

INTEGRATED MANAGEMENT TO CONTROL DIE BACK DISEASE IN SHISHAM (*DALBERGIA SISSOO* ROXB.) OF NORTH BIHAR

Ravi Shanker Mishra*

Guest Faculty, Department of Botany, Sabour College Sabour,
T.M. Bhagalpur University, Bhagalpur-812007

ABSTRACT

Surveys conducted in various regions of Districts of North Bihar indicated that shisham (*Dalbergia sissoo* Roxb.) plants are significantly affected by wilt and dieback diseases. The highest mortality rate, reaching up to 80%, was recorded along the canal banks, with 20–40% observed along highways and roadsides. The lowest incidence of disease and mortality rates was noted in plants situated on agricultural and well-managed lands. In general, older plants were found to be more vulnerable to dieback than younger ones. Nonetheless, wilt occurred commonly in both young and old plants. Conditions of stress, particularly drought and excessive soil moisture content, were identified as causes for the pathogen attack and the severity of the disease. *Fusarium solani* (Mart.) Appel and Wr. was isolated from the roots of shisham plants afflicted by wilt disease. From the roots of trees that were dying back, *Fusarium oxysporum* (Schlechtend.): Fr. , and *Phytophthora cinamomi* Rands were obtained. Control of shisham decline can be achieved through the implementation of an integrated disease management (IDM) strategy. Benomyl proved effective in managing wilt in 6-8 year old shisham plants. *Trichoderma harzianum* Rifai, *T. viride* Pers. ex Gray, and *T. aureoviride* Rifai can serve as biological control agents to diminish the inoculum of *F. solani*. Eighteen phenotypically distinct varieties of Shisham have been identified at the Horticulture Department, Sabour Agricultural University, Sabour, and surrounding areas. Resistant shisham varieties should be cultivated in well-drained sandy loam soils to mitigate wilt and dieback. Severely infected and dead plants need to be uprooted, followed by soil disinfection to prevent further dissemination of the pathogenic inoculum.

Introduction

Shisham has suffered from two highly destructive diseases, namely wilt and dieback, in North Bihar in recent years, and cases have also been noted in the lower mountain ranges of the Himalayas. In the case of wilt disease, the effects on trees resemble those caused by drought or frost to a significant extent. The disease was initially identified by Bakhshi (1954) in both natural forests and plantations in UP, India. The disease is systemic, meaning that the entire tree exhibits signs of the infection. In its early stages, a tree that has been affected displays drooping leaves and branches due to a loss of turgor. The leaflets turn yellow, dry out, and eventually fall off, leaving the branches bare. The entire tree appears thin compared to the neighboring dense green trees. The death of the affected tree occurs quickly, typically within 1 to 6 months after the crown begins to exhibit symptoms of wilt. *Fusarium solani* is believed to be responsible for this disease (Bakhshi, 1954; Manandhar and Shrestha, 2000; Bajwa et al. , 2003). The pathogen primarily targets the roots. The fungal hyphae and jelly-like substances clog the vessels, resulting in wilt symptoms (Bakhsai and Singh, 1959).

The dieback disease presents more specialized symptoms compared to wilt. The symptoms include thinning of leaves and the crown, drying of terminal branches, yellowing of the entire plant in some instances, table-topped conditions, and stag-headness in severe cases. Small dry twigs fall continuously, causing the tree to resemble a blunt stub with thick branches. Dieback occurs in successive stages and is marked by the gradual death of shoots and roots starting from the tip. There are conflicting reports concerning the causal agent of dieback. The fungus *Phellinus gilvus* has also been isolated from the roots of *shisham* trees experiencing dieback (Bakshi, 1974).

Another fungus, *Ganoderma lucidum*, is regarded as the main cause of this disease. This pathogen inhabits the roots and infects them through both intact and damaged surfaces. The disease spreads laterally in plantations via root contact (Sharma et al. , 2000). According to Gill et al. (2001), the primary cause of *shisham* dieback is *Phytophthora cinamomi*. In the current study, *F. oxysporum* and *P. cinamomi* were isolated from *shisham* trees undergoing dieback. In integrated management, all available relevant information concerning the plant, its pathogens, historical disease data from prior years, varietal resistance to diseases, anticipated environmental conditions, locality, the availability of materials, land, labor, and costs is considered when developing the control program (Agrios, 2005).

The present research outlines the integrated management of *shisham* decline through chemical, biological, and cultural methods, as well as by growing resistant varieties of *shisham*.

Materials and Methods

Survey of different areas of North Bihar: Various regions of the North Bihar districts, such as Katihar, Purnia, Araria, and Kishanganj, were surveyed between 2013 and 2017 to examine the impact of factors such as pH, drought, and excessive soil moisture on disease severity. In each district, the survey was conducted on agricultural lands, along highways and roadsides, and adjacent to canal banks.

