EFFECT OF PHYSICO–CHEMICAL PROPERTIES AND NUTRITIONAL STATUS OF SOILS ON SHISHAM DIEBACK

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Abstract

One hundred and sixty-eight soil samples were collected from farmers' fields, forest plantations, roadsides and canalsides where shisham trees were badly damaged by the dieback. The soil samples were analyzed for their physico-chemical and nutritional properties. The objective was to find out, if any of the unfavourable soil properties or nutritional deficiencies had been the cause of the dieback. About 3 % of the samples were found to be too sandy to retain and supply water to trees over a longer period of time and 60 % samples were too clayey to permit free movement of air and water. About one third of the samples were deficient only in zinc while other nutrients (P, K, Cu, Mn, and Fe) were in adequate amount to support plant growth.

Key words: Soil characteristics, nutrients, dieback, shisham tree.

Introduction

Shisham (*Dalbergia sissoo*) is the most important and extensively grown tree in the Punjab. It is a multipurpose tree and provides a high quality wood for furniture, timber and fuel all over Pakistan. Farmers grow it on their land with the purpose of providing them a long-term financial security. Moreover, *Dalbergia sissoo* is a popular species for afforestation along canals, roads and in plantations. It is a highly valuable tree for national forestry programmes and private farmers. Due to its fast growing nature, quality timber, easy propagation, drought resistance, this species has been the most favourable one for plantation in private as well as Government sectors for the last many years (Sah *et al*., 2000).

Since the last couple of years, the shisham has been suffering from a mysterious disease that has devastated it over large areas in the country. This lethal disease, to begin with, causes drying of top tips and branches, yellowing and wilting of leaves, and consequently the entire tree dies out. A tremendous loss in population of sissoo tree has occurred in the Punjab because of this dieback. The damage has been equally inflicted to the trees planted along the roads, canals, and farmers' fields and in irrigated plantations which are intensively looked after by the forest officials.

Some biotic and abiotic factors may be the cause of this rapid declining /dying of shisham trees. The biotic factors like fungi such as *Fusarium*, *Phytophthora* in the roots and *Botryodiplodia* on the stem and branches have been reported (Parajuli *et a*l., 1999). Abiotic factors like soil and climate directly influence the growth of trees. The soil properties affect the movement of water, air and nutrients, which explains the strong relationship between soil and plant productivity. Similarly, the mineral nutrients of soil influence the resistance and tolerance of plants against biotic and abiotic stresses by influencing physiology, morphology and chemical composition of plant species (Marschner, 1986). Poor and imbalance plant nutrition often makes the plant susceptible

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to diseases (Piening, 1989). Nutrient status along with the physico-chemical properties of soil provides useful information for assessing the contribution of an element on the growth and viability of trees (Sah *et al*., 2002).

Keeping in view the importance of physico-chemical properties and nutritional status of soil in plant growth, large number of soil samples needed to be collected from the close vicinity of dead or severely affected shisham trees by dieback. The sampling sites were randomly selected along roads, canals, in forest plantations and farmers' field. These soil samples were analyzed for various physical and chemical characteristics as well as for nutritional status of the soils to assess cause of the dieback.

Materials and Methods

Soil samples

A large number of soil samples were collected from different sites where shisham trees had been severely affected by dieback. These were processed, crushed and passed through a 2-mm sieve and analyzed for physical and chemical properties of the sample sites.

Physico-chemical analysis of soil

Particle size analysis was carried out with hydrometer method (Bouyoucos, 1962). Electrical conductivity (EC) was determined by using EC meter (US Salinity Lab Staff, 1954). Soil pH was ascertained with the help of pH meter (Jenway) by using soil suspension of 1: 2.5 (soil: water). Organic matter was determined by oxidizing it with acidified $K_2Cr_2O_7$ and back titrating excess of dichromate with $FeSO_4$, using a modified Walkley Black method (Watanabe and Olsen, 1965).

Nutritional analysis of soil

The soils were also analyzed for various macro- and micro-nutrients. Phosphorus was determined by the technique of absorption spectrophotometery and potassium by flame photometery. Extraction of P was carried out as described by Olsen and Sommers (1982) whereas that of K was done as described by Richards (1954).

Micronutrients such as copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) were extracted with DTPA, diethylene triamine pentaacetic acid (Lindsay and Norvell, 1978). Soil samples were shaken for two hours with the extracting solution then filtered through Whatman filter paper No. 42. The elements were determined using absorption spectrophotometer and standards containing the extracting reagents.

Results and Discussion

The analytical data regarding physico-chemical properties of the collected soils are summarized in Table 1 to 4. A variety of physical features of soil can adversely affect or restrict the tree growth. Among the various samples analyzed, 30.4 % soils were sandy clay loam in texture (Table 1). There are four textural classes namely, loamy sand, silty clay loam, sandy clay and clay that may restrict the growth of shisham tree due to excessive drainage (loamy sand) or restricted drainage (silty clay loam) conditions. Under excessive drainage conditions, availability of water to plant is limited while plants suffer from lack of oxygen supply under restricted drainage conditions. Among the analyzed soil samples, twenty-one soils constituting 13% of the total samples analyzed, represent non-conducive conditions for the growth of shisham tree whereas the rest of the textural classes (87% soils) provide good physical environment for growing of shisham trees.

