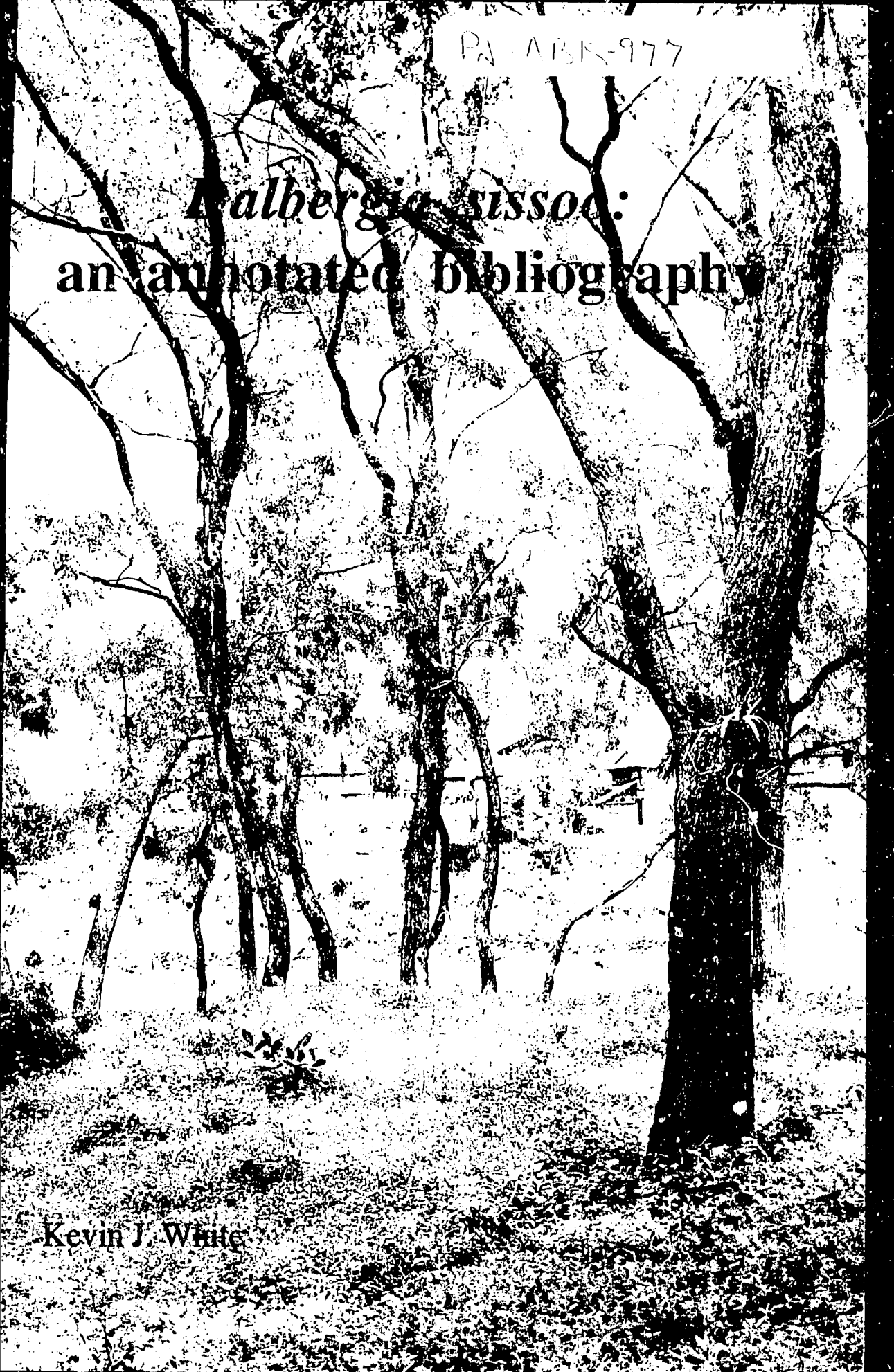
Albergia sisso: an annotated bibliography



Kevin J. White

The Winrock International Institute for Agricultural Development is a private, nonprofit U.S. organization working in agricultural development around the world. It was established in 1985 through the merging of the Agricultural Development Council (A/D/C), the International Agricultural Development Service (IADS), and the Winrock International Livestock Research and Training Center. Winrock International's mission is to help increase the agricultural productivity, improve the nutrition, and advance the well-being of people throughout the world. Its main areas of emphasis are human resources, renewable resources, food policy, animal agriculture and farming systems, and agricultural research and extension. Winrock International's headquarters are located in Morrilton, Arkansas, with regional offices in Arlington, Virginia and Manila, Philippines.

Winrock International sponsored this bibliography under the Forestry/Fuelwood Research and Development (F/FRED) Project, for which it is the primary implementing agency. Funded by the U.S. Agency for International Development, F/FRED is designed to help scientists address the needs of small-scale farmers in the developing world for fuelwood and other tree products. It provides a network through which scientists exchange research plans, methods, and results. Research and development activities center on the production and use of multipurpose trees that meet the several household needs of small farmers.

Cover photo: K.J. White

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ADDENDUM

These abstracts were obtained after publication. The following citation, with corrected author's name, should appear after reference number 7 on p. 2, replacing reference 27 on p. 7:

7a
Ahsan, J

A guide to the selection of superior trees and stands of some important trees of West Pakistan

For. Gen. Bull. No 1. Div of For. Res. PFI Peshawar, 1970

English

Author: "The guide outlines basic principles and provides necessary instructions to the field staff for the selection of elite trees and plus stands of the more important forest tree species of West Pakistan. The instructions are based on current knowledge of the genetical behaviour of these species and serve as a fairly good practical guide for the present."

Selection of trees/stands and management is covered with practical detail. In discussing broad leaf species, the author notes that plantations offer good opportunities for selection of desirable characteristics among trees experiencing similar growth conditions (e.g., irrigated *Dalbergia sissoo* plantations). The guide includes selection criteria for assessing superior quality trees and stands. Photographs illustrate Sissoo trees of good and bad form.

Index to: **165.3**; **165.62**; 232.311.2.

74
Chaudhry, M.I., Hanif Gul

Shisham defoliator control

For. Ent. Br. Bio, 1. Re. Divn. Leaflet No. 9 Peshawar, 1984

English

Shisham (*Dalbergia sissoo*) is the most common tree species included in the increasing planted area. Unfortunately, the tree leaves are eaten by a semilooper, *Plecoptera reflexa*. Guen. A complete defoliation removes 60% of annual growth and subsequent defoliation stops growth entirely; 5-7 defoliation years commonly occur in a rotation of 20 years, taking away at least 5 years' growth.

From the spring (March) emergence to the December hibernation, the insect passes through 11 overlapping generations. High pupae survival through winter and favorable weather conditions in early spring are the main causes of epidemic attacks in April-May. Hot, dry weather suppresses the insect in June-July. However, if hot summer survivals achieve a certain threshold, outbreaks also occur in nurseries and regeneration areas at the end of the active season as these remain green, and in nurseries sprouting in early spring due to irrigation. In these situations, the pest multiplies and later moves to the main plantation if left unchecked. Careful monitoring of these areas is recommended to control outbreaks before they spread to plantations. Careful selection and timely application of insecticides is important to kill the pest while preserving natural predators. Application of Alsystin or Dimilin (25% W.P.), both antimoultants, is recommended at the rate of 350 gms in 350-500 l of water per ha.

Index to: **151.42**; 153; 232.327.4; 414.12; **414.13** antimoultant; 416.11; 453.

139
Hussain, R.W., Glennie, E.B.

Provisional yield tables for shisham (*Dalbergia sissoo*) in irrigated plantations in the Punjab

For. Mens. Br. Div. of For. Res.:19. Peshawar 1978

English

Yield tables presented in the bulletin are based on data from 291 sample plots of irrigated plantations in Punjab, 1960-1973, aged 4-32 years. The data/plot/acre available included: age, basal area, timber and small wood volume for both thinned and main crops, timber and small wood form factors. Top height was calculated from the plot height dia. curve by using the mean dia of the 100 tallest trees per acre. A guiding curve of average top height at age was determined.

The Site Index (SI) is the top height in feet at age 15 years, the reference or key age. For the guiding curve, it is 55 feet. The SI for a plot of A years is found from this equation: SI = (Top height of the plot x 55)/top height of the guiding curve at age A. Note: Top height gives a reliable indication of site quality only if the plot is at least 10 years old.

Site Quality classes were: Quality 1, SI > 60; Quality 11, SI 50 - 60; Quality 111, SI < 50.

The rotation period for maximum volume production is the age at which the current and mean annual increments are equal; the table shows this is about 15 years for Quality 11, slightly less for Quality 1 and slightly more for Quality 111. It seems reasonable to assume annual increments remain at the same value: 10.5 m^3 ha for Quality 1; 7.7 m^3 ha for Quality 11; 5.6 m^3 ha for Quality 111.

Tables are in British and metric units for Qualities 1, 11, and 111. Data are shown for: age, av. dia., av. ht., basal area, no. of trees, main and thinned and total crop volumes and yield, and CAI and MAI volumes.

Index to: 524.3; **541**; 561.1; 561.2; **562.2**; **566**; 567.

72a
Chaudhry, G.U., Chaudhry, M.I., Ahmand, M.I.

Control of Shisham defoliator

For. Ent. Br. Biol. Sc. Div., PFI, Peshawar, 1970

English

Large areas of irrigated plantations of *Dalbergia sissoo* have been established. The leaves are eaten by a semilooper, *Plecoptera reflexa*, which has 10-11 generations in a year, each of 17-38 days. If there are sufficient population of the pest under hibernation and the weather conditions are favorable in spring, the first defoliation by the second or third generation occurs in April-May. The trees remain leafless for the major part of the growing season due to defoliation. Experiments have shown that these defoliations take at least 5 years growth out of 20 years' rotation of the crop. Efforts were made in the past to control the pest by methods of irrigation and destruction through natural parasites and predators, but without success. Birds, such as starlings, occasionally do a good job but appear only after tremendous damage has been caused. A control program with FAO was carried out in 1955-60.

Silvicultural control: *Plecoptera reflexa* pupates on the soil under plant debris. Flood control was successful in experimental plots but was impracticable in plantations due to a shortage of irrigation water.

Biological control: no promising and potent parasite was found; parasites were unable to keep up with the development of the host.

Insecticidal control: detailed and large-scale experiments were conducted with insecticides against all stages of the pest. Eggs: no insecticide showed ovicidal effect. Larvae: Endrin was the most effective (100% mortality for 10 days with a 0.025 % dose) others, in descending order can be substituted: Lebaycid, Sevin, Gammaxene Emulsion Concentrate, Malathion, Thiodon, and Dimecron. The last three have good knock down but no residual effect. Pupae: The larvae leaf-feed for 8-18 days and then come to the ground for several pupations in summer under debris and dry leaves, and for hibernation in winter. The emerging moths were found to provide the weakest link in the life and seasonal history. After emergence, moths spend some hours at rest on undergrowth and at risk to the above poisons at 1-2 lbs/40 gallons of water per acre.

Details are given for nursery and plantation pest control. Epidemic control in plantations is effected by aerial spraying; management instructions are given for this.