Chemical control of *F. solani* – The cause of wilt: The in vitro toxicity of three fungicides, namely Ridomil Gold, Benomyl, and Aliette, was evaluated against *F. solani* using the poisoned food technique (Nene and Thapliyal, 1979). Each fungicide was individually combined with autoclaved melted PDA medium to achieve the desired concentrations of 10, 20, 30, 40, and 50 ppm. Twenty milliliters of the poisoned melted PDA medium were poured into each sterilized plate and allowed to solidify. The PDA medium without fungicides acted as a control. After the medium solidified, 3 mm agar plugs of the fungus on PDA were placed in the centers of the plates. Each treatment was repeated three times. All plates were incubated at 25±2°C. The growth inhibition rate was assessed after 8 days of incubation. The percentage of inhibition in fungal growth was calculated according to Vincent (1957). The data were analyzed using a t-test.

The fungicide (Benomyl), which was identified as the most effective in inhibiting the mycelial growth of *F. solani* by the poisoned food technique, was further tested in the field to control *shisham* wilt through soil drenching with a fungicidal solution at a concentration of 200 ppm. Three *shisham* plants aged 6-8 years, exhibiting distinct wilt disease symptoms, were selected at different sites of North Bihar. Fifty liters of a 200 ppm Benomyl suspension were applied to the soil around each chosen tree. The incidence of the disease was recorded 45 days post-treatment.

In vitro biological control of *Fusarium solani*: Cultures of *F. solani*, isolated from the roots of wilted *Shisham*, were sustained on malt extract agar (MEA) medium. *Trichoderma koningii*, *T. areoviride*, and *T. pseudokoningii* were procured from the University Department of Botany, Tilka Manjhi Bhagalpur University, Bhagalpur, and were maintained on MEA medium. To investigate the antagonistic effects of various fungal species on the growth suppression of *F. solani*, 6 mm diameter plugs of *F. solani* and different antagonists were extracted with a sterilized cork borer and placed at opposite sides of the Petri plates containing MEA medium. Following inoculation, the plates were incubated at 25±2°C. Petri plates containing only *F. solani* served as the control. Each treatment was replicated three times. Data on the mycelial growth of the pathogenic fungus were recorded

after 5 days of inoculation. The data were analyzed using Duncan's Multiple Range Test (Steel and Torrie, 1980).

Identification of resistant Shisham varieties: Various varieties of *Shisham* were identified based on their physical characteristics, branching patterns, leaf and leaflet sizes and shapes, leaf and branching densities, and pod and stem surface traits. The incidence of dieback in different varieties was recorded. Surveys of the districts of Katihar, Purnia, Araria, and Kishanganj were subsequently conducted to assess the disease resistance potential in the recognized varieties under varying environmental and edaphic conditions.

Results and Discussion

Survey of different areas of North Bihar: The highest rate of mortality of *shisham*, ranging from 75–80%, was observed along the canal banks, indicating that elevated soil moisture is a significant contributor to disease severity. The mortality rate along the roadsides, particularly by highways, was also considerably high, ranging from 20–40%. The lowest mortality and disease incidence recorded was 10% or less in the *shisham* trees located on agricultural fields. The incidence was also notably high in areas experiencing drought stress.

Chemical control of *F. solani*: Among the three fungicides tested against *F. solani* in vitro, Benomyl proved to be highly effective, resulting in a substantial decrease in the mycelial growth of the test fungus even at a very low concentration of 10 ppm. Ridomil was effective at higher concentrations, while Aliette did not significantly affect the fungus's growth even at a concentration level of 50 ppm (Fig. 1). Additional fungicides, such as Vitavax, Dithane M-45, Bavistin, and Benlate, are also recognized to exert a significant suppressive effect on the growth of *F. solani* (Ahmad et al. , 1996). Benomyl, the most effective fungicide in vitro trials, was also extremely effective in in vivo experiments. All three *shisham* plants, initially expected to succumb to wilting within the following weeks, managed to recover from the disease after receiving treatment with Benomyl. This fungicide treatment could be greatly beneficial in protecting shisham trees against the threat of wilting. However, further investigation is necessary to evaluate the effectiveness of this fungicide against wilt attacks in older trees. A benomyl-derived fungus toxicant, MBC (Methyl-2-benzimidazol carbamate), is also recognized for its efficacy against wilting. It is a stable fungicide appropriate for injection into trees (Mcwain and Gregory, 1973).

