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Dieback Resistance Potential in Different Varieties of Shisham (*Dalbergia sissoo* Roxb.)

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Abstract

Nine phenotypically different varieties of Shisham (*Dalbergia sissoo* Roxb.) were identified from Punjab University, Quaid-e-Azam Lahore, Pakistan and adjacent areas, on the basis of physical appearance of the plant, branching pattern, pod characters, leaf and leaflet size and shape, branching and leaf density and stem surface characteristics. On the basis of their relative resistance to dieback disease, the different varieties were named as Resistant 1, Susceptible 1-4, Unspecified 1-4. The Resistant 1 variety is characterized with dense, and long branches, which grow outward and downward forming a canopy. Generally plants do not attain much height. Leaves are large up to 16 cm in length, with four or five leaflets per leaf. Leaflets broad, globose or subglobose, young leaflets glaucous, mature leaflets glabrous, leaflet apex apiculate. Pods small, generally one rarely two seeded. Susceptible 1 and Susceptible 2 varieties were found to be highly susceptible to dieback showing 20% or more dieback incidence. These two varieties have been commonly cultivated in Punjab. Susceptible 3 and Susceptible 4 varieties were least susceptible showing dieback incidence not more than 2 %. The unspecified varieties 1 – 4 were named so because they did not show any disease symptoms but number of plants of these varieties was not large enough to decide their resistant potential. Shisham forestation can be revived by planting Resistant 1 and less susceptible varieties viz., Susceptible 3 and Susceptible 4 on suitable, well-drained sandy loam soils.

Key words: *Dalbergia sissoo*, dieback, resistant variety.

Introduction

Shisham is considered to be native of Tarai situated in the subtropical and dry temperate foothills in Nepal. This valuable tree species was introduced in Pakistan in mid-1800s. At present shisham is the major tree species in the irrigated plantations of Punjab. These plantations were established at various sites in Punjab mainly for production of fuel wood for steam engines. All of these plantations are located on the main railway lines. Some of the major plantations are Changa Manga, Daphar, Perowal, Bahwalpur, Kundian, Kamalia and Chichawatni. At present, the area under such plantations in Punjab is 154,886 ha, with an average annual production of 28,000 m^3 (Khan and Khan, 2000). Shisham has been extensively planted along roadsides, canal banks and sometimes on the private vacant and agricultural lands. Shisham occupies more than 80% forest area of the Punjab (Gill *et al*., 2001).

In the recent past this valuable species has been inflicted with two types of diseases viz. dieback and wilting. These diseases have also been reported from Bangladesh (Baksha and Basak, 2000), India (Sharma *et al*., 2000) and Nepal (Joshi and Baral, 2000), causing a huge damage to this species. Incidence of *D. sissoo* dieback and wilt particularly in central Punjab has been a matter of serious concern to foresters and farmers since its proliferation in recent years. These diseases caused 5% plant mortality during 1990-91, 25% during 1999-2000 and 33% in 2001 in different districts of Punjab (Gill *et al*., 2001). During a recent survey of Sialkot, Gujranwala, Lahore and Sargodha districts of Punjab, Bajwa *et al*. (2003) observed up to 70% shisham mortality along the canal sides.

Mycologists have recorded some 62 pathogenic species of fungi on *D. sissoo* but no bacterial or viral pathogens have ever been reported. Most of the fungi have been studied from mycological point of view and a little has been mentioned on pathological aspects (Khan 1989). *Fusarium solani* is suggested to be the cause of wilt disease. The pathogen is mostly restricted to roots. The fungal hyphae and jelly-like substances plug the vessels resulting in wilt symptoms (Bakhshi, 1954; Manandhar & Shrestha, 2000). According to Khan and Bokhari (1970) wilt is due to *Fusarium oxysporum. Ganoderma lucidum,* a root rot and heart rot fungus, has been attributed to be the primary cause of dieback of *D. sissoo*, with secondary cause from pinhole and long horn beetles. Under stress, termites attack the root

