DISEASES OF WILLOWS IN WEST PAKISTAN

by
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Abstract

14 fungal pathogens were recorded on Willows growing in different areas of West Pakistan. Melampsora epitea (Kze. and Schm). Thuem. appeared in an epiphytotic form on nursery plants. Absence of large scale and compact plantations of Willows seemed to be a limiting factor in the appearance of few other pathogens in epiphytotic forms. No bacterial or virus disease was observed.

INTRODUCTION

Willows (*Salix spp.*) are fast growing trees and shrubs. Many of these constitute an important component of vegetation along the river banks, torrents and streams. The genus Salix has about 303 species throughout the world, of which 25 species have been reported by Khan (1967) from Pakistan. In addition there may be a large number of hybrids as well. Many of these species are Himalayan. Besides the indigenous species, some exotics have also been successfully grown and the latter include *Salix alba, S. fragilis, S. babyloanica, S. caprea* and *S. coerulea* (Khan, 1967). The willows coppice profusely and the plants can easily be raised from cuttings.

The willow wood is soft, white to red and even-grained. It finds many uses in sports goods, fence posts, roofing material, gates and brake-blocks, etc. The cricket-bat willow ranks high among all the species and the hybrids, mainly because of the particular suitability of its timber for the manufacture of cricket-bats. Some willows provide and rods for basket-making and others are planted as ornamental plants. In forestry, it has a number of uses in reclamation, training of torrents, river-bed stabiliza tion, channel revetting in the fixation of land slides on hills, and of blowing sand.

Unfortunately like all other plants, willows are also subject to many diseases which stand in the way of their successful cultivation and in obtaining a valuable timber from them. Keeping this situation in view, the present study was taken up with special reference to the nature of the pathogen, symptoms and development of the disease and distribution and nature of the damage caused by each disease. These studies are aimed at helping in the diagnosis of diseases and providing basis for their control.

REVIEW OF LITERATURE

Very little work has so far been done on the diseases of willows in West Pakistan.

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Ahmad (1956; 1969; 1972), however, recorded 16 fungi, on some species of *Salix*, which with the exception of a few, do not appear to be parasitic.

Robbins and Hervey (1959) recorded *Poria ambigua* Bres. on a *Salix* sp. in the United States of America and studied its physiology.

Spaudling (1961) listed as many as 100 parasitic fungi on different species and hybrids of *Salix* growing in various parts of the world. Many of these pathogens are found common on various host species. These pathogens are responsible to cause many diseases in the living trees as well as in the felled timber.

Browne (1968) included *Salix* sp. among the hosts of *Fomes fomentarius* (L. ex Fr.) Kicks in Europe.

STUDY OF DISEASES

A thorough survey of the Salix growing areas of West Pakistan was carried out to study the diseases and to collect the fungal material. The symptoms, development of the pathogen, distribution and damage caused were studied. The fungi were identified by comparing them with the specimens available in the Mycological Herbarium, Pakistan Forest Institute, Peshawar, and other herbaria of the country.

Since there exists no large scale and compact plantation of willows in the country, there may be little chances of disease appearing in an epiphytotic form. Only fourteen fungal diseases were recorded. No bacterial or virus disease was observed. The fungal diseases thus recorded were arranged alphabetically and divided into two groups, ie, diseases of felled timber and diseases of living trees. They were further classified on the basis of parts of the plant attacked and on the type of rot produced. A brief description of each disease is given below.

A. DISEASES OF FELLED TIMBER

1. *White spongy rot*

Pathogen:—*Coriolus vericolor* (L. ex. Fr.) Quel.

Syn— *Polystictus versicolor* L. ex. Fr.
(Basidiomycetes, Aphyllophorales)

Polystictus versicolor is a fairly wide distributed and is known to cause more decays in felled hard woods than any other fungus. It is very active and consumes lignin and cell lose vigorously. In case of willows it destroys the entire wood. Stumps/ insect attacked plants and felled timber can be seen full of basidiocarps.

