

**REVIEW: MAJOR CONSTRAINTS ON SHISHAM (*DALBERGIA SISSOO* ROXB.) PLANTATIONS AND PATHOLOGICAL DEBATE ON DIEBACK DISEASE IN PUNJAB, PAKISTAN**

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**ABSTRACT**

Economical and pathological review of shisham plantations is often carried out as part of the working of forest/plant pathologists and encomiasts multidisciplinary team meetings. This review describes the author's experience regarding the major issues identified during this process. Current research article covers; actual problems in shisham plantations and reason of controversy in pathology of dieback disease in Punjab (province), Pakistan. This review is intended to be of practical use to the foresters and pathologists reporting shisham dieback disease.

**Key words:** Shisham, dieback disease, plantations, forest.

**INTRODUCTION**

Forests play vital role in the social, architectural, climatic, ecological and economical status of a country. Globally, forest resources cover 33 percent/4 billion hectares (ha) of Earth land and vital constituent of the economy and ecology world wide (Sabine *et al.*, 2004; FAO, 2006). How ever, total area of forest cover constitutes 4.2 million hectares in Pakistan that represent only 4.8 percent of the total land area of 79.6 million hectares (Anonymous, 2006). This forest area percentage is low as compared to other Asian countries like India (24%), Japan (36%), Srilanka (42%), Philippine (43%), South Korea (49%), Bhutan (50%) and Brunei (90%). Pakistan is basically a forest deficient country with only 0.0265 ha of forest per capita (Pakistan Economic Survey, 2004-05) as compared to the world average of one hectare. The forests provide only 3.5 million m<sup>3</sup> of industrial wood each year. Due to population growth of 2.66% annually, the forest resources per capita decline is increasing (Anonymous, 2003). The direct contribution of forestry sector in GDP of 0.2 percent is nominal, which is not satisfactory, but this does not include the intangible and indirect benefits (Anonymous, 2007).

The total forested area is distributed in different provinces and territories of Pakistan viz. Sindh (0.92), Baluchistan (0.33), Punjab (0.69), Khyber Pukhtunkhwa (1.21), Azad Kashmir (0.42) and Northern areas (0.66) (Anonymous, 2005). In Punjab, approximately 200 million trees are present in farm lands, of which 90% are in irrigated areas. Shisham (*D. sissoo*), is one of the important timber tree in Punjab region along with other species like Phulai

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(*Acacia modesta*), Kikar (*Acacia nilotica*), Bakain (*Melia azadirachta*) and Ber (*Zizyphus mauritiana*) (Qureshi, 2004).

The genus *Dalbergia* commemorates a Swedish Botanist Nicholas Dalberg. It is a pantropical genus with approximately one hundred species in different regions of the tropical Asia, America and Australia (Thothathan, 1987). Approximately, twenty seven *Dalbergia* species are represented in the Indo-Pak subcontinent, of which fifteen are native. *Dalbergia sissoo* Roxburgi, is an important and established forest species of this genus in Pakistan, Bangladesh, Nepal, Bhutan, India, and Afghanistan. This species is also distributed in tropical to subtropical regions of Africa and Asia. However, it is most likely to found in Java, Nigeria, Mauritius, Srilanka, Kenya, Northern Zimbabwe, Palestine and South Africa (Tewari, 1994). Shisham is one of the important deciduous forest trees in Pakistan (Khan and Khan, 2000). Due to its great socioeconomic value, this tree has been extensively planted along roadsides, canal banks and sometimes on the private vacant and agriculture lands.

### **Major Constraints of Shisham (*Dalbergia sissoo*)**

Shisham is cultivated in tropical regions world-wide due to its high timber quality. The geographic distribution of Shisham spans over a broad region in the Indian subcontinent generally at a height of 900 to 1500 m from sea level (Southon, 1994). However, this precious tree is facing many devastating challenges from last six decades that dragging it towards disappearance from the subcontinent. The three main leading causes of shisham mortality/deforestation in subcontinent are; (i) mismanagement and poor planning for shisham distribution (ii) forest diseases and (iii) timber mafia.