system to accentuate the dieback. The study at Pakistan Forest Institute (Khan and Khan, 2000) has verified the root rot fungus, *G. lucidum* as the primary pathogen, and insect borers, which attack trees already under stress, as secondary invaders. Another fungus *Phellinus gilvus* has also been isolated from the roots of dying back shisham trees (Bakshi, 1974). *Phellinus gilvus* causes root rot in shisham (Khan, 1989). Recently Gill *et al*. (2001) have suggested *Phytophthora cinamomi* as the causal agent of this disease. However, the actual cause of mortality of *D. sissoo* still remains uncertain.

So far no research based biological and chemical control measures have been suggested to tackle the problem of shisham mortality. Under these circumstances cultivation of resistant varieties could be a possible measure to save this valuable tree. Unfortunately studies regarding the genetic variation in shisham are entirely lacking. The present survey of Quaid-e-Azam Campus of Punjab University where more than 2000 shisham plants are growing was, therefore, undertaken to identify different varieties of shisham and their relative resistance to dieback disease. Studies were further extended to survey of Lahore, Gujranwala Sargodha and Sialkot districts to confirm the resistance potential of the identified varieties.

Materials and Methods

A thorough survey of Quaid-e-Azam Campus of Punjab Uniuversity, Lahore and adjacent areas was carried out during July-August 2003. Different varieties of *D.* sissoo were identified on the basis of physical appearance, branching pattern, leaf and leaflet size and shape, leaf and branching density, and pod and stem surface characteristics. The dieback incidence in various verities was recorded. Surveys of Lahore, Sialkot, Sargodha and Gujranwala districts were undertaken afterwards to study the disease resistance potential in the identified varieties under different environmental and edaphic conditions.

Results and Discussion

Nine shisham varieties were identified from Quaid-e-Azam Campus of Punjab Universality Lahore and adjacent areas. On the basis of their disease resistance potential they were named as Resistant 1, Susceptible 1, Susceptible 2, Susceptible 3, Susceptible 4, Unspecified 1, Unspecified 2, Unspecified 3 and Unspecified 4. The unspecified varieties were named so because plants of these varierities did not show any disease symptoms but their number was not large enough to define their resistance potential.

The characteristic features of nine identified varieties are as under:

***Dalbergia sissoo* var. Resistant 1:** Plants of this variety have dense, long and weak branches, which grow outward and downward forming an umbrella shaped canopy. Generally plants do not attain much height (Fig. 3A). Leaves are large up to 16 cm in length, generally with four to five leaflets per leaf. Leaflets broad, globose or sub-globose, adaxial side dark green, abaxial side light green, young leaflets glaucous, mature leaflets glabrous, apex apiculate. Pods small, generally one rarely two seeded (Fig. 4 A).

In Punjab University 8 % Shisham plants belong to this variety. Also in Lahore city many plants of this variety have been planted. However, in other surveyed areas viz. Sialkot, Gujranwala and Sargodha districts, this variety is rare. None of the plant of this variety was found affected with dieback.

***Dalbergia sissoo* var. Susceptible 1:** In this variety branches grow more upward than outward resulting in a typical shape of a tree. Generally branches are short and strong showing minimum or no drooping. However, in some plants a few very long and weak branches are hanging vertically downward from underside of the tree (Fig. 3 B). There is great variation in leaf and leaflet size in different plants of this variety or in different parts of the same plant. Generally leaves on upper branches are larger than the leaves on lower branches. Leaves are always distinctly smaller than the leaves of Resistant 1 variety. Leaflets are ovate with acute or apiculate apex (Fig. 4 B).

This variety is one of the most commonly planted varieties of shisham in Pakistan. It is very common on agricultural lands, and along the roadsides and canal banks. In Punjab University Campus about 70 % shisham plants belong to this variety (Fig. 1). This variety is highly susceptible to dieback. In the University Campus 20 % plants of this variety were showing dieback symptoms and a much higher disease percentage was observed along the roadsides and canal banks in other areas (Fig. 2).