Sporophores

The fungus is gregarious in habit and forms imbricate fructifications which are thin and tough brackets, 3 to 8 cm. across. The upper surface is greyish or brownish

and always velvety and marked with zones of contrasting colour. Under surface is cream coloured and in darkness the fructifications are pale creamy-yellow or white in colour. Pore tubes are very short and the oblong spores measure 6 to 8 X 3μ which are cream coloured in mass (Fig. 1(a) and (b).

The rot

In the begining of the attack a white flecking appears and later the wood is changed to a white spongy mass and is very light in weight. The attacked wood still retains its original shape and no shrinkage cracks appear.

2. *White rot*

Pathogen: *Trametes lactinia* Berk.
(Basidiomycets, Aphyllophorales).

This fungus has been recorded on many hosts (Khan, 1960) like *Populus ciliata. Aesculus indica, Morus alba, Lophoptellum fimbriatum, Abies pindrow* and *Dalbergia sissoo* but all on dead wood. This was recorded by the author on a stem having the attack of borers etc. (Thana, Malakand).

Sporophores

Fruit body a shelving bracket, hard, corky, irregular, white to creamy-biscuit colour, singly or in imbricate fashion appears on the stem. Upper surface of fruit body is uneven of undulating, pruinose, sometimes velvety, generally verucose to regulose and indistinctly zoned. Margins regular, thin slightly reflexed ,context creamy. Pore tubes 5 to 15 mm. long with pores round and spores white (Fig. 2).

The rot

The attacked wood is bleached to light colour and is very light and friable.

3. *Streaky rot*

Pathogen: *Stereum hirsutum* (Willd ex. Fr.) S. F. Gray.
(Basidiomycetes, Aphyllophorales).

It is widely distributed in many countries of the world but was not found common on *Salix* spp. in West Pakistan. However, it was recorded on the bark of some plants near Charsadda (Peshawar District) and Parachinar and on a stump near Ayun (Chitral). In Pakistan this fungus has already been recorded (Browne, 1966) on *Picea smithiana* and *Pinus griffithii.*

Sporophores

The fruit bodies are tough skined and are attached in the middle to the substratum, more often resupinate, forming a thin bracket upto 2 cm. deep when fully

formed. Upper surface strigosely hair and sub-zonate, hymenium on the lower surface which is smooth and even. The colour is bright yellow at first and then changes to dull greenish when mature. Spores are white elliptical, measuring 6 to 8 X 3 to 4μ, cystidia absent (Fig. 3).

The rot

The affected wood becomes white fibrous, light in colour and soft but retains its shape. It is uniformly distributed throughout the wood and is plentiful in early stages in the medullary rays and later in vessels which become plugged with mycelium.

4. *White stringy rot.*

Pathogen:—*Lentinus* sp.
(Basidiomycetes, Agaricales).

It is common throughout Salix growing areas of West Pakistan and is geneally confined to moist and humid places and on the logs submerged in water. *Lentinus tigrinus* (Fr.) Fr. has been recorded on *Slalix* spp. in Europe and on *Shorea robusta* in India (Spaudling, 1961). This fungus seems to be closely related to *Lentinus cochleatus* (Fergus, 1963).

Sporophores

Basidiocarps fleshy-tough in texture and woody when old; edges of gills notched or toothed like a saw with a lateral or excentric stem, spores white in mass, cap yellowish to brownish with brown spot like scales and mushrooms caespitose (Fig. 4).

The rot

It causes a white rot with zone lines. The rotten wood becomes very light in weight.

B. DISEASES OF LIVING TREES.

Leaf and shoot diseases

5. *Rusts.*

Pathogens:—(*i*) *Mllampsora epitea* (Kze. and Schm.) Thuem.
(*ii*) *Melampsora salicis*-albae Kleb.
(Basidiomycetes, Uredinales).