Electrical conductivity refers to the concentration of soluble salts in the soil solution. High concentrations of soluble salts in soil affect plant growth adversely. The shisham tree does not thrive well under saline conditions (high EC). Only about 8 % soil samples had moderate to strong salinity that could pose serious problem for the normal growth of shisham. This salinity could not be attributed to be the cause of dieback as 92 % sampled sites were non-saline to slightly saline where the dieback had created havoc (Table 2).

Regarding pH of the sampled sites (Table 3), it was between 7.5-8.5 which is the range of normal soils of the Punjab. Similar was the case with respect to the organic matter (Table 4) that falls between 0.86-1.30 percent. Shisham being a leguminous plant does not need much nitrogen for its growth (Sah *et al*., 1999).

Nutritional elemental data of the samples collected from the disease-affected sites are given in Table 5. All the samples had satisfactory to adequate levels of phosphorus and potassium indicating that there was no deficiency of these nutrients in the soils where the dieback incidence has badly affected the shisham trees.

In the case of micronutrients, there was no deficiency of copper (Cu), iron (Fe) and manganese (Mn) whereas 28% soil samples were deficient in zinc (Zn). Zinc is one of the essential micronutrients which can affect plant growth. Zinc deficiency has been reported in many soils of the Punjab. However, this Zinc deficiency may not be considered the cause of dieback as 72% sampled sites were satisfactory to adequate in Zinc where shisham trees have been badly suffered from dieback. Whether Zinc deficiency in soil and consequently in the shisham trees makes them vulnerable to the dieback incidence needs to be investigated experimentally under controlled conditions.

Table 1. Soil texture of soil samples collected from shisham dieback sites

Textural class	No. of samples	%age of samples
Loamy sand	6	3.6
Sandy loam	36	21.4
Loam	21	12.5
Silt loam	1	0.6
Sandy clay loam	51	30.4
Clay loam	38	22.6
Silty clay loam	5	3.0
Sandy clay	2	1.2
Clay	8	4.8

Table 2. Electrical conductivity of soil samples collected from shisham dieback sites

Electrical conductivity (dS m^{-1})	Soil salinity class	No. of samples	%age of samples
0.0-2.0	Non-saline	98	58.3
2.0-4.0	Slightly saline	57	33.9
4.0-8.0	Moderately saline	9	5.4
8.0-16	Strongly saline	4	2.4

Table 3. pH of soil samples collected from shisham dieback sites

pH range	No. of samples	%age of samples
7.0-7.5	46	27.4
7.6-8.0	83	49.4
8.1-8.5	39	23.2

Table 4. Organic matter of soil samples collected from shisham dieback sites

Organic matter (%)	Class	No. of samples	%age of samples
<0.86	Poor	100	59.5
0.86-1.2	Satisfactory	44	26.2
>1.2	Adequate	24	14.3

Table 5. Macro and micro-nutrients of soil samples collected from shisham dieback sites

Nutrient	Amount in soil (mg kg^{-1})	Class	No. of samples	%age of samples
Phosphorus	<8.0	Poor	0	0
	8.0-15	Satisfactory	90	53.6
	>15	Adequate	78	46.4
Potassium	<80	Poor	0	0
	80-180	Satisfactory	63	37.5
	>180	Adequate	105	62.5
Zinc	<0.5	Poor	47	28.0
	0.5-1.0	Satisfactory	61	36.3
	>1.0	Adequate	60	35.7
Copper	<0.2	Poor	2	1.2
	>0.2	Adequate	166	98.8
Iron	<2.5	Poor	0	0
	2.5-4.5	Satisfactory	1	0.6
	>4.5	Adequate	167	99.4
Manganese	<1.0	Poor	0	0
	1.0-2.0	Satisfactory	0	0
	>2.0	Adequate	168	100

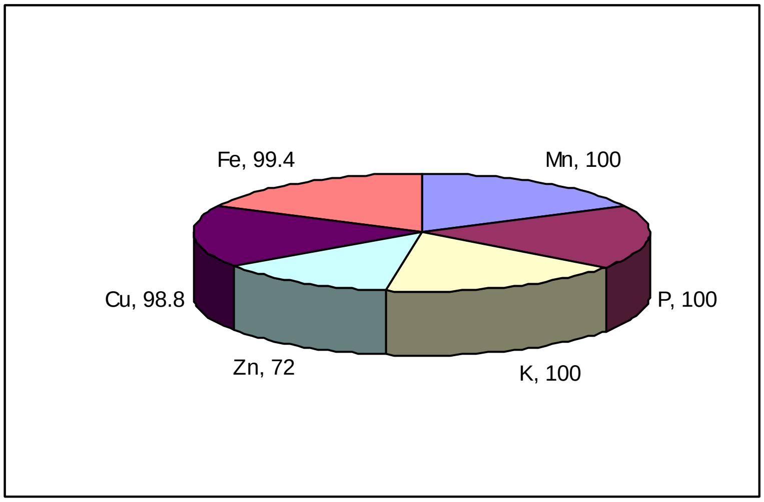

Fig. 1. Percentage of sampled sites with satisfactory concentration of nutrients

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