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Causes of *Dalbergia sissoo* Dieback in Dargai Forest Subdivision, Khyber Pakhtunkhwa, Pakistan

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Abstract

Dalbergia sissoo (Shashim) is an important multipurpose planted tree species in Pakistan. However, Shashim Dieback is a common problem with the species. Here this study explored the effect of Dieback in Dargai forest subdivision, Khyber Pakhtunkhwa, Pakistan using field inventory. The results showed that the Dargai forest subdivision was too much affected by Dieback. Among the different plantation sites, the Abazai canal side was severely affected (69%) as compared to the other sites. The fewer infestations were found in Pirsaddo Disty. The mature *Dalbergia sissoo* crop was severely affected by the disease as compared to the young plantation. The results showed that insect, termite and some species of fungi were responsible for the Dieback of the tree. Especially two species of fungi (*Fuserium soloni* and *Ganoderma lucidium*) were responsible for the Dieback disease. Furthermore, the present findings revealed that ., show temperature have no obvious effect on the severity of the Dieback but the low amount of precipitation and deep water table were the prominent climatic factor for the disease.

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Introduction

Dalbergia sissoo is a well-known timber species of the rosewood genus. However, it is also used for fuel wood and charcoal, shade, sporting goods, and fodder tree (Sheikh, 1993). *Dalbergia sissoo* belongs to the family Leguminosae, subfamily Papilionoideae. The genus *Dalbergia* is named after Swedish botanist Nicholas Dalberg. *Dalbergia sissoo* is native to the sub-Himalayan tract of India, Pakistan, and Nepal within elevation range of 900-1500 m. The tree has a native temperature range of 12-22°C, but it can tolerate up to 50°C. The average rainfall needed from 300-2000 mm (Sheikh, 1993; Khan, 2000; Singh *et al.*, 2011).

According to Tewari (1994), *Dalbergia sissoo* is indigenous only to the sub-Himalayan tract of India, Pakistan, and Nepal, growing naturally here as well as in the outer Himalayan regions up to 1000 m altitude. The tree is found over a vast region extending to the Indus Assam, except in the coldest, wettest and driest area. The species grows on riverbeds, along with water canal and alluvial flats subjected to annual floods. *Dalbergia sissoo* is a gregarious colonizer of landslides, new embankment, grassland and other places where mineral soil is exposed (Lodhiyal *et al.*, 2002).

Irrigated plantation in Pakistan covers a sizeable area in various localities in the country. The pure monoculture plantation of the *Dalbergia sissoo* usually suffers more from different diseases (Khan, 2000). Most of the studies showed that the dieback is the main cause for the loss of the *Dalbergia sissoo* (Webb & Hossain, 2005).

Root rot of *Dalbergia sissoo* is caused by *Ganoderma lucidum* in both natural forests and in plantations (Khan *et al.*, 1999). *Meloidogyne javanica* has been reported to form galls on roots of *Dalbergia sissoo* in Dehradun (Sharma & Mehrotra, 1992). In Khyber Pakhtunkhwa, Pakistan *Dalbergia sissoo* is distributed throughout the canal system of Mardan, Charsadda, Bannu, Peshawar, Malak and (Dargai) and D I Khan. It is also grown on private land,

community forestland along the canal, roadside, and along railway lines. The tree is susceptible to a variety of diseases in different parts of Khyber Pakhtunkhwa. However, up-to-date no sophisticated scientific information is available regarding this. Therefore, the present study was designed to assess the dieback in the *Dalbergia sissoo* crop.

The objectives of the present study were to conduct a survey for the assessment of dieback in *Dalbergia sissoo* crop and to identify the disease-causing agents. It is expected that the results obtained from this study will be helpful for policy makers to have for taking remedial measure.

Materials and methods

Study area

The study area is located in the south of Malakand pass and west Dargai city, Khyber Pakhtunkhwa, Pakistan. Malakand is located between the latitudes 34°37' and 35°00' N and longitudes 71°37' and 72°40' E. It has an average elevation of about 450 m from sea level.

The climate of the tract is sub-tropical. The average monthly maximum and minimum temperature, rainfall and relative humidity recording in Malakand are shown in Table 1. The present study deals with canal strips and avenue plantation growing on the bank of upper, Swat canal system. The canal provides a full supply of water and makes the Jabban fall that, feeds Dargai Hydro Station. At Dargai, two sub-canals originate namely Abazai and Machi.