***Dalbergia sissoo* var. Susceptible 2:** In branching pattern and habit, this variety is similar to that of susceptible 1 variety. However, this variety is characterized with production of large number of pods. Pods are almost equal or sometimes greater in number than leaves imparting the plant a yellowish green appearance (Fig. 3 C). Leaves are large, resemble with those of Resistant 1 variety, leaflets slightly glaucous, upper surface dark green, lower surface light green, ovate, globose or

subglobose with apiculate apex. Pods broad, long up to 9 cm in length, 1 –3 seeds per pod (Fig. 4 C).

Similar to Susceptible 1 variety, this variety is also very common along roadsides, canal banks and on agricultural lands. In the University 8 % plants belong to this variety. This variety is also highly susceptible to dieback. Hundreds of plants of this variety have become dead by dieback disease along roadside of canal BRB near Daska, Sialkot. The dieback incidence in this variety is at par with that of Susceptible 1 (Fig. 1).

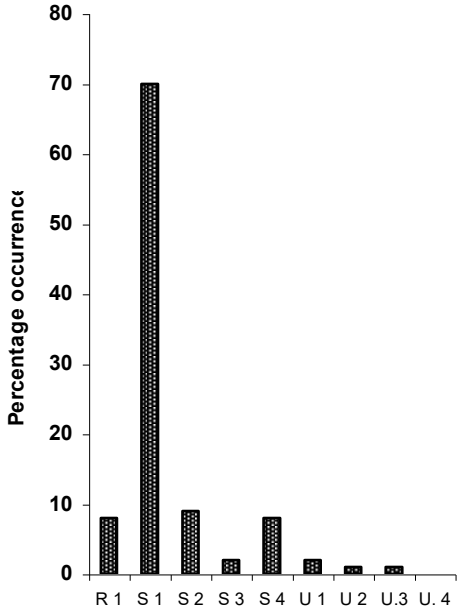

Fig. 1: Percentage occurrence of nine identified Shisham varieties in Punjab University Lahore. **R:** Resistant, **S:** Susceptible **U:** Unspecified

***Dalbergia sissoo* var. Susceptible 3:** The characteristic feature of this variety are large leaves up to 18 cm in length, four or five rarely three broad, globose, and glaucous leaflets per leaf, upper surface dark green, texture sub-coriaceous. Pods small, narrow, one or two seeded (Fig.4D). Branches and leaves are not very dense. Branches are generally short and strong showing minimum drooping. The main stem and older branches are light grayish in colour (Fig. 3D). This variety is not very abundant. In the University Campus there are 2 % Shisham plants belonging to this variety (Fig.1). In Lahore and other districts, plants of this variety were also very rare. This variety is less susceptible to dieback. In the University Campus disease incidence was not more than 2 % (Fig. 2).

***Dalbergia sissoo* var. Susceptible 4:** The characteristic feature of this variety are very long, weak, shiny and light green drooping branches. Branches do not spread outwards thus plant attains the shape of a typical tree (Fig. 3E). The leaves are very long up to 20 cm in length, weak, drooping down, glabrous, bright green, four or five leaflets per leaf, leaflets ovate or ovate lanceolate, apex acute. Pods narrow, one or two seeded, mostly on upper branches (Fig. 4E).

There were 8 % Shisham plants in the University Campus belonging to this variety (Fig.1). In Lahore, about 10% shisham plants belong to this variety. Similar to Susceptible 1, this variety is also less susceptible to dieback. The disease incidence was not more than 2 % in the University Campus and elsewhere in Lahore (Fig.2).