In last two decades, Shisham has faced high mortality and drying at an epidemic rate. This massive mortality of Shisham caused billions of dollars lose to forest economy in different countries of subcontinent (Dayarum *et al.*, 2003). The main reason of this high Shisham decline is mismanaged/overexploited forest planning through out subcontinent.

Rich germplasm, suitable agro-climate and cultural practices are important in the sustainable forestry. In early forest planning, seeds used, rarely came from broad genetic pool. However monoculture technique was adopted without considering sustainable productivity in various areas of subcontinent. Monoculture practice is one of the reasons in rapid spread of the diseases in plants. In the dense monoculture plantations, the root system of healthy plants easily makes contact with the infected roots of diseased plants and thus infection transfers from one plant to another plant. Therefore in previous years, monoculturing has been one of the factors involved in high mortality due to wilting in all trees irrespective of age in Bangladesh. In Nepal, shisham seeds of

unknown source and origin have been openly imported for use in various shisham trials (TISC 1999a; Dhakal, 2000). Until present, there is no specific Shisham germplasm system in sub continent.

The abiotic stresses and management constraints are basis of reduction/ low growth and disease development in forest cover. Several species of fungi and insects has been reported as minor pest involved in Shisham (Beeson and Bhatia, 1937; Indian Forest Record, 1938; Beeson, 1941; Browne, 1968; Bakshi, 1976; Joshi and Kumar, 1986; Sharma and Bhardwaj, 1988; Sheikh, 1989; Sharma, *et al.*, 2000; Sharma *et al.*, 2011) from nurseries, plantations and natural forests throughout subcontinent. However there is no host specific biological control is mention in the research literature. Fungal dieback, wilt and canker have been extensively recorded on Shisham in this region (Bagchee, 1958; Bakshi, 1963; 1976; Browne, 1968; Khan and Khan, 2000; Bajwa *et al.*, 2003a).

Dieback and wilting are the two main diseases in Shisham plantations. Shisham dieback disease has characteristic symptoms that progress from top to bottom like thinning of leaves and crown, drying up at ends of branches, table topped conditions and stag headness in extreme cases (Khan 2000; Bajwa *et al.*, 2003b). In wilting key symptoms are chlorosis, leaf thinning, death and progressive defoliation (Bakshi, 1963 & 1976). Wilt disease progresses from bottom to top and trees show susceptibility for wilting regardless of age and may die within few weeks (Bajwa *et al.*, 2003a).

Due to high wood quality of shisham, timber mafia and habitual forest offenders are one of the factors to reduce the shisham cover in subcontinent. Hundreds of shisham trees have been felled illegally with help of some forest officials and influential political agents in Pakistan. Timber mafia is also exploiting the fixed-price and net-sale systems of this valuable tree. It is leading to the disenfranchisement of the local stake holders, the profits for the concessionaires and ultimately the unsustainable harvesting of shisham resources. According to present situation, this high cutting rate of trees will result forest into bare lands very soon.

### **Underlying Causes of Shisham Dieback Outbreak**

Forest decline is interpreted as deforestation, forest degradation or a combination of both. However in general term, the gradual but slow reduction of growth and vigor in a plant is called Decline. Whereas, Dieback means the progressive death of twigs and branches that starts at the tips. Generally, trees/shrubs may die within 3-5 year by dieback disease, after symptoms first appear or in some cases survive indefinitely.

Since early 1900, dieback and wilting has been prominent Shisham diseases in subcontinent. However in last two decades, these two diseases has changed the forest situation in subcontinent altogether. Dieback condition usually occurs in fairly old trees of 25 or more years in age. Trees appear to lose vitality, become sparsely foliated, do not produce a crop; and branches begin to die back from top and stagheadness is evident.