In Dargai, forest sub division *Dalbergia sissoo* crop is grown by Forest Department on the Abazi branch, Shingrai minor Machi branch and Pirsaddo Disty. In Abazai branch the plantation starts from Dargai and ends on Reduce Distance (RD) number 55 near to Henrich and. The Shangrai minor plantation starts from Palon-Nau and ends on RD number 17 in Ghawar Kaly, while in Pirsaddo Disty it starts from Mula Misri, and ends in Koper.

Collection of data

First, all the trees on both side of canal side were counted in the study sites. Then the trees were classified into healthy and dieback trees. The ocular observation was made for counting the healthy and infested trees. Trees were counted while moving slowly on a motorcycle. Percent infestation rate was calculated on bases of the total number of trees both healthy and infested. Infestation percentage was also found in mature and young trees. From all study sites, soil samples were collected from infested trees to find the agents responsible for the disease. Soil sample was also collected from 12" radius of the plant. The data collected from the field area was put in Microsoft Excel for necessary analysis. About 15 samples were collected from three localities. Similarly, wood samples were also taken from the bottom middle and top portion of the infested trees. The samples taken from the field area, were handed over the biotechnology laboratory, department of

biotechnology, University of Malakand, Pakistan, for fungus analysis.

Results and discussions

Infestation severity in the study area

Pirsaddo Disty

On the Pirsaddo Disty *Dalbergia sissoo* plantation was carried out only by the Forest Department. The results showed the the old age *Dalbergia sissoo* crop was more affected by the disease as compared to the pole and sub-mature crop (Table 2).

During the field investigation, it was noted that the respective Forest Department has removed some of the infested trees from the crop. However, still, a number of diseased trees were found that might be increasing the infestation of the remaining crop in future.

Table 1. Meteorological data recorded at Dargai, Malakand Pakistan.

Month	Mean monthly Temperature °C		Total precipitation(mm)
	Max	Min	
Jan	12	4	85.598
Feb	16	10	10.160
Mar	19	14	2.54
Apr	29	22	137.570
May	28	23	No rain in this month
Jun	34	28	133.858
Jul	32	27	178.07
Aug	32	26	169.36
Sep	31	27	No rain in this month
Oct	29	19	27.94
Nov	20	12	3.81
Dec	17	9	59.69

Source: (2004-2014) Statistical Office, Crop Reporting Service at Dargai, Malakand, Pakistan.

ShaangraiMinor

On the Shangrai Minor, most of the dieback-infested trees were removed by the Forest Department. The infestation rate was found higher in this area as compared to the other sites. The results highlighted that in Shaangrai Minor the mature, the sub-mature and pole stage trees were affected a (Table 3).

Abazai Branch

In the Abazai canal side plantation, the 31% of trees were recorded healthy and 69% were effected by dieback in the mature class, while in sub-mature and pole stage, 96% trees were healthy and 4% were dieback. Detail results for the Abazai canal plantation are presented in Table 4.

Table 2. Status of the *Dalbergia sissoo* by age class in Pirsaddo Disty.

Category	Mature stage	Sub mature and pole stage
Healthy	66%	93%
Effectuated by Dieback	34%	7%

Table 3. Status of the *Dalbergia sissoo* by age class in Shangrai Minor.

Category	Mature stage	Sub mature and pole stage
Healthy	50%	80%
Effectuated by Dieback	50%	20%

Effect of environmental parameters on Dalbergiasissoo dieback

Effect of precipitation

The average favorable concentration of rainfall for *Dalbergia sissoo* dieback is varied from 750 to 4500 mm, most of its falling in June to September (Luna,

2005; Rajwat *et al.*, 1990).The rainfall was relatively very low in the studied area, which is shown in Fig. 1. The fluctuations in the rainfall over the last 10 years might put *Dalbergia sissoo* under stress and Nitrogen replenishment from the atmosphere may not occur.

Table 4. Status of the *Dalbergia sissoo* by age class in Abazai branch.

Category	Mature stage	Sub mature and pole stage
Healthy	31%	96%
Effectuated by Dieback	69%	4%

Table 5. Water table depth in study area.