Index to: 151.42; 232.327.4; **411**; 412; **414.12**; **414.22**; 416.11; 453.

Erratum: p. ix, near the bottom -- change 'interceding' to 'inbreeding.'

Dalbergia sissoo (Roxb.) an annotated bibliography

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PREFACE

Dalbergia sissoo Roxb. (shisham, sissoo) is widely used in forest plantations in Pakistan, India and Nepal and is extensively grown by small farmers for wood, fuel, fodder, and other products. Sissoo is a well-known rosewood and offers an excellent example of a commercially important multipurpose tree. Though sissoo has been widely planted in both its homeland and as an exotic in many countries, it has attracted limited research attention in the improvement of tree form, growth rates, wood qualities, fodder, bee pasture or medicinal and insecticidal properties.

In an effort to enhance research on sissoo, the Forestry/Fuelwood Research and Development (F/FRED) Project supported a small meeting in September 1989 to review sissoo research and to draft a regional research plan. This plan is intended as a step to enhance research on this important species. The plan called for the production of an annotated bibliography of relevant *Dalbergia sissoo* publications and this present work is a result of that effort. The tireless efforts of Mr. Kevin White, who compiled this volume, and the assistance of Ms. Leela Wuttikraibundit are gratefully acknowledged.

Kenneth G. MacDicken
Team Leader/MPTS Network Specialist
Forestry/Fuelwood Research and Development Project
December 1990

ACKNOWLEDGEMENTS

The bibliography is the outcome of a group of scientists' meeting in Bangkok in 1989 to consider regional coordination of research on *Dalbergia sissoo*. In drafting a plan of research, the group assembled much of the information which is gratefully included in the introduction to this work.

I have been generously assisted in the location of references by the helpful staff of many of the region's libraries and personal contacts. The difficulty of access to literature is a real problem.

In Thailand, Ms. Kloyjai Yotaprasert and Ms. Supalux Sirimongkon, staff librarians at the Faculty of Forestry, Kasetsart University; Ms. Wanvimon Art-sum-ang and Ms. Rabiab Noparat, librarians of the Royal Forest Department; and staff at the Food and Agriculture Organization of the United Nations, F/FRED, and the Siam Society were most helpful.

In the Philippines, the assistance of the Dean, University of the Philippines College of Forestry is acknowledged.

From Indonesia, Dr. Dudung Darusman of the Faculty of Forestry, Bogor Agricultural University and Dr. Mien A. Rivai of the Herbarium Bogoriense gave considerable assistance.

Ms. Paula Reid, Librarian of the Department of Forestry, Australian National University, was most helpful in supplying references and subject indexing. Mr. D. Pegg, Queensland Department of Forests, supplied useful references. Professor L. J. Webb of the Griffith University helpfully eludicated for me the possible changes in weather patterns that appear to place sissoo out of phase with current patterns.

In Nepal, I owe a particular debt to Mr. Dasrath Thapa and his colleagues at the Department of Forests library in Kathmandu for their cheerful tolerance of the unexpected workload I showered on them. Equally helpful were the libraries and staff at: the Tribhuvan University Institute of Forestry, Hetauda Campus; the National Herbarium and Plant Research; and the Nepal-Australia Forestry Project.

Ms. Salma Zabaneh, Librarian of the International Bee Research Association, Cardiff, provided a sheaf of references on the overlooked aspect of honey as a minor - or in some cases a major - forest product.

I have enjoyed the support and assistance of the F/FRED project office in Bangkok and generous thanks are due to all staff there, in particular Mr. Ken MacDicken, Team Leader, and not least to Khun Leela Wuttikraibundit, who had the onerous task of typing the manuscript and enduring the never-ending corrections.

My grateful thanks.
Kevin White

INTRODUCTION

Scope and Arrangement of This Bibliography

Dalbergia sissoo Roxb. (shisham or sissoo) is widely recognized as an important multipurpose tree in Pakistan, India and Nepal. It is a highly valued timber and provides a range of other products such as fodder, fuelwood, honey, and medicine. A long held, accurate, and precise assessment of *D. sissoo* is quoted by William Roxburgh, who named the species early in the nineteenth century: "Upon the whole I scarcely know of any other tree that deserves more attention, for when its rapid rate of growth in almost every soil, its beauty, and uses are taken into account, few trees can be compared to it." The uses of *D. sissoo* have been well known for over 3,000 years. Over the past 160 years, scientists and recorders have amassed copious information on this species. Yet it is a truism to note it is still inadequately studied, and little progress has been made in improving the significant characteristics of either the tree form or wood qualities.

This bibliography is a data base of the relevant information presently available on *Dalbergia sissoo*. It has a genesis in a meeting of a group of scientists, most of them from countries where *D. sissoo* occurs naturally: Pakistan, India and Nepal. Under the leadership of Winrock International - F/FRED, they met in Bangkok, Thailand in October 1989 to review *D. sissoo* research and draft a research plan that would enhance and form part of existing national research programs. The group considered that a coordinated regional effort is likely to yield greater results than three independent research programs. The sharing and evaluation of germplasm and knowledge of silviculture, management, and utilization are likely to improve the effectiveness and efficiency of research on this important species.

This bibliography is intended to support research in the cultivation and management of *Dalbergia sissoo* with particular reference to: silvicultural practices, growth and yield, tree improvement, fodder, utilization, economics, marketing, and social science research. Many of the references have been drawn from CAB indices, others from earlier comprehensive reports by J.K. Jackson (1987), M.I. Sheikh (1989), and Anon. (F/FRED, 1989). A number come from literature references and personal communications. Generally, CAB abstracts are quoted verbatim, but a few are modified to highlight salient features. A number of authors' summaries are used. The remaining abstracts are my own.

Some 450 references were studied, of which 382 relevant items have been included here. Abstracts for 18 references considered of importance were unfortunately unavailable for review. These references are included in the hope that others may obtain access to them. Attention is drawn to them here to illustrate the broad cover of existing *D. sissoo* research. Undoubtedly, many other references have been missed due to problems in locating them. Indeed, the scattered and inaccessible nature of much literature caused concern in developing this bibliography, which is therefore perhaps best regarded as a first approximation of the relevant literature.

Some repetitive references are included to allow maximum opportunity for local access.

References are arranged alphabetically by senior authorship and are serially numbered. The numbers appear in in a subject index arranged according to the Oxford system of Decimal Classification. As many references cover more than one subject, the abstracts are intentionally cross-indexed under a number of subject heads. A bold number in the index indicates a key reference to the subject. Where possible, the references are informative, and so may be lengthy, to provide a first reference base to researchers who may not have easy access to library support services. As an introduction to *D. sissoo,* I would recommend first reading the often broad-ranging abstracts referenced under the 177.36 head.

The format of each entry is as follows:

(1) Serial number of the reference

(2) Author(s)

(3) Title

(4) Source

(5) Language

(6) Abstract of the reference

Natural Occurrence of the Species

Early perceptions of the natural distribution of *D. sissoo* perhaps point to its long-term use as a cultivated tree which has considerably expanded its habitat. For example, Roxburgh places it "native to Bengal and the adjoining provinces to the northwards." This view is shared by Hooker (1879): "plains throughout India proper." Brandis (quoted by Watt) views it as a native of the sub-Himalayan tract, extending 50 to 100 miles into the plains. Watt (1908), says, "I have never seen it wild outside the sub-Himalayan tract," but notes "it may be said to occur in every district in India, many of its localities however being the result of the effort to extend its cultivation. It is probable that its indigenous habitat is very much narrower than we think."

Current appreciation based on this literature review is that *D. sissoo* regeneration and survival occurs in a specific, narrow niche ecosystem requiring generally a seed water distribution, full sunlight for germination and development and root access to freely moving water. It has a natural distribution from Afghanistan to Assam in the rivers and their tributary systems in the sub-Himalayan tract of the Indrus, Ganges and Brahmaputra watersheds, entering to a limited degree the plains of north India in riverain forest associations; *elsewhere planted.* An hypothesis is that

the wide distribution occurred back when the Brahmaputra and the Ganges flowed west into the Indrus, its southerly extension in nature being curtailed on regeneration by environmental constraints (climate, riverbed profiles, etc.). Authorities concur on its altitudinal limit of approximately 1500 m in the Himalayan hills.

It occurs gregariously in these separated watersheds on river sands, shingle banks, riverside or island alluviums, where its water-borne, pod-encased seed is deposited, and its future growth is related to root access to moving waters. Its survival in the early growth phase requires full exposure to sunlight and freedom from weed competition-conditions provided on new sand bars, shingles, etc. It is occasionally said to colonize landslides, a distribution from localized strong winds.

Affinities

The genus *Dalbergia* is the major worldwide genus of woody legumes in the sub-family Papilionaceae (Appendix 1, Table 1). It includes some of the most valued tropical hardwoods, commonly grouped as "rosewoods" but ranging from rose to black in heartwood color. The genus includes about 100 species, of which some 70 are indigenous to Asia (Appendix 1, Table 2). Most of these are arboreal, several are shrubby, and many are climbers. Distribution is centered in the Himalayas, ranging from north Pakistan to China, with some species distributed south in the Malay Archipelago to Indonesia.

There are at least seven highly valued timber *Dalbergia* species in Asia, most of them indigenous to Assam and Burma (Appendix 1, Table 3). *Dalbergia sissoo* is among the most wide ranging and widely planted of these species, and one of the few tested outside Asia.

The taxonomy of the genus *Dalbergia* can be considered as fair but, subject to revision, synonymies can be expected. It may be predicted with certainty that some of the species can hybridize with *D. sissoo*. Any serious study of *D. sissoo* must include consideration of its close relatives. This should extend to seed collections and to species and provenance trials.

Little basic research has been conducted on cytology, breeding system, developmental morphology, genetics, stress and pest tolerance, or physiology. Although attention is drawn to it by Vidakovic and Ahsan (1970), no reports are available on its breeding system, whether it is inbreeding or out-crossing. References suggesting an interceding mechanism are cited. *D. sissoo* is one of the 24 *Dalbergia* spp. known to nodulate and fix nitrogen (Appendix 1, Table 1), but little is known of the type of *Rhizobium* or of strain specificity.

Silviculture and Growth Characteristics

The species

D. sissoo is a large deciduous tree up to 1m dbh and 30m tall, characteristically described with a crooked stem. Watt quotes Brandis as saying, "large trees became scarce 60 years [i.e., some 150 years] ago". Pearson notes trees of 100 feet height, 8 ft. girth and 35 ft. clear, cylindrical stem. It sheds leaves November/December, new foliage appears in the spring February/April and is in full leaf throughout the hot summer season. It flowers abundantly early in the summer, attracting, bees and is a major source of honey. Seed crops are set almost every year from the age of four, and remain on the tree for a lengthy period; tree yields of 1-6 kgs of pods (18,500-111,000 seeds) are recorded. A post-maturation dormancy period is unnecessary. Germination of 60-80% is known for fresh seed. Dry seed in sealed containers stores up to four years with little loss of viability.