According to literature, dieback disease has caused up to 55% mortality of the Shisham population in various regions of subcontinent (Webb and Hossain 2005). In Pakistan, It has caused 5% plant mortality during 1990-1991, 25% during 1999-2000 and 43% in 2001 in various districts of Punjab province (Gill *et al.*, 2001). However in another detailed survey of Punjab, Shisham mortality was recorded 70-80% along the canal sides, 20-40% along the roadsides and highways. It was also clarified that dieback and wilting are main reasons and share holder in serious Shisham decline during 1998 to 2001 (Bajwa *et al.*, 2003b). Underlying causes are so numerous and interrelated, however following major causes of Shisham dieback in subcontinent are,

(i) Distribution of susceptible germplasm: The selection of seed/germplasm and area for the plantation are the two most important criteria in artificial forestation. The narrow genetic bases, often one or few clones (trees), contribute to inferior progeny (higher chance of inbreeding) that are prone to pest and disease attack. Tree Improvement and Silviculture Component (TISC) of IUCN market survey shows that the user (Forest department/ private growers) obtain seeds from different sources without complete genetic suitability (TISC, 1999a; 1999b). In early Shisham plantations, seeds used rarely come from a broad genetic pool in Pakistan and other south Asian countries. The plantations were promoted without considering the risk involvement in monocultures and site selection. It has been estimated that around 90% of the plantation in Nepal terai come from monoculture that caused a serious dieback incidence (Parajuli *et al.*, 1999; FORESC, 1998). Therefore, distribution of susceptible germplasm/ Shisham growing stock by Forest Department and other agencies in past, caused a severe dieback and wilt outbreak during 1998 to 2005 all over south Asia.

In recent past, phenotypically different varieties of Shisham have been grouped under resistance, susceptible and unsusceptible varieties on the basis of their relative resistance to dieback disease (Javaid *et al.*, 2003 & 2004). Moreover, Dhakal *et al.* (2005) studied genetic variation in mortality by comparing survival of Shisham progenies, originating from different parts of Nepal and found a significant difference in mortality percentage between Shisham biotypes. Selection of improved germplasm is crucial for success of plantation programme. The thriving of healthy Shisham directly or indirectly will impact on the amount and quality of the forest outputs, economic productivity and sustainable forest

cover (Hansen and Kjaer, 1999). Shisham dieback in Pakistan could be avoided or minimised if: (i) appropriate matching of seed sources to planting sites was properly done; and (ii) genetically superior planting material was used. According to current scenario, Forest department is giving no attention in Shisham planting programs to grow seedlings from the best germplasm in Pakistan and like wise in other south Asian countries.

(ii) Lacking in Disease Diagnosis: An effective disease management strategy depends on knowledge of disease and pathogen. The lack of adequate disease information and non-linear interactions between biotic and abiotic induce disturbance in forest ecosystem that can cause widespread of tree mortality. In pervious studies, various factors have been discussed as causes of the Shisham dieback disease. Abiotic factors such as drought, flooding or soil conditions, suggested to contribute to Shisham dieback (Sharma *et al.*, 2000; Sah *et al.*, 2003; Dahiya *et al.*, 2004), while these agents were negated by other workers (Webb and Hossain, 2005).

The dieback has been reported in literature as early as 1900 and presumes to be one of the major threats to Shisham in subcontinent. Fungi have been predominantly claimed as causative agents of dieback, including *Fusarium solani*, which was reported from India early 1954 as putative agent of a disease (wilting) on Shisham similar to dieback (Bakshi, 1954). However, Shisham dieback and wilting mortality has been confused by foresters and researchers for long time (Gill *et al.*, 2001; Khan *et al.*, 2004). Therefore, an actual loss due to dieback or wilting can not be estimated. Several fungal pathogens including *F. solani*, insect and bacteria are recorded during dieback disease investigations in Napal (Joshi and Baral, 2000; Manandhar and Shrestha, 2000; Shakya and Lakhey, 2007) and Bangladesh (Baksha and Basak, 2000; Tantau *et al.*, 2005). However, Shakya and Lakhey (2007) claimed that *F. solani* is the primary causative pathogen of Shisham dieback in Nepal.