Area	Water table in (m)
Shangrai Minor	16
Pirsaddo Disty	11
Abazai Branch	14

Temperature

Dalbergia sissoo grows naturally under the subtropical climatic condition, characterized by a mean annual temperature of 18-24°C, with a pronounced winter and occasional frost (Siddiqui *et al.*, 1999). However, in the natural habitat and in the regions where the species introduced in the Indo-

Pakistan sub-continent, the absolute maximum temperature of the hottest month may be as high 50°C and also fall down extremely down(Sharma *et al.*,1988).The temperature had no effect on *Dalbergia sissoo* but prolonged drought might have caused dieback in *Dalbergia sissoo*.

Table 6. Status of the fungi in the study areas: ■ Represent *Fausarium solani* and *Ganoderma lucidium*▲ = *Fausariumsolani*● =*Ganoderma lucidium*♥ = not found, in the samples.

Pirsaddo Disty	Shaangrai Minor	Abazai Branch
■	●	▲
■	■	●
■	■	■
▲	■	♥
▲	■	■

The temperature of the area was also not suitable for the *Dalbergia sissoo*. The average temperature from 2004-2008 is shown in the Fig. 2.

Groundwater table

Most of the locals of the surveyed area referred dieback due to the fall in the groundwater table. The water table of the area had fallen due to the digging of

canal systems as shown in Table 5. The Salinity Control and Reclamation (SCARP) operation has caused damages to the root system in the observation of water (Khan, 2000). Fall in the groundwater table might be another reason for dieback. As continuous fluctuations in groundwater effect roots directly i.e. might cause root rot and nutrients lost.

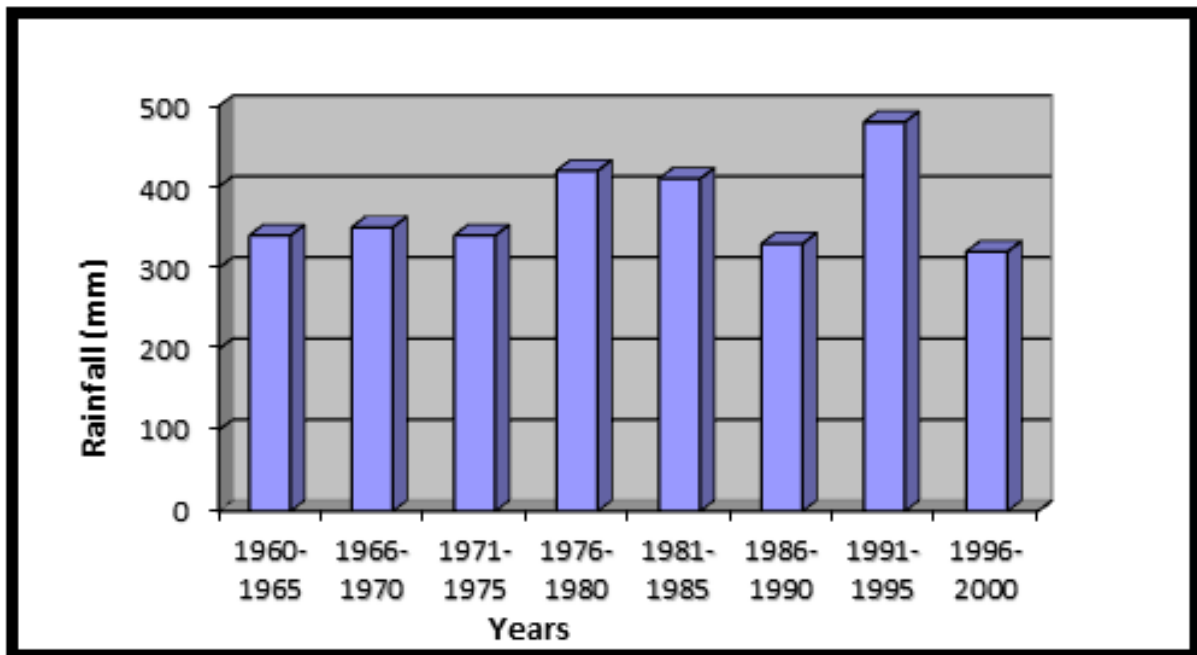


Fig. 1. Rain fall in the study area.