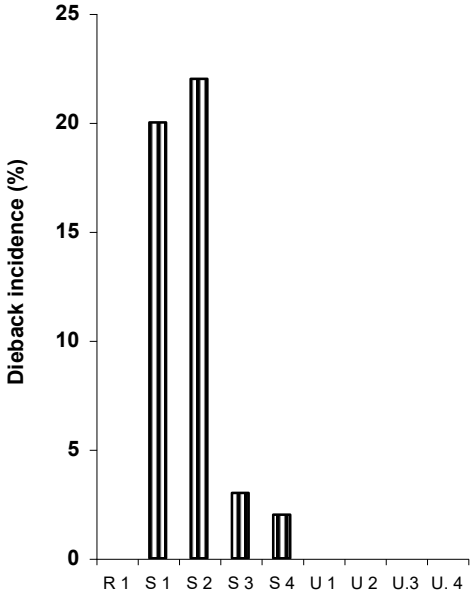

Fig. 2: Dieback incidence in different shisham varieties in Punjab University Lahore. **R:** Resistant, **S**: Susceptible, **U:** Unspecified.

***Dalbergia sissoo* var. Unspecified 1:** Plants of this variety closely resemble with Resistant 1 in branching pattern, bushy appearance and canopy characteristics (Fig.3F). However, in contrast to Resistant 1, this variety exhibits heterophylly. Leaves on outer branches are very large up to 21 cm in length, generally four, rarely three or five leaflets per leaf, leaflets glabrous, thick, and ovate with acuminate apex. Leaves on inner branches have three or four globose leaflets with apiculate apex. Pods narrow, one or rarely two seeded (Fig.4F). Only 2% shisham plants in the University Campus belong to this variety. This variety was not common in other areas. Since this variety closely resembles with Resistant 1, it is expected to be a resistant one.

A: Resistant 1

B: Susceptible 1

C: Susceptible 2

D: Susceptible 3

E: Susceptible 4

F: Unspecified 1

G: Unspecified 2

H: Unspecified 3

I: Unspecified 4

Fig. 3 (A - I): Plants of different varieties of Shisham.

