Shisham (*Dalbergia sisoo*) Mortality: Causes and Remedy

Distribution: *Dalbergia sissoo* Roxb. (Shisham) is native to the plains, low hills and mountain valleys of the sub-Himalayan region. It occurs naturally from sea level up to 1000 m msl sometimes even up to 1500 m msl, from the Kabul River in Afghanistan through northern Pakistan, northern India, Nepal, Bhutan and Bangla Desh and commonly planted throughout all of Pakistan, India and the Terai region of Nepal. It was successfully introduced to other parts of the Asian subcontinent as well as Southeast Asia, Africa, the Middle East, the Caribbean, tropical America, and Florida and Arizona in the United States.

Suitable conditions: It occurs naturally in riverine environments where sunlight and moisture are plentiful with annual rainfall averaging 500 to 4500 mm. Temperature in native range varies from 4° to 50°C and it is tolerant of light frosts but killed by low temperatures or long freezes. It grows well on rich alluvial soil, pure sand or gravel conditions with plentiful moisture and good drainage. It easily survives the periodic flooding associated with riverine sites but do poorly under waterlogged conditions. It requires a pH of 5.0 to 7.7 and tolerates some salinity, but growth is stunted on heavy clayey soils. Natural regeneration is also common on newly exposed sites such as embankments, landslides, overgrazed areas and abandoned farmland.

Mortality: Shisham mortality is spread throughout the Shisham distribution zone, more severe in eastern Uttar Pradesh and Bihar in India. It falls under the category of decline diseases.

Pathogens: Two pathogens have been found responsible for shisham mortality - *Fusarium solani* f. sp. *dalbergiae* causing vascular wilt and *Ganoderma lucidum* causing root rot. The former pathogen was found spread throughout shisham growing area whereas *G. lucidum* is associated in drier localities such as Haryana and Punjab.

Virulent and avirulent strains of *Fusarium solani* f. sp. *dalbergiae* exist. The pathogen moves up the stem from the roots, *F. solani* found in soil, roots and stem as established through DNA finger printing. Fungus can tolerate wide pH range from 4.0 to 10.0 and temperature range from 10 to 35^{o}C, optimum being 20 – 25^{o}C.

Symptoms: The symptoms are yellowing of foliage, followed by gradual wilting and drying leading to top dying, oozing of sap (pitch) and ultimately complete death of the plant. Decline/ wilt is result of both root rotting and colonization of vascular system of stem by the fungus, which blocked water transport though fungal structures and fungal metabolites and byproducts.

Extent of damage: Trees of all the age and diameter classes are affected in the monoculture plantations. Mixed plantations show less signs of mortality. Mature trees of more than 50 years age are highly affected in Shisham plantations. Though younger plantations of Shisham show

high mortality in some areas, particularly where biotic stresses, and erratic rainfall and extreme temperature variations/water-logging have occurred during recent years. Dead trees, partially dead trees as well as stumps are not removed which act as source of infection. Resistant and susceptible seed sources against *F. solani* and clones against *G. lucidum* have been identified. Biocontrol agents like *Trichoderma* species and *Pseudomonas fluorescens* have been found effective against *F. solani* in laboratory, glasshouse and field trials.

Predisposing factors for shisham mortality – edaphic, ecological and biotic:

Unsuitable site selection is one of the main reasons of shisham decline, it grows well on well-drained sites and does not grow well in soils of heavy texture (with more clay and silt content and less sand). Improper soil aeration in stiff and clayey soils cause death of fine/feeder roots due to asphyxiation besides water logging, even for a short duration, causes poor aeration and death of fine/feeder roots due to asphyxiation. Root disease pathogens enter through these dead roots (infection courts) and then attack living roots. Extended period of low temperature/freezes expose the trees to disease.

Biotic pressure resulting into weakening of tree vigour such as:

- Injury to roots in agriculture (in fields) and construction activities (near roads, avenues)
- Cleaning and weeding done through harrowing in plantations causing root damage
- Covering of basal area with landfill, garbage and other material particularly on roadsides and urban areas
- Uncontrolled lopping in agriculture fields
- Blazing of bark for numbering of trees (on roadsides)
- Injuries by cattle
- Intentional girdling (on roadsides for removal)

All these biotic pressure result into opening of wounds, site deterioration and overall weakening of vigour resulting into attack by the pathogens and decline/mortality.

Integrated Disease Management

- Selection and preparation of site – raise shisham on a site having light textured soil with adequate soil moisture and good drainage, avoid stiff clayey soils with water logging tendency

- Sanitation in the field of dead trees, stumps and roots – This will not only allow the timely utilization of the timber from the dead trees but also check the spread of the pathogen to the adjacent trees.