It occurs on well-drained, colluvial and alluvial soils of pH 5.0 to 8.5, in rainfall areas of 750-2,000 mm. The species has a high water consumption/biomass production ratio; it tolerates or requires flowing waters, but it will not stand waterlogging by stagnant water, which leads to physiological stress and attack by wilt and root rot pathogens. It has numerous insect pests. It tolerates mildly sodic soils. It is cold tolerant but is damaged by frosts. It is highly susceptible to fire damage when young. Browsing damage occurs from livestock and wild herbivores. It coppices, and volunteer root suckers are noted as useful in afforesting degraded ravine lands.

The wood characteristics center on its strength, elasticity and durability. It has a beautiful brown figured heartwood and features in a wide range of uses.

It is an excellent fuelwood, with a calorific value of about 5,000 kcal/kg; produces good charcoal; its specific gravity is usually in the range 0.64 - 0.70. The young branchlets and leaves are regarded as a good fodder and the pods are also used for this purpose in extreme drought periods. In farmlands, these uses are often noted as complementary to *D. sissoo*'s primary higher value as wood. It is an under-appreciated honey flora component. It is a preferred windbreak species around mango orchards in eastern Nepal, as it is in full leaf in the mango flowering season and affords flowers protection from the strong winds of early summer.

D. sissoo has long provided medicines to treat a wide range of illnesses and the knowledge of these uses predates current medicinal lore.

Phenology

Valuable secondary uses of this multipurpose species are strongly intertwined with the redevelopment of foliage and with the flowering season. Fodder from the new leaf is a significant source of animal nutrition in the late winter/spring early summer period in the north of the Indian subcontinent, and honey is an important cash crop. The long term detailed phenological studies carried out at Dehra Dun (Krishnaswamy et al. 1954) provide evidence of advantageous selection potential both

to bring forward the new leaf flush for earlier fodder supply and to increase the length of the flowering - and honey cash flow - period.

The out-of-phase foliage development in adverse climates and seed ripening long before conditions are suitable for germination introduce fundamental questions.

Champion notes that this northern riverain forest type resembles the moist rather than the dry deciduous, and that *D. sissoo*'s specific characteristic - in full leaf during the hot summer - is one not shared by its associates. It is assumed that its demand for moisture in this period is related to its constrained ecological distribution. Seed tests show no advantage from the enforced post maturation period, and the above study establishes that it "does not show any relationship with temperature, rainfall or humidity."

It is speculated that *D. sissoo* evolved and developed its genetic characteristics in an earlier climate, when seed ripened in association with a contemporary monsoon season. Time changes may have brought a development of the monsoon belts to the present situation. It may be possible to link *D. sissoo* site niche as refugial and for sequential changes of vegetation and climate.*

Form

A remarkable characteristic of *D. sissoo* is its stem form. Descriptions of *D. sissoo* invariably note a first impression of crookedness, whether in a natural stand or roadside, farmland or forest planting. Another identified character is forking and the presence of a ramicorn branching habit. There is a high probability of interrelationship of these form defects stemming from a common physiological origin. *D. sissoo* has a growth pattern similar to many other members of the Leguminoseae (e.g., *Acacia, Cassia, Intsia, Pterocarpus*) where the lengthening stem arches: as underside secondary thickening occurs, the stem becomes erect but possibly sinuous; there is often the release of an axillary bud to become a branch which becomes a competing leader. Should the original leader assert dominance, the tree may show a pattern of forking or of ramicorn stem development. If the competitor acquires dominance, however, the stem form will become sinuous and the markedly crooked *D. sissoo* form appears. *D. sissoo* stem form has been identified as under strong genetic control and its form can be modified to suit utilization objectives. Straight stem form plantations are possible. The adverse effect of centuries' repeated planting of unselected trees from degraded stands or unimproved sources on a quality tree with naturally indifferent stem form can be easily imagined.

Provenances

The widespread natural distribution of *D. sissoo* in sub-Himalayan watersheds in now isolated stands in a truncated former natural water borne distribution system

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*See Singh, G. History of aridland vegetation and climate: a global prespective. *Biol. Rev.* (1988) 63:159-195.

has provided opportunities of endemism in discrete major provenances. The Nepal provenances demonstrate this and point to a decline in quality in Nepal of both form and vigor from the western (Karnali) to the eastern (Sapta Kosi) watersheds. There is evidence (from Nepal) that within the major watershed provenances there are sub-provenances inhabiting long separated tributary localities. Both major watershed provenances and tributary sub-provenances are inadequately identified and tested. The distribution hypothesis provides a convenient background for provenance identification and testing.

Provenance differences are recorded. Provenances from some watersheds have been analyzed in Nepal and very distinct variations in form and vigor are recognized. One of six provenances studied is recommended for widespread planting. In these Nepal trials, provenances from Pakistan were inferior in growth and more susceptible to diseases than local provenances. Land race selections also exhibit distinctive differences from the original natural provenances. This may account for some cited differences in wood qualities in India.

Heritability, selections and seed orchards

Heritability of *D. sissoo* stem straightness was demonstrated to be under strong genetic control in Pakistan trials. The same trials gave lesser evidence of the same control in diameter and height growth due to field management problems. Vigor (volume production) was seen as genetically controlled in Nepal trials.

In addition to major form and growth differences between provenances in the Nepal trials, very large within provenance differences indicated a potential to develop straight stem *D. sissoo* with a capacity to produce at least 100% more volume than present planting stock.

Seed orchards of open-pollinated selections of stem straightness and superior height growth were established in Pakistan in 1975.

Natural regeneration

D. sissoo has a regular annual seeding and the seed is retained in the pod. Floodwater-borne dissemination leaves the pods on well-drained sites where the seed germinates. Some localized wind distribution is possible, as *D. sissoo* is occasionally said to colonize landslides. In effect, it regenerates under a traditional uniform forest crop system and a mixture of tree sizes reflects genetic potential/site/treatment interactions rather than differences of tree ages; it does not regenerate under canopy. The requisites for regeneration are seed access to mineralized soil, freedom from weed/pest competition, and adequate soil moisture.

Artificial regeneration

A number of early references advise direct sowing to avoid root damage and lower survival. A wide range of data, however, notes *D. sissoo* also establishes readily

by transplants, root suckers, stem and branch cuttings, and root/shoot pruned "stumps," which is now almost the standard method of planting. It is easy to graft and responds to air layering. There is practically no reference to extensive establishment by vegetative reproduction as cuttings, though this is the quickest method of introducing genetic gains to new plantings. There is only the earliest advocacy of vegetative reproduction via tissue culture technology.

There is over 100 years of recorded plantation experience in growing *D. sissoo* and an age old contact prior to this of its culture by village tree farmers. The techniques of nursery stock production and of tree establishment and its cultural practices are well described and reflect the diverse and particular objectives of management.

Growth and yield

Species trials have indicated that *D. sissoo* is a moderately fast producer of wood. In India, a study of natural riverain sites showed growth of 5, 7 and 7 m^3 for 20-, 30- and 50-year-old stands. A 10-year old irrigated stand in Pakistan yielded 510, 231 and 244 tons/ha of main stem, branches, leaves and roots. In Nepal, yields ranging from 18.1 m^3 on a very good site to 4.3 m^3 on a drier site are recorded. A Nepal rating places *D. sissoo* plantation MAI wood production as: Site Quality 1, 8-16 m^3; S.Q. 2, 3-8 m^3; and S.Q. 3, 0-3 m^3. In Pakistan, MAI volumes are cited of: S.Q. 1, 11.2 m^3; S.Q. 2, 8.4 m^3; and S.Q. 3, 5.9 m^3.

Pests and diseases

D. sissoo is a species of antiquity and gregarious habit, both characteristics leading to interactive host/pathogen developments while at the same time indicating a resiliency to diseases and a capability of co-existing with them under normal conditions. When growth or site conditions are inferior, *D. sissoo* is placed in a stress condition, and serious disorders of insect or fungal origin will occur. A large number of pathogens have been registered but relatively few are significant. It is attacked by a variety of leaf miners, and the defoliator *Plecoptera reflexa* accompanies it through its range and appears as the most serious insect problem; bark and stem borers may become problems on stressed trees. Leaf rusts, *Uredo sissoo* and *Maravalia achroa*, are common. *Maravalia* may cause deaths in nurseries, *Uredo* is epidemic in nurseries and plantations but as it matures at normal leaf fall time its pathogenicity is somewhat limited. Pakistan *D. sissoo* provenances were much more susceptible in Nepal trials to local "strains" of these diseases. A black leaf spot, *Phyllachora dalberginae*, is widespread and a powdery mildew *Phyllactinia dalberginae* is reported. *D. sissoo* wilt caused by *Fusarium solani* is a common and serious problem. Bakshi points to physiological stress that weakens and conditions trees to wilt attack, and increases their susceptibility to root rot by *Ganoderma lucidum* and *Polyporus gilvus*. Phanerogamic pathogens include the mistletoes *Tolypanthus involucratus, Loranthus* spp., *Dendrophthoe falcata*, etc. *Cuscuta reflexa* parasitism is recorded. Termites can cause damage in establishment and young plantations may be damaged by porcupine, *Hystrix*, spp., wild boar *Sus scrofa*, jungle rats, and wild and domestic cattle. The langur monkey, *Presbytis entellus*, eats young shoots and leaves.

Performance as an exotic

The record shows *D. sissoo* has been widely planted outside the sub-continent but there is little data on substantial successful use. Good development is reported in sewerage irrigated plantations at Karthoum, and it is grown in Java and Bali. The report on *D. sissoo* culture in Indonesia by Dasuki is particularly informative. Interestingly, the U.N. Food and Agricultural Organization's forest seed directory shows off-shore seed availability from Cyprus, Kenya, and Sudan.

With deeper understanding of provenance variation and with relevant and precise bioclimatic analysis, it is considered that *D. sissoo* would find wider use in sub-tropical and semi-arid zones.

The species has amenity and ornamental value in Arizona and Florida. Selections can enhance this ornamental and amenity value.

Uses

Wood

D. sissoo has a proto-historic record of use (back to some 3,000 years B.C.), which implies an earlier, long-term acquaintenance with the species. The pre-eminent use of *D. sissoo* is as timber; Trotter notes that it finds its proper metier in use as one of India's finest cabinet and furniture woods.

The timber values lie in its color and grain, strength, elasticity, and heartwood durability. It is esteemed, and widely used from early historic times, in such uses as: highly decorative furniture, panelling, veneers, bentwood and carvings; construction timbers; coach work and wheels; tool handles, toys, musical instruments, etc.

The physical and chemical properties are well documented, as are its workability and machine use technology. Seasoning and preservation practices are understood and implemented.

Medicinal

The early (and later) records list *D. sissoo*'s many applications in the field of medicine. There is no reference to its uptake and large-scale use in formal pharmacology. One Indian reference, in promoting its amenity roadside tree value, notes it is not an object of bark stripping for tannin and medicines.

Fodder and fuel

D. sissoo is regarded as a moderately good fodder, providing fresh leaves in the spring and early summer when there is a general scarcity of this commodity. Its use as fodder is not a first objective in *D. sissoo* culture. Its value in this regard is seasonal and possibly regional; several authors from Nepal note this value is quite secondary

to a primary value as wood in high value end uses. Similar considerations apply to its farm-level use as a fuel. Though fodder and fuel have seasonal and use importance, they are not the prime factors in farmland planting *D. sissoo*. Plantations managed on the coppice-with-standards system naturally produce large fuelwood outputs. Watt noted early in this century that "it has been tried successfully for railway sleepers, it is an excellent fuel and makes very good charcoal, but it is too expensive to be used for these purposes."