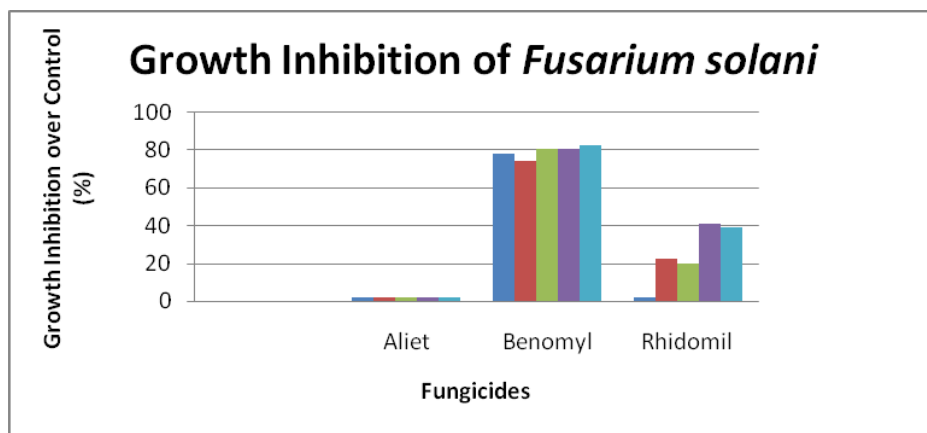


Fig. 1.0: Percentage reduction in *Fusarium solani* growth (%) due to fungicides, Aliet, Benomyl and Rhidomil.

In vitro biological control of *Fusarium solani*: The effects of five species of *Trichoderma* on the in vitro growth of *F. solani* are displayed in Fig. 2. *T. harzianum* demonstrated the best performance, where the colony growth of the test pathogenic fungus was 23 mm compared to 49 mm in the control treatment. This antagonistic fungus inhibited the colony growth of the pathogen by 52. 4%. *T. viride* followed *T. harzianum* in efficacy, decreasing the colony growth of *F. solani* by 24%. The remaining three species of *Trichoderma*, namely *T. aureoviride*, *T. pseudokoningii*, and *T. koningii*, reduced the colony growth of *F. solani* by 13. 7%, 9%, and 2%, respectively. The effects of all tested *Trichoderma* species, except for *T. koningii*, were statistically significant against the test pathogenic fungal species (Fig. 2). Earlier, Dennis and Webster (1971) and Elad et al. (1982) reported that *Trichoderma* spp. can produce either antibiotics or extracellular lytic enzymes or both, which are responsible for antagonism. According to Brasier (1975), the volatiles emitted by *Trichoderma* spp. inhibited the growth of *Phytophthora* spp. , followed by vacuolation of its cell contents that ultimately resulted in lysis of hyphal tips. Lorito et al. (1993) investigated the antifungal activity of *T. harzianum* and found that chitinolytic enzymes produced by *T. harzianum* inhibit the growth of a variety of plant pathogenic fungi.

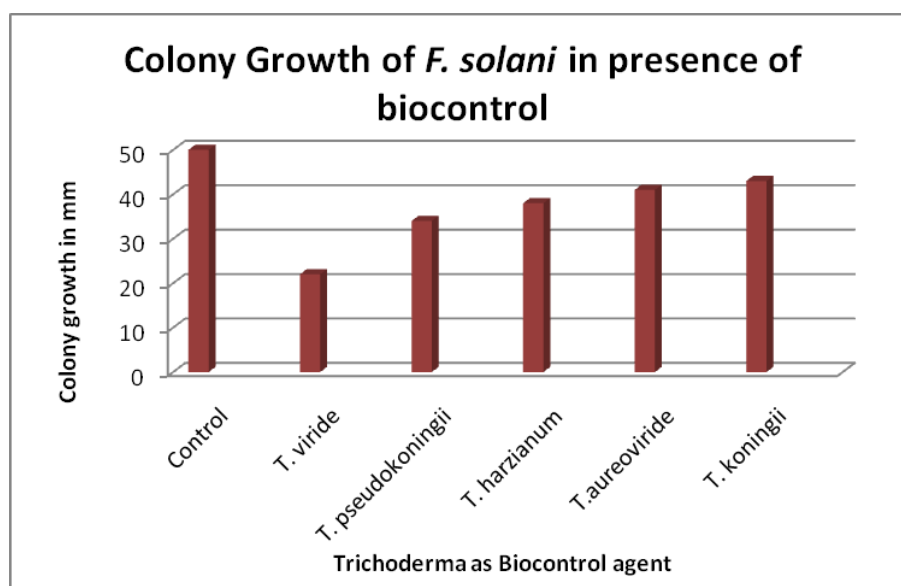


Fig. 2.0: Colony growth of *Fusarium solani* in control and in the presence of different bio-control of *Trichoderma* origin.