In the Punjab province (Pakistan), incidence of Shisham dieback and wilt has been a matter of serious concern to foresters and farmers since its proliferation in the last three decades. According to Khan and Bokhari (1970), the primary cause of Shisham dieback is *F. oxysporum* and *Ganoderma lucidum* where as secondary causes are pinhole and long horn beetles. Khan and Khan (2000) concluded that the root rot fungus, *Ganoderma lucidum* is a primary pathogen of dieback. Several fungal isolates like *Phytophthora cinnamomi*, *F. dimerum*, *F. solani* and species of *Pestalotia*, *Spergillus*, *Botrytrichum*, *Botrytis*, *Phoma*, *Drechslera*, *Botryodiploia* sp, *Alternaria* and *Rhizoctonia* were also isolated from samples including root and bark of dieback infected trees and *P. cinnamomi* was declared as dieback pathogen in Punjab (Gill *et al.*, 2001; Zakaullah, 2001). Whereas, Gul (2001) believed root and stem rotting fungal pathogens are the main cause of Shisham dieback in Punjab, Pakistan.

In recent studies, *F. solani* along with *F. oxysporum* (Bajwa and Mukhtar, 2006) isolated as dominant fungal species in various agroecological zones and *Botryodiplodia theobromaewas* was reported as causal organism of shisham dieback during 2003-2005 in Punjab (Idrees *et al.*, 2006). Whereas, Pathan *et al.* (2007) and Rajput *et al.* (2008) isolated *F. solani*, *Rhizoctonia solani* and *Curvularia lunata* as prominent fungal species from dieback infected shisham trees samples. However, recently *Ceratocystis fimbriata* along with *F. solani* has been claimed as pathogen of Shisham and cause of decline disorder of shisham in Pakistan (Poussio *et al.*, 2010), however, previous records and typical symptoms of *Ceratocystis* attack have not been mention in the literature in association of with shisham dieback (Khan and Khan 2000; Gill *et al.*, 2001; Zakauallah, 2001; Bajwa and Mukhtar, 2006).

Despite many national and even regional forest monitoring efforts, there is an absence of adequate and accurate data on Shisham dieback status in Pakistan and Shisham growing countries. Currently, all the Provincial Forest Departments and National and Provincial Research Institutes are conducting maga research projects on this problem in collaboration with national institutions and Agricultural Universities. However, a number of information gaps and scientific uncertainties have limited the conclusions level in case of Shisham dieback. There is need to create link between studies that will be helpful to evaluate trends in Shisham mortality and the forecast about future disease. Inappropriate or non-existent management and silvicultural regime has contributed the problem more severe in the form of pathological and entomological incidences.

Pervious contradictions in shisham dieback studies clearly indicate that there are two schools of thought that make Shisham dieback a complex issue in Punjab. According to one group quite a large number of pathogens are shown to be involved in Shisham dieback, a number of pathogens have been claimed without any link with pervious studies (Khan and Bokhari, 1970; Khan and Khan, 2000; Gul, 2001; Gill *et al.*, 2001; Zakauallah, 2001; Idrees *et al.*, 2006). The second group in early literature, strongly supports the involvement of only one or two pathogens in support of early literature (Joshi and Baral, 2000; Manandhar and Shrestha, 2000; Bajwa and Mukhtar, 2006; Shakya and Lakhey, 2007; Poussio *et al.*, 2010). Therefore overall, additional monitoring of Shisham health/infection and result oriented research is needed to improvise with scientific certainty regarding Shisham dieback. A modify scientific research will be helpful for accurate input to policy decisions and forest management in Pakistan.

## REFERENCES

Anonymous, 2003. Forest Sector Master Plan: National perspective. Ministry of Food, Agriculture and Cooperatives, Government of Pakistan, Islamabad, Pakistan. pp:12.

Anonymous, 2005. Pakistan Statistical Year Book. Govt. of Pakistan Statistics Division Federal Bureau of Statistics. PP:26.

Anonymous, 2006. Depleting forest cover. Editorial ,July 21,2006.Pakistan Observer (A daily news paper).