Honey

Honey is a major commercial by-product of *D. sissoo* that is poorly referenced in forestry literature. It is a key element in the spring honey flow of April/May, when honey surplus to hive needs can be stored by bees (i.e., is available for harvest). As a major cash crop from *D. sissoo*, honey production should feature more prominently in forest management. Extension of the *D. sissoo* tree-flowering period of 28 days and its wider distribution would be commercially valuable.

Agricultural/horticultural

It is noted that crop yields close to *D. sissoo* trees are adversely affected, and that distance from the tree and direction of tree shade significantly affect wheat yield. In multi-species trials, however, *D. sissoo* showed the least depression of crop yields, followed by eucalyptus, poplars, and simal. The light canopy of *D. sissoo* favors its use in tea gardens, where it is also considered a soil improver. It has been successfully intercropped (Nepal) with a range of crops in the early years of plantations and later underplanted to shade-tolerant crops, pineapple, tumeric, and ginger. It is a standard windbreak component of mango orchards in east Nepal.

Suggested Directions for Management and Research

Improvement objectives

D. sissoo research should formally recognize its multi-purpose functions. However, because the species primary role is as high-value timber and its by-product uses are complementary to this (e.g., as fuel, fodder, medicine, honey), the thrust of research should be to that use. The major vehicle of improvement research should have a primary objective of improving the quality and quantity of its wood production. This focus will also favor other uses (e.g., fodder and fuel) for which improved vigor will also increase yields, and by lengthening and spreading the flowering time of more productive trees, honey yield can also be enhanced.

D. sissoo has a rosewood status, a valuable marketing tag. It is one of the few cabinet timbers that has a range of valuable complementary uses, which foster the growing of *D. sissoo* to a size that adds the highest value to its use. From this, it is an unusually renewable resource of quantity and quality and value dimension. Furthermore, it has an accepted community image and in toto has the qualities for which Roxburgh commended it to succeeding generations.

Wherever possible, the major improvement strategy for timber should integrate improvement of complementary use values. Should a complementary use assume a major priority in *D. sissoo* tree improvement, with wood as a minor element, then separate, parallel strategies should be evolved for that specific end use.

Priorities

Clear priorities for the early improvement of *D. sissoo* are:

1. Identification of provenances, sub-provenances and land races.

2. Ranking of the above in wood yield and form quality.

3. Plus tree selection and comparative testing to maximize yield and quality of heartwood.

4. Ranking of these selections with regard to multipurpose yields of:

   a) fodder production (timing, quantity, quality)
   b) honey production (yield, period, quality)
   c) other products

5. Development of expertise in robust cuttings techniques and clone bank management to introduce superior quality selections into routine production plantings.

Genetic resource degradation

The gene resource of this species in its isolated distribution of potential endemic populations has been systematically mined through the application of selective, high-grading felling systems. This creaming of the larger (and by inference, more vigorous) trees of a species of uniform forest regeneration erodes and degrades the gene resource. Today, visions of large trees, 3-4 ft. dia. with 35 ft. of clean bole (cylindrical in some reports) have a dream-like quality. Indeed, this century and more of selective high-grading may have placed the gene resource of superior genotypic plus trees in a "threatened" status. Action is required to reserve plus trees in every discrete population to assess their qualities and bring superior genetic resources into production.

A review of natural forest logging prescriptions could lead to such legal amendments to forestry ordinances as may be necessary to reserve/preserve a plus tree population in each endemic locality. A country register could be developed of reserved stands/trees.

Provenances

The ecological distribution of *D. sissoo* in naturally separated and isolated watersheds and tributaries encourages the development of endemic populations and

sub-populations. The provenance status of these is largely unknown, though preliminary studies in Nepal indicate major differences.

Detailed country mapping of natural stands in main streams and in tributaries is a prerequisite to systematic provenance sampling and testing.

Provenance trials with seed from distributed plus trees within a specific defined (watershed) population (provenance?) area need intensification in internal trials. These should adopt Regional techniques to identify vigor (biomass, quantity and distribution) at an early age (1-2 years) and to assess form within five years of planting.

Regional trials should follow national evaluation trials, although early, widespread, simultaneous trials of likely superior provenances will be an advantage.

Isozyme frequency studies should commence on a modest level to assess the utility of this technology in establishing provenance benchmarks.

Studies of the nodulating nitrogen-fixing bacteria in selected natural forest areas throughout the species range are recommended. Laboratory trials could demonstrate plant biomass variability and/or provenance host/symbiont interrelationships.

Selection

Heritability of stem form and vigor has been shown to be under strong genetic control; there every is likelihood that other features are similarly of genetic nature. Selection of plus trees in existing forest plantations and farmland plantings should be intensified. Care should be taken to minimize sibling representation. Regional guidelines for selection and assessment would be helpful.

Selections must be vegetatively reproduced and comparatively rated. A standardized trial format and evaluation methodology could be developed. Exchanges of select material (e.g., in tissue culture media) could be encouraged through the region for simultaneous testing.

A review of progeny of the 1975 Pakistan seed orchard based on selections for stem straightness and height would be of value.

Vegetative reproduction

Selection and breeding gains can be quickly brought into large-scale production through vegetative reproduction. Tissue culture reproduction has been demonstrated to large-scale production and tissue cultured trees have performed satisfactorily in the field. Tissue culturing is not advocated as a routine plant production technique, but it is a useful method of quickly multiplying selected trees for multiple field tests, or for multiplying genotypes for large-scale clone banks. Reproduction by stem cuttings from one-year-old coppice is a robust, successful method of vegetative reproduction and can be used with coppicing clone banks to multiply superior parents. Grafting is

useful for rejuvenating older trees to facilitate tissue culturing and/or limited production of coppice stem cuttings.

D. sissoo nurseries would be well advised to develop staff experience in stem cuttings techniques under local conditions and test clone bank management regimes.

Breeding systems

It is essential that the breeding process be identified and documented quickly. Data is required on: pollination, out/self crossing, mating systems and hybridizing techniques.

Breeding directions

As mentioned above, the primary objective should be to improve wood quality and quantity improvement and at the same time accommodate complementary product supplies (i.e., a focus on vigor and form). Superior genotypes need to be identified to lead to inter- and intra-specific hybridization for optimum harvest indices.

The objective is to sexually produce desired combinations, which after testing would be vegetatively mass reproduced for routine planting.

Some breeding objectives beyond wood quantity and quality might be:

Inter-specific hybrids with woodland species as *D. cultrata, D. latifolia, D. oliveri*, and *D. sissoides* to extend the riverain habitat of *D. sissoo* to wider soil environments and to improve growth rates;

Improved medicinal and fodder values; to complement the identified "best" timber-yielding provenances by searching for high-yielding by-product trees, and combine these qualities to enhance total tree value;

Increasing the length and spreading the average flowering time of 28 days and improving honey quantities and qualities.

Mensuration

A standardized approach to biomass and volume tables is required to facilitate intra-region comparisons. Biomass tables should concentrate on the April/May period when trees are in full leaf. Form differences among natural stand seed sources may be apparent and may require that provenance volume tables be produced.

Fodder

It is considered that all genotype selections for improved tree form and wood production should be assessed and defined in fodder values also (i.e., time of leaf production and fodder quality). Early production of new foliage (i.e., a long fodder harvest in the drought period) would be a marked tree improvement.

Agroforestry

D. sissoo is well known and commonly used in land management arrangements in a large part of Asia and is an integral component of farms, orchard windbreaks, tea shade, and boundary separation plantings. The accepted limits of adverse competition are not defined, nor are the benefits of shade, wind, soil nitrification quantified. Identification of shade-tolerant crops and their cultural regimes would be useful information. Potential tree improvements to assist this sector need identification and specification (e.g., narrow crown to facilitate intercrops; desirable leaf shed date for agroforestry crop combinations; refoliage time for wind protection, and fodder production; vertical rather than spreading root systems).

Uses, promotion, marketing future development

D. sissoo finds its metier in quality furniture and cabinet making, and all plantings and tree improvements should have this high return market in primary focus. It is appreciated that not every tree will be so used and a vast local market exists for fuel and small round wood, though if durability is required in the latter end use, preservation treatment must be applied.

For its prime high-value use as wood, urban and international export markets offer the highest returns. *D. sissoo* as a raw material can have value added by craftsmen close to the wood supply base. *D. sissoo*, with its supporting complementary by-products, is one of the few cabinet timbers that have the potential of an increasing supply. A process of cultivation, local handicraft processing, and export maximizes country and social returns, and presents an attractive aspect of land-use management, whether by formal agencies or by farmers. These broad use and marketing arrangements exist, but it would be beneficial if the concept were institutionalized and recognized, and improved uniform practices were followed.

Positive steps are required to improve (or to recapture) the international image of *D. sissoo*, increase its demand, and enhance its returns. A promotion and marketing approach suggests itself through a regional guild of export manufacturers following a strategy of: image-creating presentations of works of art; trade fair participation; quality reproductions of period furnitures; sponsorship of sculpting, carving and art work exhibitions; quality publications; quality advertisements, etc.

Some have expressed concern over the shortage of *D. sissoo* for expanding the export market. A concentration on high-value end use and appropriate returns to the tree farmer could help minimize this gap (i.e., making *D. sissoo* wood a quality, market related commodity).

Amenity/Arborculture

D. sissoo is a handsome tree and has found a place in amenity planting. There is no indication of any improvement program to enhance its qualities in this end use, though horticultural variations in natural stands are available and appropriate selections can be vegetatively reproduced. *D. sissoo* arboriculture should be fostered.

1
Agarwal. A. K., Joshi, A. P., Kandwal, S. K. and Dhasmana, R.

An ecological analysis of Malin riverain forest of outer Garhwal Himalaya (western Himalaya).

Indian Journal of Ecology 1986. 13 (1): 15-21

English

Riverain forests represent the initial stage of a succession towards a climax *Shorea robusta* forest; they are often degraded by biotic (human) interference. A quantitative ecological evaluation was made of such a forest in Uttar Pradesh, on unstable alluvial sandy soil, at 395-1200 m alt., in an area with annual rainfall of approx. 1100 mm. Twelve species of canopy vegetation were found. Ten quadrats (10x10 m) were dropped randomly at 5 positions on the river bed to evaluate species abundance and species associations. Measurements were also made of height and girth at b.h., and calculations were made of bole length and canopy diam. Tree lopping was categorized into 4 classes (25, 50 and 100%, and unlopped). Density and Importance Value Index (IVI) were max. for *Acacia catechu*, followed by *Dalbergia sissoo* and *Holoptelea integrifolia* (and also *Bombax ceiba* [*B. malabaricum*] for IVI). Min. densities were found for *Adina cordifolia* and *Emblica officinalis [Phyllanthus emblica]* and min. IVI for *Aegle marmelos*. Seven species pairs were significantly positively associated and 2 negatively. Max. positive associations were found between *D. sissoo and P. emblica*, and between *Moringa oleifera* and *Ficus glomerata*. Negative associations were found between *B. malabaricum* and *H. integrifolia*, and between *A. catechu* and *P. emblica*. Seven species were not lopped, but heavy lopping occurred on 2 valuable fodder species, *A. catechu* and *M. oleifera*. Analysis of correlations between different growth parameters of all species indicated a negative correlation of girth and bole length with canopy diam., probably because of lopping pressure. According to the riverain succession described by Champion and Seth in 1968, this forest is in the first succession stage (*A. catechu-D. sissoo*) of the 5 transitional stages to a *S. robusta* climax, with the presence of other species, and the defined associations, indicating an approach to the next stage.

