole surface of leaves. The infected leaves finally shed off from the tree.

The disease is caused by the fungus *Uredo zizyphi*. Pathogen produces large numbers of round to oval, unicellular, light brown uredospores within the lesion. The spores were developed on tip of the short spore bearing structures within the pustules rupturing the epidermis. Such type of symptoms was also recorded by Quan-YuJie (5) on ber caused by the same pathogen. Rust disease was first reported from Bihar, Maharashtra, West Bengal and now occur in the all the ber growing tracts of India (2). The leaf rust of ber was observed during drier months of the year and was restricted within February to May. Highest disease severity recorded during the month of March (32%) and lowest during May (17.5%).

Cladosporium leaf spot

The symptoms of the diseases are produced on leaves in the form of small, light brown to brown irregular spots. Individual spots may coalesce to form large irregular areas on the leaf blade. The growth of the fungus is observed on the lower surface of leaves. The disease is caused by *Cladosporium zizyphi* Karst and Roum. Gupta and Madan (1) re-

ported other species of the fungus *i.e.* *C. herbarum* as casual organism of the leaf spot from Hisar, India. The fungus consists of highly branched, septate mycelium. Conidiophores are short and erect, little branched, septate, brown to olive-green in colour and normally ranges 5-10 µm in length. Conidia usually oval to elongated, one celled.

Red rust

The disease is also known as algal leaf spot of ber. Red rust is characterized on ber as reddish brown, raised lesions on the upper surface of leaves. Spots were circular to irregular in shape having 2 to 3 mm diameter and few spots (3 to 5) were observed on a leaf. Spots are generally isolated from each other during initial stage of infection, however, they may coalesce to each other during maturity. The causal organism associated with the disease is the *Cephaleuros* sp. Similar type of symptoms was observed by Lim and Sangchote (6) on mangosteen plant and causal agent identified as *Cephaleuros virescens* causing algal spots on mangosteen.

Fruit spot of ber

The first visible symptoms are appearance of isolated, round to oval black lesions on the developing fruits with clear margin. Gradually the spots enlarge in size and often become elevated with smooth surface. In severe case reduction of fruit size and deformation of the

same takes place due to this malady. Occasionally affected fruits may dry up and fall off from the tree before maturity. No microorganism was isolated from the affected fruits and actual causal factor is yet to be identified.

During two years investigation, six different diseases recorded and their pathogens were also isolated and identified. The major diseases of ber encountered were black leaf spot (*Isariopsis indica* var. *zizyphi*), rust (*Uredo zizyphi*), anthracnose (*Colletotrichum gloeosporium*), powdery mildew (*Oidium erysi-phoides* f.sp. *zizyphi*), red rust (*Cephaleuros* sp.) and a leaf yellowing with green island symptom (unidentified causal agent). Seasonal variations of all the diseases were also recorded.

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Table 1.

Diseases of ber, their causal agents and plant parts affected

Name of the diseases	Causal agents/factors	Plant parts affected
Black leaf spot	<i>Isariopsis indica</i> var. <i>zizyphi</i>	Leaf
Powdery mildew	<i>Oidium erysiphoides</i> f.sp. <i>zizyphi</i>	Leaf
Leaf rust	<i>Uredo zizyphi</i>	Leaf
Anthracnose	<i>Colletotrichum gloeosporium</i>	Leaf and fruit
Leaf spot	<i>Cladosporium zizyphi</i>	Leaf
Black fruit spot	Unidentified causal factor	Developing fruit
Algal rust	<i>Cephaleuros</i> sp.	Leaf and fruit

Table 2.

Seasonal variation of different disease severity on ber

Months	Black leaf spot (% leaf infection)	Powdery mildew (% leaf infection)	Leaf rust (% leaf infection)	Anthracnose (% leaf infection)	Leaf spot (% leaf infection)	Black fruit spot (% infection)	Algal rust (% leaf infection)
Nov,10	32.5	15.6	NF	NF	NF	03.6	NF
Dec, 10	34.5	18.1	NF	NF	NF	07.9	NF
Jan,11	40.0	23.1	NF	NF	NF	16.4	NF
Feb,11	45.5	34.2	21.0	NF	NF	09.8	NF
Mar,11	47.0	35.0	32.5	10.0	NF	01.8	10.5
Apr,11	35.0	21.7	20.5	15.5	NF	NF	13.4
May,11	20.5	NF	17.5	17.0	NF	NF	08.3
June,11	NF	NF	NF	NF	13.5	NF	NF
July,11	NF	NF	NF	NF	26.5	NF	NF
Aug,11	NF	NF	NF	NF	28.4	NF	NF
Sept,11	NF	NF	NF	NF	31.8	NF	NF
Oct, 11	NF	6.8	NF	NF	30.2	NF	NF

NF= Not found