Symptoms and development

Both the rusts are heteroecious and produce orange, yellow uredia on willow leaves during early summer or spring and later on these are turned into brown telia.

Their aecial stages are produced (aecia) on different host plants but those have not been recorded in Pakistan. In case of severely attacked plants the soil surface under the plants becomes rusty (Fig. 5).

Cool and moist weather conditions are raquired for the germination of Uredospores and the periods of hot weather greatly reduce the severity of the disease. Uredospores are air-borne and can attack the healthy leaves and young shoots easily. They go on mul iplying and can do a lot of damage to the host especially in terms of defoliation and the infected rods are rendered too brittle to be used for basketry.

Damage and distribution

These rusts have already been recorded in West Pakistan. Ahmad (1956) recorded *Melampsora salicis-a*lbae on the leaves of *Salix acmophylla.* However, the author could not come across this material in the field. *Melampsora epitea* (Kze and Schm.) Thuem. is one of the common and important rust of Willows.

Rust epidemic can occur provided there are large number of susceptible hosts and favourable environmental conditions. Nursery plants can be found heavily attacked by the rusts and can have a great bearing on the health of these young plants.

6. *Powdery Mildws.*

Pathogen:—Uncinula salicis (DC) Wint.

(Ascomycetes, Erysiphales).

Symptoms and development

A white talcum-like superficial coating consisting of condia and conidiophores is produced on the leaves. Then in the same fungal material yellow dot-like cleistothecia start developing and eventually turn brown or black. (Fig. 6).

The fungus forms a superficial coating on the host surface and derives its nourishment through the haustoria. Under the microscope the cleistothecia can easily be seen as spherical and closed bodies provided with appendages whose tips are coiled. This is one of the most distinguishing feature of the genus *Uncinula.*

The asexual stage consists of conidia and conidiophores. The conidia are borne in chains on the conidiophores and are air-borne and can thus be disseminated very easly to other plants. Later on when the temperature does not remain favourable for the germination of conidia, the production of sexual stage starts. In the next spring the cleistothecia release ascopores which on germination cause infection on new plants and grow into a conidial stage. This is how the life cycle goes on in case of all the powdery mildews.

Distribution and damage

The fungus was collected from a few plants growing on the bank of a Nulla flowing near the road leading to Usho (Swat).

Phyllactinia suffulta causing powdery mildew has, however, been recorded by Ahmad (1956) on *Salix teteasperma*. This disease is responsible to cause early defoliation in the attacked plants and normally it is not wide spread.

7. *Sooty mould*

Pathogen:—*Fumago* sp.
(Fungi Imperfecti, Moniliales).

Symptoms and development

A smoky superficial coating of the fungal material consisting of conidia and conidiophores is developed on the upper surface of the leaves and twigs which is a characteristic feature of this disease. It is not an active parasite but grows saprophytically on the excreta of the insects (Fig. 7).

The disease spreads through the dispersal of conidia and conidiophores and due to this coating photosynthetic activities of the host are also retarded and thus the disease can make the plants weak to some extent and they do not give a healthy look. Insects also help in the dispersal of fungal material.

Distribution and damage

It is very limited in its distribution. The material was collected on green plants growing near Kalam (Upper Swat) and in Changa Manga near Lahore. No serious damage has so far been reported.

Root Diseases

8. *Root-rot and Butt-rot.*

Pathogen: *Ganoderma Lucidum* (Leyss. ex Fr.) Karst.
(Basidiomycetes, Aphyllophorales).