Anonymous, 2007. Economic survey of Pakistan, 2006-2007.

Bagchee, K., 1958. Diseases of forest trees in India - causes, effects and methods of prevention. *Indian Forester* 84: 407-417.

BAJWA, R and I. Mukhtar, 2006. Incidence of shisham dieback disease in different agro-ecological zones of the Punjab [Pakistan]. Proceedings of Third National Seminar on Shisham dieback, May 11, 2006. p. 89-106.

Bajwa, R., Javaid, A. and M. B. M. Shah, 2003(b). Extent of Shisham (*Dalbergia sissoo* Roxb.) Decline in Sialkot, Gujranwala, Lahore and Sargodha Districts. *Mycopath* 1: 1-5.

Bajwa, R., Javaid, A., Mirza, J. H. and N. Akhtar, 2003(a). Chemical Control and Wilt in Shisham (*Dalbergia sissoo*). *Mycopath*. 1: 111-113.

Baksha, M. W. and A. C. Basak, 2000. Mortality of sissoo (*Dalbergia sissoo* Roxb.) in Bangladesh. In: Proceedings of the Sub- Regional Seminar "Die-Back of Sissoo (*Dalbergia sissoo*)", Katmandu, Nepal, 25–28 April 2000, pp. 1–4.

Bakshi, B. K., 1954. Wilt disease of sisham (*Dalbergia sissoo*) due to *Fusarium solani* Sensus Synder and Hansen. *Nature* 174: 278.

Bakshi, B. K., 1963. Dangerous forest diseases in India. In Internationally dangerous forest diseases. Miscellaneous Publication 939. Forest Service, United States Department of Agriculture, pp. 55-61.

Bakshi, B. K., 1976. Forest Pathology – Principles in practice in Forestry. FRI Press, PLO, FRI, Dehra Dun., India.

Beeson, C.F.C. and Bhatia, 1937. Indian Forest Record. *Entomology series* 12:266-76.

Beeson, C.F.C., 1941. The ecology and control of the forest insects of India and the neighboring countries. Dehra Dun (India): Vasant Press, 1007 pp.

Browne, F. G., 1968. *Pests and Diseases of Forest Plantation Trees*. An annotated list of the principal species occurring in the British Commonwealth. Clarendon Press, Oxford.

Dahiya, S. S., Sharma, J. C. and J. C. Kaushik, 2004. Dieback of Shisham (*Dalbergia sissoo* Roxb.) and Kikar (*Acacia nilotica* L.) Trees in Haryana (India). *Annals of Agri Bio Research* 9: 175-182.

Dayaram, J., Kumar, M., Sharma, S. and O. P. Chaturvedi, 2003. Shisham mortality in Bihar: extent and causes. *Indian Phytopathology* 56: 384-387.

Dhakal, L. P., Jha, P. K. and E. D. Kjaer, 2005. Mortality in *Dalbergia sissoo* Roxb. Following heavy infection by *Aristobia horridula* ( hope ) beetles. Will genetic variation in susceptibility play a role in combating declining health ?. *Forest Ecology and Management* 218: 270-276.

Dhakhal, L. P., 2000. Sissoo dieback: is Tree improvement a problem solution?. Proceedings of the Sub-Regional Seminar. Die-Back of sissoo (*Dalbergia sissoo*). Kathmandu, Nepal, 25-28 April 2000.

FAO, 2006. Global Forest Resources Assessment 2005 – Progress towards sustainable forest management. FAO Forestry Paper 147. Rome.

FORESC, 1997. A report on field investigation of top-dying of *Dalbergia sissoo* growing at some districts of the central and eastern Terai. Forest Research and Survey Centre and Department of Forests, Kathmandu.

Gill, M. A., Ahmad, I., Khan, A. U., Aslam, M., Ali, S., Rafique, R. M. and M. Khan, 2001. *Phytophthora cinnamomi*. A cause of shisham decline in Punjab, Pakistan. Proc. of 3rd Natl. Cont. of Plant Pathol. Oct. 1-3, NARC, Islamabad, pp.33-37.