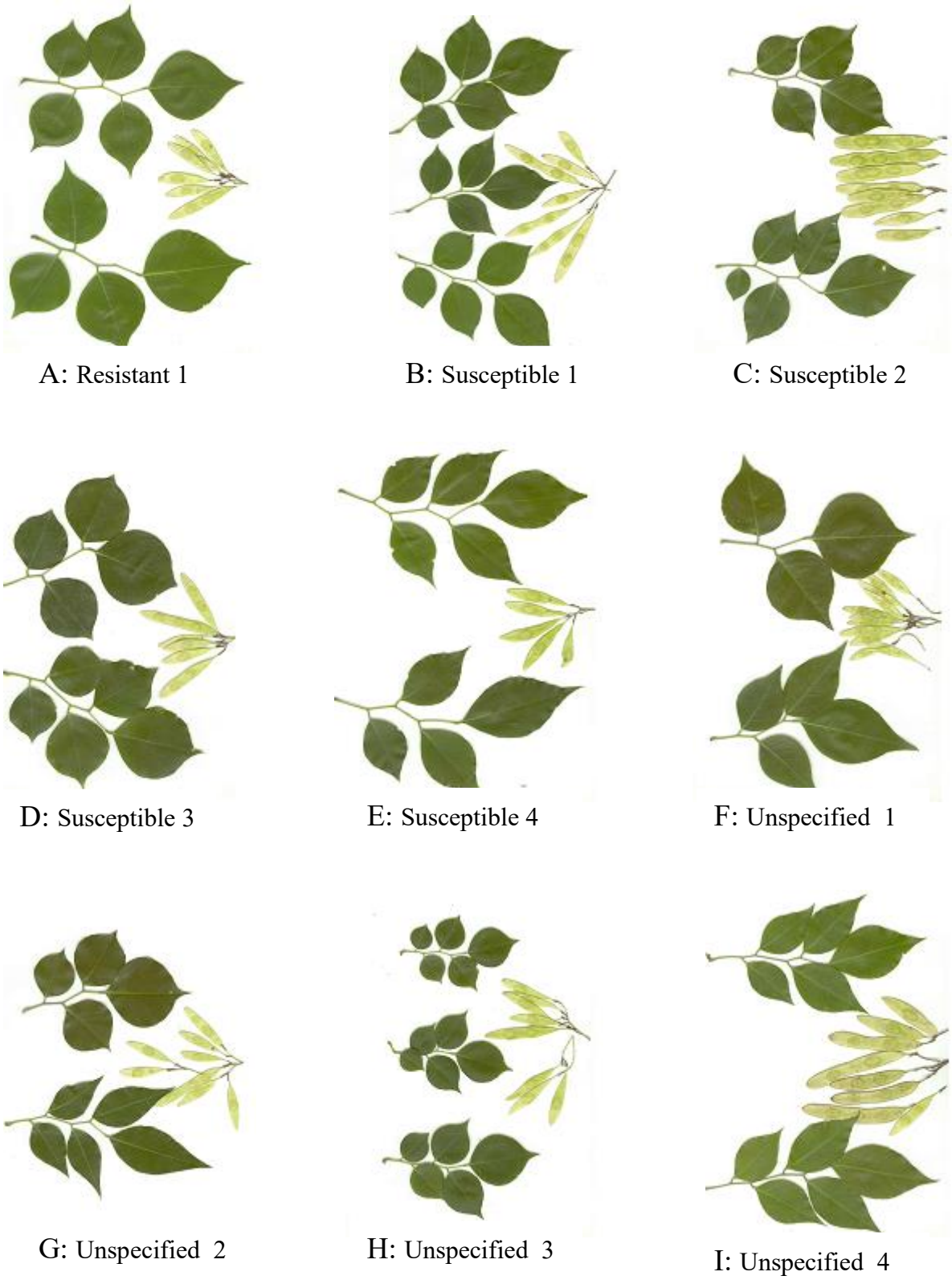

Fig. 4 (A - I): Leaf and pod shapes in different varieties of Shisham.

***Dalbergia sissoo* var. Unspecified 2:** This variety closely resembles with Unspecified 1 in bushy appearance, canopy characteristics and being heterophyllous. However, unlike Unspecified 1, leaflets on outer branches are glaucous much smaller and narrow in this variety. Pods narrow, generally one, rarely two or three seeded (Fig. 3 G & 4G). One % shisham plants in the University Campus belong to this variety. This variety was very rare in Lahore and absent in other surveyed areas (Fig. 1).

***Dalbergia sissoo* var. Unspecified 3:** Plants of this variety exhibit typical tree habit. The characteristic features of this variety are smaller leaves of 10 – 13 cm in length, leaflets small, globose or ovate with apiculate apex. Outer branches long, weak and drooping down. Pods are small and one seeded (Fig. 3 H & 4 H). This variety is very rare.

***Dalbergia sissoo* var. Unspecified 4:** Plants of this variety are characterized with long and very weak branches, hanging vertically downwards. Plant shows a peculiar pushy appearance (Fig. 3 I). Leaves generally with five thin leaflets of bright green colour. Leaflets are similar in shape to that of Susceptible 4. Pods broad and long with 1 – 3 seeds per pod. Pod shape and size closely resembles with Susceptible 2 (Fig. 4-I). This variety was absent in the University Campus and there were only few plants in Lahore city.

If such studies are carried out in other areas of Pakistan and abroad especially in sub-Himalayan tract where Shisham naturally grows, more varieties can be identified. It is, therefore, highly recommended that research work regarding identification of Shisham varieties and their relative resistance to dieback and other diseases should be started in different agro-ecological zones without any further delay. Moreover, genetic and molecular studies should be carried out to identify and isolate disease resistant genes and biochemicals. Only this way we would be able to save this precious tree, which is on the verge of extinction.

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