Symptoms and development

The fruit-bodies are perennial, with pileus, reddish brown, kindney-shaped, circular or round in outline, sometimes fan-shaped and measure up to 10-15 X 10-30 cm., sessile or staked. The upper portion is coated with a hard shiny substance resembling sealing wax. The fruit bodies generally appear on the base of the plants, (Fig. 8). Occasionally, however, they were also seen growing at a height of 4-6 ft. on the cut trunks near Ayun (Chitral). This may be due to the common practice with the people there that they cut the tree-tops leaving the trunks, 4-6 ft. high, in order to

get the rods of uniform size and thickness for use in basketry. The open wounds in the form of cuts serve as infection courts and fruit bodies appear after 3-5 years. The affected plants sometimes show pale and thin foliage and top-most shoots start drying up and dying back. In a dug-out plant the root and butt portions show white spongy rot advancing towards centres with a dark invasion zone. The sap as well as heart-wood are attacked and the severely attacked plants are easily blown down by wind.

Gandoddrm lucidum is known to behave as a facultative parasite and enters commonly through wounds or dead roots under favourable conditions of growth. The spores from the fruit body can easily become air-borne and are carried to long distances to cause primary infection. Water is also regarded as one of the means by which dissemination of the disease takes place.

Distribution and damage

It is a cosmopolitan fungus largely found in tropics. In West Pakistan it has a long register of hosts and is considered as a limiting factor in some shisham plantations (Khan and Bokhari, 1970). However, it was recorded for the first time on *Salix* spp. from Thana (Malakand), Ayun (Chitral), harsadda (Peshawar District) and on a stump from Parachinar. Since there are no large scale and compact plantations, the chances of its becoming epiphytotic seems to be little.

9. *Poria root-rot*

Pathogen —*Poria* sp.

(Basidiomycetes, Aphyllophorales).

Symptoms and development

Thin and pale foliage, stag-headedness and death of severely attacked trees are the most common symptoms. The fungus forms a cheesy growth at the root crown and is very conspicuous around the base of the trunk. This fungus can grow on soil and then makes it contacts with the roots of the plant and grows up the stem up to a height of 2ft. in the form of a white to yellowish crust (Fig. 9)

It is a facultative parasite and can spread rapidly under warm and humid conditions. Water as a medium of dispersal seems to be the most important and the fungus is able to spread longer distances by means of spores. Root contact could also prove an efficient method of spread if the plants are grown close to each other. Stumps of the affected trees left in the field were also found to serve as a source of spread of the pathogen.

Distribution and damage

It was found serious only near Charsadda (Peshawar District) and on the plants growing as road side plantation on Peshawar-Nowshera road. The conditions for the development were found to be optimum where the water remains standing for a certain part of the year.

No serious damage to the plants was obseved except on Peshawar-Nowshera Road. *Poria ambigua* Bres. has been recorded on *Salix* spp. in U. S. A. (Robbins ad Hervey, 1959) and on *Dalbergi sissoo* in West Pakistan (Khan, 1961) where it was seen in a very serious form.

Stem and bark diseases

10. *Trunkrot*

Pathogen —*Inonotus hispidus* (Bull. ex Fr.) Karst.

Syn *Polyporus hispidus* Bull. ex Fr r

(Basidiomy cetes, Aphyllophorales).

Symptoms and development

The fruit bodies are usually found on living trees and appear at the point of infection on the trunk. Conks are large, 8 to 25 cm. sessile, spongy then tough, rigid on drying, yellow brown to rusty red, densely hirsute on top, pores with angular mouth, thin walled, 2 to 4 per mm. In the advanced stage of decay the wood is converted into a spongy whitish, yellow mass. The rot generally starts in the heartwood and spreads outwards (Fig. 10).

The fruit bodies produce millions of tiny spores which act like seeds and are carried by air currents. When a spore comes to rest upon the exposed wood and conditions are suitable, it germinates sending a fungus filament into the wood form the filament a system of fungus hyphae develops sending up and down within the trunk or branch, decaying the wood as it goes and rendering it almost a hollow shell. The fungus generally enters through branch stubs and wounds due to lopping and other injuries.