Gul, H., 2001. Survey of Shisham dieback in the Punjab. In: Proc. of National Seminar on Shisham Dieback Oct.27, 2001.pp.23.

Hansen, C. P. and E. D. Kjaer, 1999. Appropriate Planting Material in Tree Plantings: Opportunities and Critical Factors. Proceeding of International Expert Meeting on the Role of Planted Forest Management 6-10, April 1999, Santiago, Chile. Published by: DFSC, Denmark.

Idrees, M., Zaidi, S. S., Khan, A. U. and A. S. Akhtar, 2006. Studies on Mycoflora of Shisham and Development of Dieback Disease. PP: 43-51. Proceeding of the third national seminar on Shisham Dieback 11th May 2006 (PFRI), Faisalabad.

Indian Forest Record, 1938. The Manager of Publications, Delhi, India. Entomology Series. 4(1).

Javaid, A., Bajwa, R. and M. B. M. Shah, 2003. Dieback resistance potential in different varieties of Shisham (*Dalbergia sissoo* Roxb.). *Mycopath* 1: 105-110.

Javaid, A., Bajwa, R. and T. Anjum, 2004. Identification of some more varieties of Shisham (*Dalbergia sissoo* Roxb.) and their response to dieback and wilt. *Mycopath* 2:55-59.

Joshi, H. K. and A. Kumar, 1986. On the occurrence of fungal diseases in some fodder trees. *Nitrogen Fixing Tree Research Reports* 4: 18-19.

Joshi, R. B. and S. R. Baral, 2000. A report on dieback of *Dalbergia sissoo* In Nepal. In: Proc. of the Sub-Regional Seminar on Dieback of *sissoo* (*Dalbergia sissoo*), Katmandu, Nepal, 25-28 April 2000. pp. 17-22.

Khan, A. H. and A. S. Bokhari, 1970. Damage due to fungus diseases in Bhagat Reservoir plantation, Lyallpur, Forest Division. *Pakistan Journal of Forestry* 20: 3: 293–311.

Khan, M. H., 2000. Shisham Die-back in Pakistan and Remedial Measures. Proceedings of the Sub-Regional Seminar. Die-Back of *Sissoo* (*Dalbergia sissoo*). Kathmandu, Nepal, 25-28 April 2000.

Khan, M. M. and M. H. KHAN, 2000. Dieback of *Dalbergia sissoo* in Pakistan. In: Proc. of the Sub-Regional Seminar on Dieback of *sissoo* (*Dalbergia sissoo*) Katmandu, Nepal, 25-28 April. pp. 51-56.

Manadhar, G. and S. K. Shrestha, 2000. Fungi associated with dieback of *sissoo* In: Preceding the sub-regional seminar on dieback of *sissoo* (*Dalbergia sissoo* Roxb.) (Katmandu Nepal April, 25-28) pp 27-30.

Pakistan Economic Survey, 2004-2005. Ministry of Finance. Econ. Division, Islamabad.

Parajuli, A. V., Bhatta, B., Adhikari, M. K., Tuladhar, J. R., Thapa, H. B. and G. B. Uuwa, 1999. Investigation on the causal agents responsible for the die-back of *Dalbergia sissoo* in eastern Terai belt of Nepal. Department of Forest Research and Survey, Kathmandu, Nepal.

Pathan, M. A., Rajput, N. A., Jiskani, M. M. and K. H. Wagan, 2007. Studies on intensity of shisham dieback in Sindh and impact of seed-borne fungi on seed germination. *Pakistan Journal of Agriculture Agricultural Engineering and Veterinary Sciences* 23: 12-17.

Poussio, G. B., Kazm, M. R., Akem, C. and F. S. Fateh, 2010. First record of *Ceratocystis fimbriata* associated with shisham (*Dalbergia sissoo*) decline in Pakistan. *Australasian Plant Disease Notes* 5: 63–65.