- Avoid pure plantation of shisham, go for mixed plantations preferably with non-leguminous species

- Integrated disease management – application of biological control agents like *Trichoderma* spp. and *Pseudomonas fluorescens;* chemicals – fungicides (propicanojole/bavistin), insecticides (chloropyriphos) and fertilizers (after soil testing)

- Selection of resistant clones and propagation – Such material has been worked out by Forest Research Institute and should preferably be used for future plantations. However, resistant selection should be a continuous process in field by involving specialists.

- Control biotic pressure to check injuries to root system

- Consider lowering of rotation age of shisham may be 35 – 40 years

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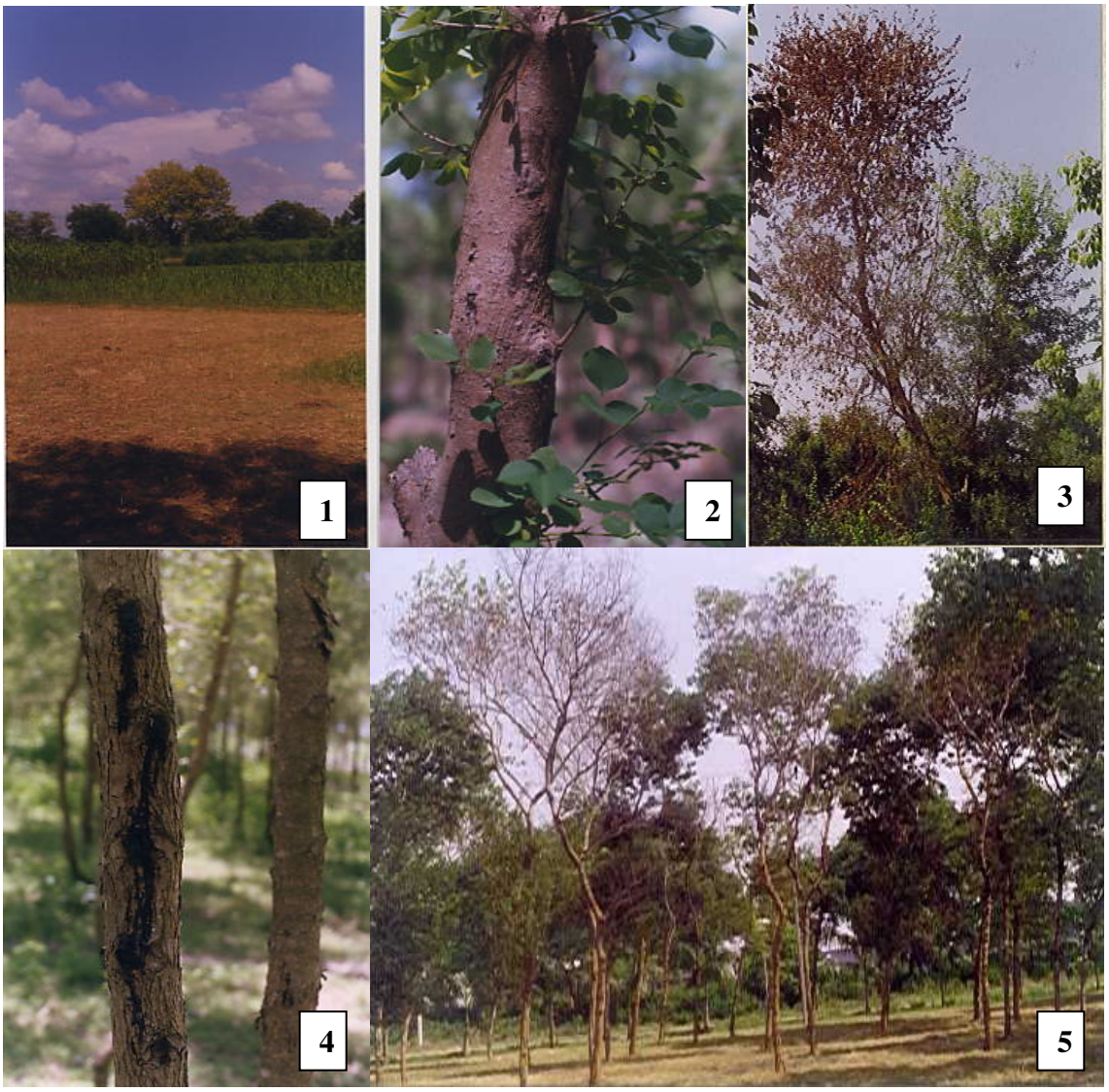
Mortality of shisham trees in field



Disease symptoms: 1. Yellowing, 2. Epicormic branches, 3. Wilting, 4. Oozing of pitch, 5. Mortality