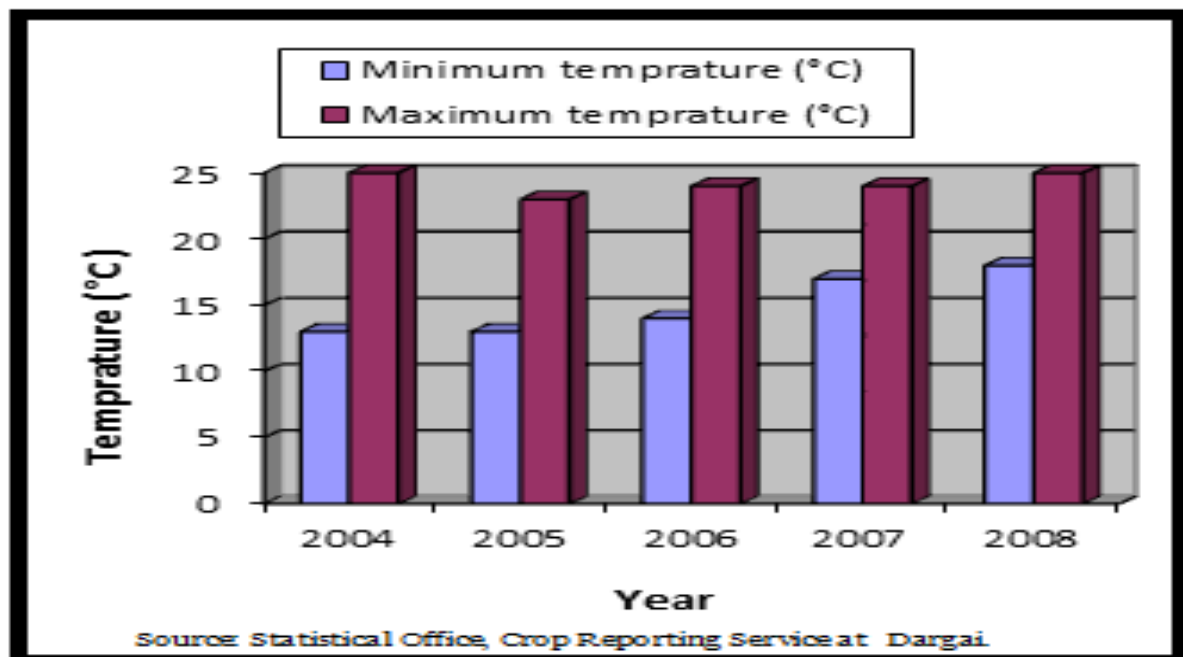


Fig. 2. Show average minimum and maximum temperature in °C during 2004-2008.

Pathological results

Of the three area visited, a total of fifteen samples, five from each site, of decaying roots and rhizospheric soil, leaves and wood have been collected. The samples were handed over to the Biotechnology Department of the University of Malakand, Pakistan for investigation of fungi. The results of the analysis show that *Fausarium solani* and *Ganoderma lucidium* were present (Table 6). *Fausarium solani* and *Ganoderma lucidium* are the main pathogen causing *Dalbergiasissoo* dieback (Bajwa *et al.*, 2003; Javaid, 2008). The recent surveys conducted indicated that the Shangrai minor plantation was heavily infected with the dieback problem. However, it was mainly due to *F. solani* and debarking by the locals for the purpose of fuel, which reduce the ascent of sap and ultimately cause the dieback. *Ganoderma lucidium* also sharing to the infestation especially in Kochain (Pirsuddodisty). These results are consistent with the finding of the other researchers (Idrees *et al.*, 2006; Rajput *et al.*, 2008).

Conclusion

In Dargai forest subdivision the planted forest of *Dalbergia sissoo* along the canal has been severely affected by Shisham Dieback. Over all 51% of the mature trees and 10.33 % of the sub-mature and pole stage trees were affected by the dieback. The pathological results revealed that *Fausarium solani* and *Ganoderma lucidium* were responsible for the diseases. Among the climatic factors the low amount of precipitation and deep water table were the prominent factors responsible for the disease. Canal-. The results concluded that most of the old age trees were infested by the diseases. Based on the findings, we recommended that proper drainage, mixed plantation, extraction of dead and diseased trees can give immediate relief from the menace.

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