Qurashi, M. A. A., 2004. Basics of Forestry. Aone Publishers Lahore. Pakistan PP:56.

Rajput, N. A., Pathan, M. A., Jiskani, M. M., Rajput, A. Q. and R. R. Arain, 2008. Pathogenicity and host range of *Fusarium solani* (Mart.) Sacc., causing dieback of Sisham (*Dalbergia sissoo* Roxb.). *Pakistan Journal of Botany* 40(6): 2631-2639.

Sabine, C. L., Heimann, M., Artaxo, P., Bakker, D. C. E., Chen, C. T. A., Field, C. B., Gruber, N. L. E., Quéré, C., Prinn, R., Richey, J. E., Lankao, P. R., Sathaye, J. A. and R. Valentini, 2004. Current status and past trends of the carbon cycle. In C.B. Field & M.R. Raupach, *The global carbon cycle: integrating humans, climate, and the natural world*, pp. 17–44. Washington, DC, USA, Island Press.

Sah, S. P., Sharma, C. K. and F. Sehested, 2003. Possible role of the soil in the sissoo forest (*Dalbergia sissoo* Roxb.) decline in the Nepal Terai. *Plant Soil Environmet*, 49: 378-385.

Shakya, D. D. and P. B. Lakhey, 2007. Confirmation of *Fusarium solani* as the causal agent of die-back of *Dalbergia sissoo* in Nepal. *Plant Pathology* (Oxford) 56.

Sharma, M. K., Singaland, R. M. and T. C. Pokhriyal, 2000. *Dalbergia sissoo* Roxb. in India. In: Proc. of the Sub-Regional seminar on dieback of sissoo (*Dalbergia sissoo* Roxb.), Katmandu, Nepal, 25-28 April 2000. pp. 5-16.

Sharma, P., Singh, N. and O. P. Verma, 2011. First report of *Curvularia* leaf spot, caused by *Curvularia affinis* on *Dalbergia sissoo*. *Forest Pathology*, doi: 10.1111/j.1439-0329.2011.00745.x-2011.

Sharma, R.C. and L. N. Bhardwaj, 1988. Forest nursery diseases and their management. In: Ram Parkash (ed.) *Advances in Forestry in India*, International Book Distributors, Debra Dun, India, Vol. II, pp. 91-118.

Sheikh, M. I., 1989. NFT Highlights Sissoo- The Versatile Rosewood, NFTA 89-07, Forest, Farm, and Community Tree Network (FACT Net), Winrock International, Morrilton, AR, 72110-9370, USA.

Southon, I. W., 1994. Phytochemical dictionary of the Leguminosae. Chapman & Hall, London.

Tantau, H., Hoque, M. I., Sarker, R. H. and H. P. Mühlbach, 2005. 16S rDNA sequence analysis of bacterial isolates from die-back affected sissoo trees (*Dalbergia sissoo* Roxb.) in Bangladesh. *Journal of Phytopathology* 153: 517-52.

Tewari, D. N., 1994. A monograph on *Dalbergia sissoo*. Intern. Book Distributors 9/3, Rajpur Road, DaraDun, India.

Thothathn, K., 1987. Taxonomic Revision of the Tribe Dalbergieae of Indian Sub continent. BSI, Howarth.

TISC, 1999a. Seed Market survey of 15 districts of Nepal, Internal Report, TISC Archive Hattisar, Naxal, Kathmandu, Nepal.

TISC, 1999b. Seedling Production Survey of Nepal, Internal Report. TISC Archive, Hattisar, Naxal, Kathmandu, Nepal.

Webb, E. L. and S. M. Y. Hossain, 2005. *Dalbergia sissoo* mortality in Bangladesh plantations: correlations with environmental and management parameters. *Forest Ecology and Management* 206: 61-69.

Zakaullah, 1999. Shisham decline in Pakistan. *Plant diseases of economic importance and their management*, pp: 12. Proc. the Second National Conf. Plant pathology organized by Pakistan Phytopathological Society, UAF, Pakistan.