2
Agarwal, R. M.

Studies in growth and differentiation of shoot apex in *Dalbergia sissoo* Roxb.

In Agarwal, S. C., Prasad, B. N. 1980. Third All India Botanical Conference, December 28-30, 1980. Journal of the Indian Botanical Society. 59

English

Abstract: Not available.

3
Agarwal, S. and Bakshi, S.

New leguminous substrate records for some fungi in India.

Geobios 1981. 8 (4): 192

English

Records included the following new for India: *Thielavia fimeti* on seeds of *Cyamopsis tetragonolobus* and *Trichoderma longibrachiatum* on leaves of *Dalbergia sissoo* and pea seeds.

4
Agarwal, S. C., Jolly, M. S. and Sinha, A. K.

Foliar constituents of secondary food plants of tasar silk worm *Antheraea mylitta D.*

Indian Forester 1980. 106 (12): 847-851

English

Analyses are given of *Lagerstroemia indica, L. speciosa, Terminalia paniculata, Careya arborea* and *Dalbergia sissoo. L. indica* and *T. paniculata* are most suitable as food plants.

5
Ahmad, M. and Malik, M. N.

Physico-chemical and biological evaluation of commercial and proprietary wood preservatives.

Pakistan Journal of Forestry 1974. 24 (2): 144-170

English

Describes studies with wood of *Pinus wallichiana, P. roxburghii, Cedrus deodara, Dalbergia sissoo* and *Eucalyptus sp.*, to evaluate the effectiveness of common water-soluble and proprietary wood preservatives available in Pakistan. The absorption of the preservatives by standard techniques, and the resistance to decay (by three test fungi), paintability, retention of preservatives, and weathering of preservative-treated wood were investigated. Some figures for total extractives (ether, alcohol, alcohol/ benzene, NaOH, and hot- and cold-water extractives) of the untreated woods are tabulated.

6
Ahmed, S.

Nectar and pollen plants of Pakistan.

Pakistan Journal of Forestry 1984. 34 (2): 75-78

English

Some of the most important bee forage species are described. In the submontane region these include: the trees *Acacia modesta* (phulai), *Robinia pseudoacacia, Liriodendron tulipifera, Ailanthus glandulosa* (tree of heaven), *Vitex negundo, Cercis sp.* (redbud), fruit trees, and *Eriobotrya japonica* (loquat, which flowers in winter). On the plains, Eucalyptus is very important; about 12 species grow well in Pakistan including some which flower in the winter. Winter forage is also provided by *Zizyphus jujuba* and loquat. Among agricultural crops valuable to bees are *Brassica* crops (toria, sarson, raya), cotton, lucerne (*Medicago sativa*) and clovers. Citrus trees are grown in many gardens, as are the climber *Tecoma grandiflora*, and also *Dombeya sp.*, a tree which *Apis dorsata* favors for nesting in; it also nests in *Kigelia pinnata* (gul-i-fanoos), *Dalbergia sissoo* (shisham), *Azadirachta indica* (neem) and *Bombax ceiba* (silk-cotton tree or semal). Some of the honeys produced from these plants are described very briefly. In Changa Manga plantation, *Apis dorsata* produces 2 crops of honey in the spring, both from *D. sissoo*, but the second crop is dark blue because it contains mulberry juice. Another well-known honey is produced by *Apis mellifera* foraging on roses, loquat and phulai (in the Salt Range).

7
Ahmad, S. S., Ayaz, M. and Mohammad, T.

Properties and uses of commercial timbers of Pakistan.

Bulletin, (No. 3) Division of Forest Products, Pakistan Forest Institute 1977, 24 pp.

English

Abstract: Not available

8
Akhtar, M. S.

Feeding responses to wood and wood extracts by *Bifiditermes beesoni* (Gardner) (Isoptera: Kalotermitidae).

International Biodeterioration Bulletin 1981. 17 (1): 21-25

English

Heartwoods of the trees *Dalbergia sissoo, Pinus wallichiana* and *Cedrus deodara* were tested in Pakistan for their natural resistance to attack by the termite *Bifiditermes beesoni* (Gardner), which is common in the subtropical continental lowland of the country and mainly attacks orchard trees. The survival and extent of feeding was recorded on wooden blocks, unextracted sawdusts, solvent-extracted sawdusts and extracts applied to filter papers; extraction was with acetone-hexane-water (53:44:3). The upper layer of the extract of *C. deodara* was toxic to the termite. The least feeding damage occurred on the heartwood block of *D. sissoo* but since filter paper impregnated with the upper-layer extract of *D. sissoo* did not affect termite survival, it is concluded that the natural resistance of *D. sissoo* is attributable to its hardness.

9
Akhtar, M. S. and Jabeen, M.

Responses of *Coptotermes heimi* (Wasmann) (Isoptera) to woods, wood extracts and essential oils of timbers.

Material und Organismen 1981, recd. 1983. 16 (3): 199-206

English

The responses of the subterranean termite *Coptotermes heimi* (Wasm.) to woods, wood extracts and essential oils of *Pinus wallichiana, Cedrus deodara* and *Dalbergia sissoo*, which are noted for their natural durability, were studied in the laboratory in Pakistan. Wooden blocks of *C. deodara* were highly resistant to attack by the termite. The upper layer (mainly hexane and acetone) of an extract of sawdust of *C. deodara* in acetone, hexane and water, and the essential oil of this wood, had a pronounced termiticidal effect. Although *P. wallichiana* was resistant to attack by *Coptotermes heimi*, the termiticidal effect of the upper layer of its extract in acetone, hexane and water was less than that of *Cedrus deodara*. Wooden blocks of *D. sissoo* were also highly resistant to termite attack, but its unextracted sawdust and the upper layer of the acetone-hexane-water extract did not affect survival of *Coptotermes heimi*; however, the essential oil of this wood recovered from 25 g of its sawdust affected termite survival to some extent.

10
Akhtar, M. S. and Jabeen, M.

Influence of specimen size on the amount of wood consumed by termites.

Pakistan Journal of Zoology 1981, recd. 1983. 13 (1/2): 79-84

English

In experiments in Lahore, Pakistan, the feeding capacity of *Coptotermes heimi* (Wasm.) and the factors governing it were tested on blocks of the highly palatable wood of *Populus euramericana* in the laboratory and the feeding capacity of *Odontotermes obesus* (Ramb.) was tested in the field both on *P. euramericana* and on the resistant wood of *Dalbergia sissoo*. Measured by weight loss, the amount of wood eaten from the same tree species increased with increasing wood block length, but the difference was significant only when the difference in length was at least 3-fold.

11
Akram, M.

The effect of NPK on the growth of *Dalbergia sissoo* stumps (shisham).

Thesis, University of Agriculture, Faisalabad. 1985. 67 pp.

Abstract: Not available

12
Alizai, I. A. and Naqvi, H. H.

Phyto-ecological studies of the flood plains of Dera Ismail Khan, Pakistan.

Pakistan Journal of Forestry 1976. 26 (1): 7-13

English

Five plant communities were recognized in the study area, corresponding to the frequency of flooding. The vegetation consisted chiefly of annual and perennial herbs and shrubs; it was generally unstable as a result of seasonal flooding. Trees (*Acacia arabica* and *Dalbergia sissoo*) were recorded (in small numbers) only at one site, which had not been flooded for 5-10 yr. It was concluded that the flood plains could be converted to agricultural or rangeland uses, if soil conservation and flood control measures were taken.

13
Ananthapadmanabha, H. S., Nagaveni, H. C. and Rai, S. N.

Studies on the effect of growth regulators on seedlings.

Myforest 1987. 23 (1): 17-19

English

One-month-old seedlings of 12 species of social forestry interest (Azadirachta indica, *Artocarpus integrifolia [A. heterophyllus], Brassica [Brassaia = Schefflera] actinophylla, Cassia grandis, Dalbergia sissoo, Delonix regia, Polyalthia pendula, Peltoforum ferruginatum [Peltophorum ferrugineum], Solanum macranthum, Swietenia mahagoni, Syzigium [Syzygium] cumini and Tabebuia rosea*) were treated with sprays of water (control), complete nutrient sol. (Arnon and Hoagland), GA or IAA (25, 50 or 100 p.p.m.), or GA + IAA (50 p.p.m.) every 15 days for 6 months. Ht. growth and general condition were recorded every month and biomass production was recorded at the end of the experiment. Each species responded differently to different concentration and type of growth regulator(s). There was a lag phase or a phase of slow growth during the initial 2 months. Species least responsive to growth regulator treatments were *A. heterophyllus, Polyalthia pendula, Peltophorum ferrugineum, T. rosea* and *C. grandis* (ht. growth), and *C. grandis, D. sissoo, Polyalthia pendula, Peltophorum ferrugineum* and *T. rosea* (biomass production). Some growth regulator treatments increased ht. or biomass production little more (or less) than did nutrient sol. compared with control values.

14
Anonymous

The use and misuse of shrubs and trees as fodder

Published by the Imperial Bureau of Pastures and Field Crops, Aberystwyth; Imperial Forestry Bureau, Oxford; Imperial Bureau of Animal Nutrition, Aberdeen, 1947

English

Dalbergia sissoo is listed under the fodder supplying trees; moisture content is cited: March, April, Oct.-Jan. as 74.9, 63.2, 54.6% and ensiled as 72.8%. Tables list chemical composition and digestibility and nutritive values.

15
Anonymous

The Commonwealth Forestry Handbook (1962)

Published by The Empire Forestry Association, The Royal Commonwealth Society, Northumberland Avenue, London, 1962.

English

Establishes under B.S. 881 British Standard Nomenclature of Hardwoods, sissoo as the Standard name for *Dalbergia sissoo*.

16
Anonymous

Forest statistics for the Teral and adjoining regions, 1967.

Forest Resources Survey Publication, Nepal 1967. (No. 4): 97 pp.

English

A report of part of the forest resources survey of Nepal, initiated in 1963, and based on aerial photography. The Terai is a predominantly level, alluvial region, situated along the Nepal-India border, and has a subtropical climate. It represents about 20% of the land area of Nepal, and contains most of the accessible timber. The main forest types are sal (*Shorea robusta*); mixed hardwoods, with asna (*Terminalia tomentosa*) and semal (*Bombax malabaricum*) as important dominants; and khair/*D. sissoo* (*Acacia catechu/Dalbergia sissoo*). For each of the 14 forest divisions in the Terai, detailed data are presented (in 60 tables) on land-use and forest types; stand-size and stocking classes; number and vol. of live trees; number of bamboo clumps; and gross and net sawlog and roundwood volumes (by merchantability class). A list of 26 important tree species (with common names) is included.