Identification of *Shisham* varieties: A total of 14 *shisham* varieties were determined, based on their disease resistance capability they were designated as Resistant 1 and Resistant 2, Susceptible 1 through Susceptible 4, and Unspecified 1 through Unspecified 08. The unspecified varieties 1 – 08 were termed as such because plants from these varieties exhibited no disease symptoms, yet their quantity was insufficient to ascertain their resistance capability.

Based on the findings of the current studies, the following integrated management strategies are suggested to manage the *shisham* decline in North Bihar.

Dead, wilted, and declining plants must be removed to eliminate the breeding grounds of the pathogens, there by preventing further spread of the disease. New plants should be established in appropriate locations, specifically on well-drained sandy loam soils. Planting on clayey and waterlogged soils should be avoided. Mixed cropping is advised instead of monoculture to prevent dieback. New *shisham* nurseries should be created from seeds and cuttings of the resistant variety, and the susceptible varieties should be gradually substituted with the

Resistant. Irrigation is advantageous during relatively dry autumns and during the dry summer months. If dieback symptoms are observed and no particular cause can be identified, consider fertilization and irrigation. Apply Benomyl to treat wilting in young shisham plants. Incorporate organic materials such as farmyard manure along with certain antagonistic fungi to mitigate the spread of the pathogen.

References

- Agrios, G.N. 2005. *Plant Pathology*. Elsevier Academic Press. pp. 348.
- Ahmad, M., M.A. Khan, F. Ahmad and S.M. Khan. 1996. Effectiveness of some fungicides on the colony growth of *Fusarium oxysporum* and *F. solani* associated with potato wilt. *Pak. J. Phytopathol.*, 8: 159-161.
- Bajwa, R., A. Javaid, J.H. Mirza and N. Akhtar. 2003. Chemical control of wilt in Shisham (*Dalbergia sissoo* Roxb.). *Mycopath*, 1(2): 111-113.
- Bakhsai, B.K. and S.L. Singh. 1959. Root disease of Shisham (*Dalbergia sissoo*). VIII: Inoculation study on wilt. *Indian forester*, 85: 415-421.
- Bakhshi, B.K. 1954. Wilt of shisham (*Dalbergia sissoo*) due to *Fusarium solani*. *Nature*, 174: 278-291.
- Bakshi, B.K. 1974. Control of root disease in plantation in reforested stands. *Indian Forester*, 100: 77-78.
- Brasier, C.M. 1975. Stimulation of sex organ formation of *Phytophthora* by antagonistic species of *Trichoderma*. I. The effect *in vitro*. *New phytopathol.*, 74: 183-194.
- Dennis, C. and J. Webster. 1971. Antagonistic properties of species groups of *Trichoderma* II. Production of volatile antibiotics. *Trans. Br. Mycol. Soc.*, 57: 41-48.
- Elad, Y., I. Chet and J. Katan. 1982. Degradation of plant pathogenic fungi by *Trichoderma harzeanum*. *Can. J. Microbiol.*, 28: 719-725.
- Gill, M.A., I. Ahmad, A. Khan, M. Aslam and T. Mahmood. 2001. *Phytophthora cinamomi* – a cause of shisham decline in the Punjab. In: *Proc. of National Seminar on Shisham Dieback, Oct. 27, 2001, Punjab Forestry Research Institute Faisalabad*. pp. 21.
- Lorito, M., G.E. Harman, C.K. Hayes and A. Dipietro. 1993. Chitinolytic enzymes produced by *Trichoderma harzeanum*: Antifungal activity of purified endochitinase and chitobiodase. *Phytopathology*, 83: 302-307.
- Manandhar, G. and S.K. Shrestha. 2000. Fungi associated with dieback of sissoo. In: *Proc. of the sub-regional seminar on dieback of sissoo (Dalbergia sissoo), Katmandu, Nepal, 25-28 April 2000*. pp. 27-30.
- Mcwain, P. and G.F.A Gregory. 1973. Benomyl derived fungitoxicant for tree wilt disease control. *USDA For. Serv. Res. Note, N.E. Forest Expt. Sta.* No. 162. RPP. 53(2): 689 Abst.
- Nene, H.L. and P.N. Thakliyar. 1979. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi, pp.507.
- Sharma, M.K., R.M. Singaland and T.C. Pokhriyal. 2000. *Dalbergia sissoo* in India. In: *Proc. of the sub-regional seminar on dieback of sissoo (Dalbergia sissoo), Katmandu, Nepal, 25-28 April 2000*. pp. 5-16.
- Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics*. A Biometrical Approach. 2nd edition. McGraw Hill Book Co.Inc. New York, USA.
- Vincent, J.M. 1957. Distribution of fungal hyphae in the presence of certain inhibitors. *Nature*, 159:850.