Distribution and damage

The fungus was recorded on a willow plant near Trarkhal (A. J. and K.) and could not be seen elsew here in West Pakistan. However, this fungus has been reported (Khan, 1960) on Mulberry in Kashmir and on *Pistacia khinjuk*, *Pistacia integrrima* and Walnut in West Pakistan, (Hazara and Baluchistan).

Damage in case of individual plant was high but it was not found common on willows.

11. *Trunk rot*

Pathogen: *Fomes fomentarious* (L. ex. Fr.) Kicks.
(Basidiomycetes, Aphyllophorales)

Symptoms and development

Fruit bodies are typically hoof-shaped, sessile, perennial, outer layer, horny, grey, zonate and medium sized. (Fig. 11). These are found on the trunks of living trees and cause a white mottled wood rot extending from the first center of infection. It is a disease of mostly mature and over mature plants and produces white spongy rot with narrow dark zones. Sheet of pale-yellowish white mycelium fills the crack in the decayed wood. It attacks both sapwood and heart wood.

The pathogen enters through stem wounds or branch stubs and, therefore, the damage remains confined to upperparts of the tree.

Distribution and damage

The fungus was recorded from two places, Thana (Malakand) and Parachinar. However, the fungus is parasitic on many hardwoods and infection can come from any attacked plant species. As far as willows are concerned, it is not found common on them and if wide spread it can bring enormous losses in terms of timber etc.

12. *White trunk rot*

Sathogen:—*Bjerkandera adusta* (Willd. ex. Fr.) Karst.

Syn— *Polyporus adustus* Willd. ex Fr.

(Basidiomycetes, Aphyllophorales).

Symptoms and development

Conks sessile to effused, reflexed, corky, rigid often lopping 3 to 10 cm. inside, white to smoke-grey, margins thin and sterile below, appear on the stem and stump. It is usually saprophytic but was found to be a wound parasite on *Salix* spp. and causes a white mottled rot (Fig. 12).

It flourishes well under the moist and humid conditions and was collected on the branches and on stumps near Charsadda (Peshawar District) and Tahana (Malakand).

Distribution and damage

Not a serious and wide spread disease but can prove very harmful to the timber stored in a moist and humid place.

13. *White sap-wood rot*

Pathogen: *Schizophyllum commune* Fr.
(Basidiomycetes, Aphyllophorales).

Symptoms and development

It is a weak parasite and grows on wouhds causing a white sap-wood rot especially within sun scorched and cracked bark of living trees. The fruit bodies are white to grey, leathery to tough, dry, reviving in moist weather, not putrescent, sessile by a narrow base, fan-shaped, very hairy , gills radiating from the point of attachment, edges of gills split longitudinally, margins revolute and spores white in mass. The basidiocarps are found on brances and trunks (Fig. 13).

The pathogen being a wound parasite prefers a cracked surface of the host and the primary infection occures through the air-borne basidiospores.

Distribution and damage

It is widely distributed throughout the world and is responsible for a white sap-wood rot.

14. *White spongy rot*

Pathogen: *Coriolus hirsutus* (Wulf. ex Fr.) Quel.

Syn— *Polystictus hirsutus* (Wulf. ex Fr.) Fr.
(Basidiomycetes, Aphyllophorales).

Symptoms and development

Hairy, greyish-yellowish or brownish sporophores appear on the thunk and on branch stubs. (Fig. 14 (a), 14 b.). The upper surface is always zonate but not multicoloured. The attacked plants give the appearance of half dead and half living. The foliage is reduced.

This species is normally saprophytic on the wood of dead dicotyledonous trees, rarely on conifers, but has occasionally been observed to invade living sap wood. On willow it was found to attack the living stem and the enterance of the pathogen seemed to be through branch stubs or the injuries on the bark due to the insects etc. *Polystictus hirsutus* causes a white spongy rot practically identical with that caused by *Polystictus versicolor* L. ex. Fr.

Distribution and damage

It is not common and the only plant attacked by this pathogen was found growing as road side plantation near Thana (Malakand)., a road leading to Swat. In Pakistan other host is *Shorea robusta* (Ahmad, 1952).