17
Anonymous

Information Series. Indian Timbers.

Editorial Board, Forest Research Institute and Colleges Dehra Dun.

English

A series of occasional pamphlets, first published in 1968, each number describing the habit and distribution, silvicultural characters of the tree, and the wood structure, physical and mechanical properties, and uses of an Indian timber. Those so far published deal with: Sissoo (*Dalbergia sissoo*), Laurel (*Terminalia tomentosa*), Haldu (*Adina cordifolia*), Toon (*Toona ciliata*), Mango (*Mangifera indica*), Kokko (*Albizia lebbek*), Chir (*Pinus roxburghii*), Hopea (*Hopea parviflora*), Semul (*Bombax ceiba*), Padauk (*Pterocarpus dalbergioides*), Rose Wood (*Dalbergia latifolia*), Khair (*Acacia catechu*) and Bijasal (*Pterocarpus marsupium*). (See Anon Sissoo 1968)

18
Anonymous

Indian Timbers, Sissoo

Compiled at the Editorial Board, Forest Research Institute and Colleges, Dehra Dun, 1968

English

The compilation covers the biology and utilization of *Dalbergia sissoo*. Local and trade names, habitat in the sub Himalayan riverain tract, widespread artificial cultivation and silvicultural conditions of growth and regeneration are summarized. Data of the physical and mechanical properties are stated; weight at 12% moisture content is 770 kg. cu. m.; strength data of green, air dry and kiln dry wood are given, together with safe working stresses compared to teak. The timber seasons in air and kilns without difficulty and with practically no degrade in the latter technique; Kiln Schedule 4 is recommended. The wood is classed as one of the four primary timbers of India, the heartwood is extremely durable and is classed as one of the least susceptible Indian timbers to white ant attack. Sapwood treats readily with preservative. It works well, machines readily and takes a good polish; it glues well and lends itself to steam bending and can be bent in large sizes. It peels well after 24 hours boiling and rotary peeling is advised for bold grain results. It has wide use in permanent structures and in spans from 3 to 6 m. It is suitable for tool handles of striking, scooping, cutting and shaping end use. Its utility in transmission pole use is established and dimensions for breaking loads at different heights are given; its use in sleepers, plywood, furniture and cabinet making, bent wood articles are discussed. *D. sissoo* wood oil yield is 5.35% of heartwood and has been found suitable as a lubricant in heavy machinery; its fatty acid components are: myristic, 5.8; palmite, 21.8; stearic, 24.3; arachidic, 19.4; linoleic 10.8; and oleic 9.4%. Numerous minor uses are listed. The wood is classed as an excellent fuel with B.T.U.s of 8,835 and 9,326 for sap and heart wood. The leaves are used as a fodder; components are given. An analysis of silage gave these percentages: crude protein 14.0; ether extr. 3.6; crude fibre 30.0; N free extr. 34.1; crude digestible protein 7.3; starch equivalent 20. The leaves are bitter and stimulant; a decoction of the leaves is said to be useful in gonorrhea; roots are astringent and the wood useful in excoriations. The pods yield 2% tannin.

19
Anonymous

Soil survey of Birgunj Division, 1969.

Forest Resources Survey Publication, Nepal 1969. (No. 7): 125 pp.

English

The soils of the Birgunj forest division, which occupies an area of approx. 650 sq. miles in S. Nepal, were classified into 35 series. A description is given of each series, its characteristic vegetation, and its present and recommended land use. A brief account is included of the forest types (chiefly sal (*Shorea robusta*) and khair-sissoo (*Acacia catechu/Dalbergia sissoo*)), livestock, and wildlife of the Division.

20
Anonymous

Afforestation of eroded soils in Java (Indonesia).

Wageningen, Netherlands; State Agricultural University. 1973. v + 64 pp.

English

A shortened version of a Dutch report, mainly based on a study of conditions in the severely eroded Tjitarum [Citarum] and Solo catchments. From a review of the literature the site requirements of 75 tree species are listed, and indications are given of those which are suitable for afforestation in the study area, and also those not considered suitable, or suitable only for small scale plantations or for trials. Those recommended for the main reforestation areas include *Agathis loranthifolia, Altingia excelsa, Acacia auriculiformis, Swietenia macrophylla, Tectona grandis* and *Dalbergia sissoo.*

21
Anonymous

Timbers of the World

TRADA/The Construction Press 1979.

English

Dalbergia sissoo grows naturally in India, Pakistan and Bangladesh but has been planted in irrigated plantations; under favorable conditions it grows to 30 m in height with a 10-meter, clear cylindrical bole and a diameter of 1.0 m, elsewhere the sizes are rather smaller. The heartwood is golden brown to dark brown with deep brown streaks similar in color to Indian rosewood (*D. latifolia*) but lacking the characteristic odor of the wood and generally more uneven and coarser textured with larger pores and wider rays. The grain is interlocked in narrow, straight lines and the wood weighs about 830 kg/m^3 when dried. The timber is reported to dry slowly with little degrade; kiln drying is said to enhance the value of the timber by intensifying the difference in color of the lighter and darker bands. It is regarded as very durable; works well and machines fairly easily; turns well and glues and polishes satisfactorily. It is used in high class furniture, panelling, cabinet making, boat building, plywood and since the timber lends itself to bending, it is also used for bent-wood chairs and bent rims.

22
Anonymous

Medical Plants of Nepal

His Majesty's Government of Nepal, Ministry of Forests and Soil Conservation, Department of Medicinal Plants Kathmandu, Nepal. Third Edition 1982.

English

Dalbergia sissoo Roxb. is described as an erect tree, the leaves bitter and stimulant, a decoction of the leaves useful in gonorrhoea, the root astringent, the wood alternative, useful in leprosy and boils.

23
Anonymous

Study on *Dalbergia sissoo* in North Cameroon.

Ctr. for Forestry Res. Rep. of Cameroon No. 23. 1987

English

Some ethnic groups in Cameroon are said to relish eating fresh leaves of young *D. sissoo.* (From Sheikh, M. I. 1989)

24
Anonymous

A Regional Research Plan for *Dalbergia sissoo*

Forestry/Fuelwood Research and Development (F/FRED, Winrock International Institute for Agricultural Development, P.O. Box 1038 Kasetsart Post Office, Bangkok, Thailand 10903. Draft No. 2 October 4, 1989

English

This draft report follows the meeting of eight scientists in September 1989 from India, Nepal and Pakistan, to review *D. sissoo* research and to prepare a draft research plan for consideration by national research programs. The draft plan is included and is intended as a step to enhancing regional research on *D. sissoo.* The state of existing knowledge, and research needs and objectives are reviewed.

25
Anonymous

Work at particular laboratories

International Association for Plant Tissue Culture Newsletter, No. 60, March 1990 The Netherlands.

English

Reports on the Godawari Tissue Culture Laboratory (HMG Dept. Medicinal Plants, Nepal) on micropropagation for several plant species (including *Dalbergia sissoo*) and noting the methods are: simple, efficient and cost effective compared to conventionally used in vitro cloning methods. At Godawari the multiplied shoots are directly rooted in sand with a high percentage of propagule production, over 50% under suitable day/night temperature regimes in the ordinary green house conditions. The procedure has reduced the production costs several times less, such that it can be compared with the production costs of seedlings and cuttings.

26
Arora, M., Rajawat, M. S. and Gupta, R. C.

Effect on properties of plywood using acetylated and normal veneers.

Indian Journal of Forestry 1982. 5 (1): 37-42

English

Properties were tested of plywood boards made with PF and UF resins from acetylated or untreated 0.32-cm veneers of chir pine, mango, *Dalbergia sissoo, Dipterocarpus turbinatus* and *Chloroxylon swietenia*. Water absorption after 24 h and % swelling at 100% humidity in acetylated boards were on average about 50% of those in untreated boards. Acetylation increased glue adhesion under all conditions with PF resin, but improvements with UF resin were limited to the dry state. MOR and MOE were improved by acetylation in all cases.

27
Ashan, J.

A guide to the selection of superior trees and stands of some important trees of west Pakistan.

For. Gen. Bull. No 1 Div. of For. Res. PFI Peshawar, 1970

English

Abstract: Not available

28
Ashley, B. and Fisk, T. (Compilers)

Tree species trials in Nepal - some early results.

Canberra, ACT, Australia; Nepal/Australian Forestry Project. 1980. v + 144 pp.

English

The objectives of the trials were to identify suitable species, and provenances, for fast-growing fuelwood plantations and to determine optimum silvicultural techniques, from nursery to post-establishment stage. The results are presented of work from 1973 to 1978 in the 15 trial plots in Kathmandu Valley, together with a brief background to Nepal and the Nepal/Australian Forestry Project. Of the 45 species tried, the most encouraging results were obtained with *Eucalyptus camaldulensis*, while *E. maidenii, E. grandis, E. tereticornis, Pinus roxburghii, P. wallichiana and P. patula* (above 1600 m) also grew well. The importance of good establishment techniques is emphasized, particularly fertilizing in B-deficient areas, and also of adequate protection for young plantations.

29
Atkinson, E. T. (Editor)

The Economic Botany of the Himalayas.

Cosmo Publications, New Delhi 1980. Reprinted from "The Himalayan Districts of the North Western Provinces of India" published in 1882.

Dalbergia sissoo is described; the leaves and saw-dust in decoction are esteemed in eruptive and

special diseases and to allay vomiting; the oil is also applied externally in cutaneous affections.

30
Avasthi, R. K. and Shafee, S. A.

First record of *Paracoccus* Ezzat & McConnell (Homoptera: Pseudococcidae) from India with description of a new species.

Journal of the Bombay Natural History Society 1983. 80 (2): 398-402

English

The genus *Paracoccus* is reported from India for the first time. *P. burnerae* was found on the tree *Dalbergia sissoo* in Alighar, Uttar Pradesh, in 1979. In addition, *P. nellorensis sp.* n. is described from adult females collected from an unidentified weed in Nellore, Andhra Pradesh, in 1979. A key to the 3 oriental species of the genus is given.

31
Ayaz, M.

A note on the sapwood percentage in shisham (*Dalbergia sissoo* Roxb.) in Changa Manga and Daphar forest plantations.

Pakistan Journal of Forestry 1985. 35 (2): 89-93

English

Average sapwood percent (u.b.) was calculated for 316 butt logs from Changa Manga and 294 from Daphar in Jan. and Feb. 1985. Av. d.b.h. for each tree and ht. of measurement were also recorded. Relations between sapwood percent and d.b.h. were calculated. Av. sapwood percent for logs from Changa Manga was 40% for d.b.h. 46 cm at an av. ht. of 3.84 m, compared with 39% for d.b.h. 45 cm at an av. ht. of 3.20 m for logs from Daphar, i.e. n.s.d.

32
Ayaz, M.

Performance of tools in tree felling and conversion in Changa Manga forest plantation.

Pakistan Journal of Forestry 1987. 37 (3): 141-150

English

The performance of conventional tools (axes, and cross cutting saws with peg teeth) and improved tools (bow saws, and cross cutting saws with raker teeth) was compared on the basis of labor productivity and physical workload in the winters of 1984 and 1985. The plantation was a mixture of *Morus alba* and *Dalbergia sissoo* ready for its main felling. The workers used conventional tools first and were then trained in the use of the improved tools; they worked in parties of 2-4 and altogether felled and converted 351 trees of av. d.b.h. 27 cm. The work cycle was timed at observation intervals of 1 min and divided into 9 work elements (personal and operational delays, walk to tree, felling, hang-up [lodge], delimbing, conversion to fuelwood, measuring and cross cutting). Number and wt. of timber pieces and fuelwood wt. were measured daily. Pulse rates were measured before work and at 3-min intervals during work with respect to different work elements. The results are analyzed statistically. Use of improved tools reduced the time per m^3 timber and fuelwood converted by 12.4 min. The technical labor productivity was increased by about 24% and the physical workload was significantly reduced, leading to an av. pulse rate reduction of 9 beats/min. Multiple linear regression analysis showed that total work time per tree was significantly related to d.b.h., number of branches and total vol. for conventional tools but only to branch number and vol. for improved tools. For the different work elements, pulse rate reduction with improved tools was greatest for felling and lodge. Use of improved tools and work techniques reduced the cost of felling and conversion by about 11%.

33
Ayaz, M. and Siddiqui, K. M.

A note on the comparative efficiency of power chain saw and hand tools for felling and conversion in irrigated plantations.

Pakistan Journal of Forestry 1982. 32 (1): 1-6

English

Preliminary results of studies in 2 plantations in the Pakistan plains, felling *Dalbergia sissoo, Morus alba* and *Salmalia malabarica [Bombax malabaricum]* (92 trees, diam. 28-61 cm) with a 2-man felling crew using 1 chain saw and a 2-9 person hand-felling crew using axes and cross-cutting saws. Data are tabulated on av. felling and cross cutting efficiencies of each method, and cost analyses are given. The chain saw was more efficient for felling and cross cutting, 3.5X faster in timber production and cost Rs 11.69/m^3 compared with Rs 15.57/m^3 for hand felling and cutting.

34
Bagchee, K.

Pathological Notes No 2. Die back of shisham, babul, khair in the artificial regeneration under Agriculture-cum-Forestry Management.

Indian Forester Vol LXX1 No 1 1945 20-24

English

Abstract: Not available

35
Bagchee, K.

A review of work done on Indian tree diseases and decay of timber and methods of control

Commonwealth Forestry Conference 1952 Indian Forester Vol LXXV111 No 11 540-546

English

The paper deals with the problems investigated over the past two decades. Shisham, *Dalbergia sissoo* either grown as a pure crop or in admixture with *Acacia catechu* or *A. arabica* is susceptible to root rot diseases due to *Ganoderma lucidum* and vascular wilt due to *Fusarium* sp. Controls have been worked out in the form of suitable admixtures with resistant species and protection against wound parasites. Wide spread mortality of *D. sissoo* in taungyas is due to root injury during cultivation which makes the plants susceptible to *Fusarium* and the root rot fungi *Ganoderma lucidum* and *Polyporus gilvus* attack them subsequently. Canal bank *D. sissoo* has its roots exposed by erosion and injured by grazing cattle and *G. lucidum* enters. Wilt control is suggested through mixtures of species and the period of cultivation minimized. Canal bank plantings need protection from grazing damage. The rotation between two succeeding crops should be of such a period as to eliminate the fungal inoculum from the soil.

36
Bagchee, K.

Diseases of forest trees in India - causes, effects and methods of prevention

Indian Forester Vol 84 No 7 1958 407-417

English

The paper updates the report to the Sixth Commonwealth Forestry Conference, 1952. Attack of *Fusarium solani* in pure crops of *Dalbergia sissoo* causing severe wilt damage are noted and that it attacks saplings and poles in ravine lands with great intensity. Attack was absent in arid sandy Rajputna soils. Experimental observations pointed to inhibition of growth of *F. solani* in soils with 20% of moisture; suggestions of periodic flooding to control the disease were not favored. The author notes it appears *D. sissoo* cannot be cultivated on flat land without the risk of wilt. Mixed plantings are preferable to reduce damage from wound parasites as *Ganoderma applanatum, G. lucidum, Fomes senex*, and *Polyporus gilvus*. Protection from grazing, lopping, removal or cutting of soil and fire reduce the factors favoring infection.

37
Bakshi, B. K.

Wilt disease of shisham (*Dalbergia sissoo*) Roxb. 11. Behavior of *Fusarium solani*, the wilt organism in soil.

Indian Forest Records (New Series) Mycology, Vol 1 No 5 64-69

English

Abstract: Not available

38
Bakshi, B. K.

Wilt disease in Shisham (*Dalbergia sissoo* Roxb.)

The Indian Forester, No 1 1955 pp 276-281

English

Fusarium solani, causing wilt of sisham, has been proved to be soil-borne. The fungus occurs in the form of mycelium and possibly also as spores. The saprophytic activity of the fungus in the soil has been studied.

Due to clogging of vessels in the sapwood the water supply to the crown is stopped, or considerable reduced, and the crown wilts. Wilt of leaves and branches indicates a late stage in the development of the disease. Death of affected trees is rapid and may occur within a few months of the crown symptoms becoming evident.

Soil behavior of *F. solani* has been studied; 1 gm of soil may contain 10,000 colonies (max. recorded 40,000); it is found in soils in healthy and in infected stands of *D. sissoo* and in soils carrying other tree species. Occurrence is independent of the host species; it is usually present as mycelium. It has quick and wide powers of saprophytic colonization of dead roots.

39
Bakshi, B. K.

Wilt of shisham (*Dalbergia sissoo*) Roxb. due to *Fusarium solani* Snyder and Hansen.

Nature Vol 174 1954 p. 278

English

Dalbergia sissoo is an important timber species of north India and suffers from wilt disease in the Dehra Dun and Saharanpur Districts of Uttar Pradesh. The disease occurs both in natural forest and taungyas artificially regenerated with mixed other species. Only trees of about 15-20 years age suffer from the disease; wilting has not been noticed in seedling, sapling and pole stands. The symptoms of wilt are systemic and are characterized by drooping leaves and branches due to loss of turgor; the leaflets turn yellow and eventually drop off. The entire tree is "thin" and light colored and stands out sharply in contrast to adjoining densely clothed green healthy trees. Nodules and slender branches on roots are absent on wilted trees. On splitting the diseased root, the bark and the outer sapwood exhibit a well defined pinkish brown stain; the stain rarely penetrates the inner sapwood. The stain progresses along the root to the stem and in the late stage may extend up the stem some ten feet from the ground.

The wilt disease is identified as *Fusarium solani*. It is soil borne, invades the tree through roots, usually the laterals, then travels to the tap root and to the stem. In the wood hyphae are abundant in all tissues, particularly the vessels.

40
Bakshi, B. K.

Control of root disease in plantations in reforested stands (with special reference to Khair, Sissoo, Eucalyptus etc.).

Indian Forester 1974. 100 (1): 77-78 + 1 pl.

English

Briefly describes damage caused by *Ganoderma lucidum* to young plantations of *Acacia catechu, Dalbergia sissoo and Eucalyptus spp.* and suggests methods of control: removal of residual roots and stumps, which act as a source of infection after clear felling; planting of mixed stands containing some resistant species; and digging of isolation trenches.

41
Bakshi, B. K.

Forest Pathology, Principles and Practice in Forestry.

Controller of Publications, Delhi; Printed at FRI Press, Dehra Dun. 1976

English

The author draws attention to the soil conditions of successful *Dalbergia sissoo* growth. The species can withstand high soil moisture under good drainage; it cannot withstand water logging even

for a short period, but can sustain long drought periods. Major diseases are discussed; Wilt disease, *Fusarium solani*, is common in plantations raised on unsuitable sites; root rot, *Ganoderma lucidum* is common in natural and plantation forests; *Polyporus gilvus* is usually a wound parasite. Leaf spots *Cercospora, Colletogloeum, Phyllachora, Phyllosticta* and *Mycosphaerella* are listed. Powdery mildew, *Phyllactinia*, and leaf rusts *Maravalia* and *Udedo* are widespread. Phanoerogams as *Tolypanthus, Cuscuta, Dendrophthoe* and *Loranthus* attack *D. sissoo* in India. Other diseases are noted. Attention is drawn to the stress of physiological disorders which promote attack by fungal organisms.

42
Bakshi, B. K., Puri, Y. N., Singh, S. and Sharma, R. P.

A note on decay resistance of teak, shisham and khair

Indian Forester Vol 87 No 1 1961 40-41

English

The durability of samples taken from single trees growing at Dehra Dun was graded after exposure to four fungi species according to weight loss. Class 1, very resistant, weight loss up to 5%; Class 11, resistant, loss to 15%; Class 111, moderately resistant, loss to 25%; Class 1V, non resistant, loss above 25%. *D. sissoo* was Class 11, resistant; the outer heart is relatively more decay resistant than the inner heart; there appears to be no difference in the decay resistance at different heights in any one species either in the inner or outer heartwood; the sapwood of *D. sissoo* is of low decay resistance comparable to the perishable *Salmalia marabaricum* which was used to check the severity of the test, which was indicated as severe.

43
Bakshi, B. K. and Singh, S.

Root diseases of shisham (*Dalbergia sissoo*) Roxb. V111 Inoculation Studies on wilt.

Indian Forester, Vol 85 No 7 1959 415-421

English

All the symptoms of shisham wilt observed in nature could be artificially reproduced through inoculations of *Fusarium solani* (Martius) forma *dalbergiae* Gordon.

44
Bakshi, S. and Chauhan, R. K. S.

Germination behavior of conidia of *Phyllactinia dalbergiae*.

Indian Phytopathology 1979, publ. 1980. 32 (2): 330-331

English

Germination of conidia, studied on different surfaces, was highest on the upper leaf surface (65.1%), lower leaf surface (63.61%) and leaf extracts (49.86%) of the host, *Dalbergia sissoo*.

45
Bakshi, S. and Chauhan, R. K. S.

Changes in phenolic contents of sheshum leaf exudates in response to infection with *Phyllactinia dalbergiae*.

Acta Mycologica, Warsaw 1982, publ. 1986. 18 (2): 145-147

English

After infection of *Dalbergia sissoo*, the phenolic content in leaf exudates at first rose and then decreased with the progress of the disease. In exudates from healthy leaves, there was a gradual decline in the phenolic content as the leaves matured.

46
Bakshi, B. K., Reddy, M. A. R. and Singh, S.

Ganoderma root rot mortality in khair (*Acacia catechu* Willd.) in reforested stands.

European Journal of Forest Pathology 1976. 6 (1): 30-38

English

G. lucidum was reported in *A. catechu* plantations in Uttar Pradesh [RAM 48, 1328], established after clearing natural forests without removal of residual roots and stumps. The fungus spread by contact from decayed roots to healthy ones and destroyed up to 55% of trees in 9-yr-old stands. *A. catechu* and poplar are highly susceptible, *Dalbergia sissoo* less so. Control measures include the removal of old stumps and roots, planting resistant spp. in the first rotation or mixing them with susceptible ones, and trenching to confine the disease to affected areas.