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Explanation of Plntes 1-14

1. (a,b) *Coriolus versicoior* (L. ex Fr.) Quel.
   (Inhabiting a stump and an Insect attacked stem)
2. *Trametes lactinia* Berk
3. *Stereum hirsutum* (Willd. ex. Fr.) S.F. Gray.
4. *Lentinus* sp.
5. *Melampsora epitea* (Kze and Schm.) Thuem.
6. *Uncinula salicis* (DC) Wint. (Powdery mildew)
7. *Fumago* sp. (sooty mould)
8. *Ganoderma lucidum* (Leyss. ex Fr.) Karst.
9. *Poria* sp.
10. *Inonutus hispidus* (Bull. ex Fr.) Karst.
11. *Fomes fomentarius* (L. ex Fr.) Kicks.
12. *Bjerkandera adusta* (Willd. ex Fr.) Karst.
13. *Schizophyllum commune* Fr.
14. (a,b) *Coriolus hirsutus* (Wulf. ex. Fr.) Fr.

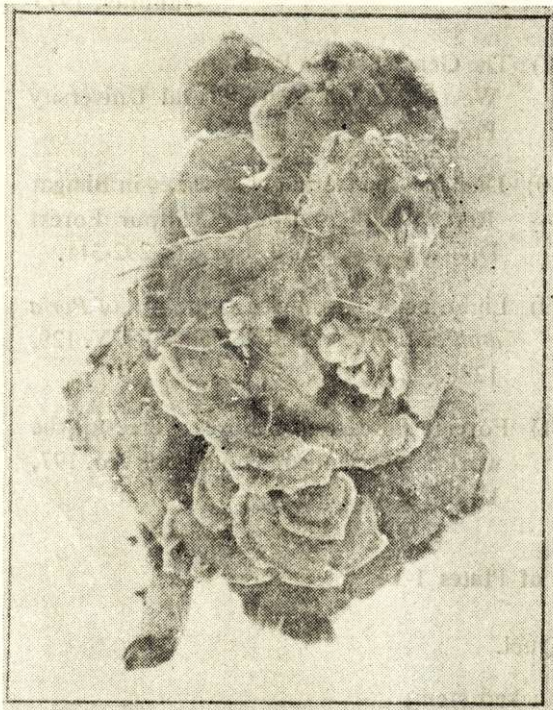

FIG 1a

FIG.1b

FIG.2

FIG 3

FIG.4

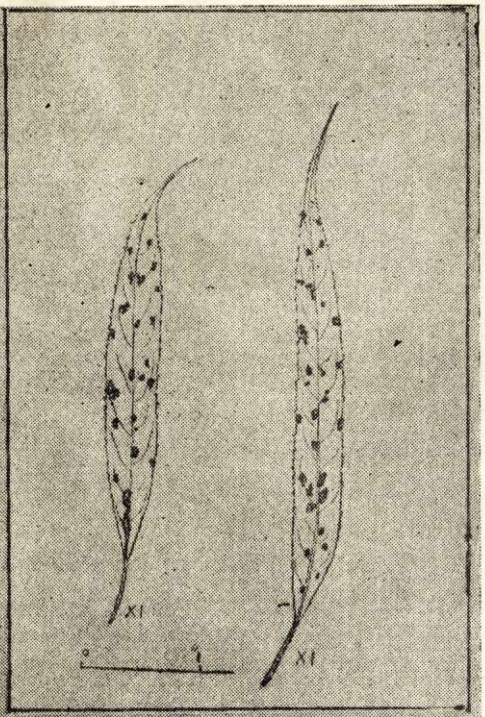

FIG.5

FIG.6

FIG.7

FIG.8

FIG.9

FIG.10

FIG.11

FIG. 12

FIG. 13

FIG. 14 a

FIG. 14 b