47

Bandre, T. R. and Patil, B. V.

Studies on the leaf blight of *Embelia robusta* Roxb. from India.
Ceska Mykologie 1975. 29 (4): 208-210

English

Glomerella sp. is newly reported on this wild shrub in Maharastra, spreading to other, economically important hosts such as *Dalbergia sissoo*.

48
Basu, P. K. and Kabi, M. C.

Effect of application of biofertilizers on the growth and nodulation of seven forest legumes.

Indian Forester 1987. 113 (4): 249-257

English

Tests were carried out in a nursery bed in the Arabari Range of East Midnapore Forest Division, West Bengal, using 7 species: *Albizzia lebeck [Albizia lebbek]; Leucaena leucocephala; Prosopis juliflora; Pongamia glabra [P. pinnata]; Acacia auriculiformis; A. arabica [A. nilotica]*; and *Dalbergia sissoo*. Healthy seeds were surface sterilized and inoculated with either *Rhizobium* spp. (RI) or *Rhizobium* + *Azotobacter chroococcum* (RI + AI); some were pelleted with lime (RI + L and RI + AI + L), and some kept untreated as controls. The treated seeds (and controls) were sown in 20x10 cm polypots filled with soil and compost (3:1) and arranged in the nursery bed (red lateritic soil, Ph 5.5). After 150 days, data were recorded on plant ht., root length and dry wt., and nodule numbers and wt. Nodulation and growth were enhanced in all treatments compared with controls. The most effective treatment varied with the legume species, in some cases RI was better than RI + AI, and in some pelleting with lime (to protect the inoculants from the acid Ph of the soil) further increased the effects of the inoculants. Max. response was shown by *L. leucocephala*.

49
Bawa, K. S.

In "Tropical Trees - Variation, Breeding and Conservation"

Linnean Society Symposium Series No 2 edited by Burley, J. and Styles, B.T. Department of Forests, Commonwealth Forestry Institute, Oxford University 1976 p 52

English

In considering genetic variation in natural populations the author notes the amounts and patterns of genetic variation in natural populations are not known even for a single tropical tree species. This includes taxa as Teak and Eucalyptus. Breeding programs with a number of species including *Dalbergia sissoo* have not progressed beyond the selection stage.

50
Beeson, C. F. C.

The Ecology and Control of the Forest Insects of India and the Neighboring Countries.

Government of India. First published 1941, First reprint 1961

English

This monumental work references the numerous insect predators of *Dalbergia sissoo*. Epidemic attack follows seasonal patterns of fresh leaf resource or may follow in the wake of trees weakened by defoliators or wilt disease. The

cumulative effect of repeated attack on poor quality plantations in off site locations can cause abandonment of these. The life history as known, damage, season of attack and economic importance are discussed. Control measures as effective often relate to the nursery situation. Some major insect pests are: leaf rollers *Apoderus sissu, A. blandus*; defoliators, *Dichomeris eriaantis, Dasychira dalbergiae, Plecoptera reflexa*; scale, *Aspidotus orientalis*; shoot borer *Cladobrostis melitricha*; bark and sapwood borer, *Perissus dalbergiae*, etc.

51
Ben-Jaacov, J. and Hagiladi, A.

Plant introduction and landscaping development around the Sea of Galilee using an extensive agrotechnical approach.

Israel Journal of Botany 1977. 26 (1): 49-50

English

The Kinneret (Sea of Galilee) is the only fresh water lake in Israel. It is the country's main water reservoir and also an important recreational site. In autumn, 1974, a number of species were planted at 4 different sites around the lake. The sites differed from each other mainly in soil composition, wind velocity and land exposure, as well as degree of interference from the public sector. Of the different plants used the most successful were: *Tipuana tipu, Dalbergia sissoo, Ficus sycomorus, Peltophorum dubium, Agonis flexuosa, Schinus lentiscifolius* and *Enterolobium contortisiliqua*, while *Platanus orientalis, Taxodium distichum* and *Acacia baileyana* developed poorly. Specimens planted around the lake became self maintained when their roots reached the water table and various attempts were made to accelerate this. One of the techniques used was to prepare the plant in a long (80 cm) narrow (8-cm diameter) screened-plastic tube. These tubes were inserted into holes of the same dimensions drilled in the ground.

52
Benthall, A. P.

The Trees of Calcutta

Thacker Spink & Co., Calcutta 1933. Reprinted, Bishen Singh Mahendra Pal Singh. 23-A Connaught Place Dehra Dun 1984

English

Dalbergia sissoo (Dalbergia, named after Nicholas Dalberg a Swedish botanist who died in 1820, sissoo, an Indian vernacular name) is described as a large tree, found in nature growing on the banks of streams and rivers to which their pods have been carried by floods. The *D. sissoo* is a native of the outer hills of the Himalayas and is now found throughout India. It is commonly planted as an avenue tree though, owing to its light shade, it is perhaps less suited for this purpose than many others. The leaves fall in the cold season and are replaced in January and February by new foliage which is closely followed by the flowers which are very fragrant and their scent carries far on the evening air. An oil from the seeds is used to cure skin diseases; the powdered wood is considered valuable in leprosy and skin eruptions.

53
Bhadran, C. A. R.

The Monas game sanctuary, Assam

Indian Forester Vol XL No 12 1934 802-811

English

The paper details the objectives and management practices of the Monas game sanctuary, north of the Bramahputra river. The area is flat and marshy and along the Bhutan boundary a strip of open forest occurs including *Acacia catechu* and *Dalbergia sissoo*

54
Bhattacharjee, J. W., Dogra, R. K. S., Lal, M. M. and Zaidi, S. H.

Wood dust toxicity: in vivo and in vitro studies.

Environmental Research 1979. 20 (2): 455-464

English

In tests on wood dust from *Dalbergia sissoo* and *Mangifera indica* (the most common woods used

for furniture and building materials in India) in vitro hemolytic activity was shown to be indicative of the degree of acute toxicity and in vitro macrophage cytotoxicity was indicative of fibrogenicity.

55
Bhimaya, C. P. and Chowdhary, M. D.

Plantations of wind-breaks in the central mechanized farm at Suratggahr - an appraisal of techniques and results

Indian Forester Vol 87 No 6 1961 354-367

English

This new farm was placed in a treeless sandy poorly drained alluvium; rainfall is a scant 9 inches a year, evaporation is high and soluble salts accumulated creating many saline and alkaline patches; ph is around nine. The soils blow in the frequent storms and there are dune formations. The typical tropical desert climate is not congenial for plant growth. Tree planting was done along the farm roads which run at right angles to each other every 1100 yards. Detail is provided on composition of the wind breaks, spacing of rows, soil working, sowing, planting and choice of species. *Dalbergia sissoo* has done well as a main row tree choice.

56
Biswas, G. S.

Afforestation of *beel* areas in Malda Forest Division.

Indian Forester Vol 86 No 3 1960 172-176

English

The Malda forest division with its *beel* areas (swamps) is confronted with serious problems of afforestation with useful tree species. The great fluctuations of water level on the land and various other adverse climate factors create serious difficulties. Establishment techniques emphasize mound heights be sufficiently high and well designed to withstand flood damage; mounds be planted with large sized seedlings to keep heads above flood water level; plants be established well in advance of flood water inflow. Stumps and cuttings of *Dalbergia sissoo* gave 75% survival after floods.

57
Bose, R. K. and Bandoyopadhyay, S. K.

Economics of energy plantations in alkali soils of Indian semi-arid regions.

Biomass 1986. 11 (1): 51-60

English

7Y Results are reported from a field experiment on 4.7 ha of salt-affected community land in the Gurgaon district of Haryana, India, with *Prosopis juliflora, Acacia nilotica, Eucalyptus hybrid [E. tereticornis], Dalbergia sissoo, Leucaena leucocephala, Azadirachta indica* and *Albizia lebbek*. Mortality rates 3 months after planting were high for *A. nilotica* (27%) and *E. tereticornis* (19%). Ht. after 2 yr was best in *E. tereticornis* (3.04 m) and least in *A. indica* (0.5 m). Fuelwood plantations on such sites are thought to be economically feasible.

58
Brandis, D.

Indian Trees

Constable & Co London. 1907, 233

English

Describes the distribution of *Dalbergia sissoo* in the sub Himalayan tract as from the Indrus to Assam ascending to 3,000' and in places to 5,000'; a brief account of the tree, bark, leaflet, flower and pod is given.

59
Browne, F. G.

Pests and Diseases of Forest Plantation Trees

Clarendon Press, Oxford. 1968

English

The annotated list of the principal species occurring in the British Commonwealth - a list of tree species and their pathogens. The pathogens of *Dalbergia sissoo* are given as:

Fungi. *Auricularia auriculajudae, Colletoglocum sissoo, Diplodia dalbergiae, Fomes durissimus, F. robiniae, Fusarium oxysporum, Ganoderma applanatum, G. lucidum, Hypoxylon hypomiltum, H. investiens, H. rubiginosum, Irpex flavus, Marasmius equicrinis, Maravalia achroa, Meliola bicomis, Mycosphaerella dalbergiae, Nectria haematococca, Phellinus gilvus, Phyllachora dalbergiae, P. spissa, Phyllactinia guttata, Phyllosticta sissoo, Polyporus anebus, Poria ambigua, Rosellinia aquila, Schizophyllum commune, Phanatephorus cucumeris, Trametes corrugata, Uredo sissoo.*

Angiospermae. *Cuscuta reflexa, Dendrophthoe falcata, Loranthus pulverulentus, Tapinanthus dedoneifolius, Tapinanthus Tolypanthus involucratus.*

Coleoptera. *Adoretus caliginosus, Amblyrhious poricollis, Anotnala dalbergiae, Apate monachus, A. Terebrans, Apoderus blandus, A. sissu, Aulacophora foveicollis, Batocera rufomaculata, Bruchus pisorum, Dorysthenes hugcli, Gonocephalum depressura, Halyzia sanscrita, IIIeis cineta Minastra cyanura, Mylioceras blandus, M. cardoni, M. discolor, M. lefroyi, M. sabulosus, M. setulifer, M. transmarinus, M. undcimpustulatus, Perissus dalbergize, Platymycterus sjoestedti, Rhinyptia indica, Sinoxylon anale, Tanymecus hispidus.*

Hemiptera. *Acaudaleyrodes iachipora, Aleurolobus marlatti, Aonidiella orientalis, Aspsidoproctus bifurcatus, atelocera stictica, Dialeuropora decempuncta, Drosicha dalbergiae, D. mangiferae, D. octocaudata, D. stebbingi, Gargara mixta, G. varicolor, Hemaspidoprocrus eineres, Hemiberlesia lataniae, Laecifer lacca, Myzus persicae, Nipaecoccus vastator, Oxyrbachis formidabilis, O. mangifferana, Texopteraaurantii.*

Isoptera. *Bifidinermes beesoni.*

Lepidoptera. *Anomis sabulifera, Archips micaceanus, Ascotis selenaria, Bucculatrix mendax, Buzura suppressaria, Caloptilia tetratypa, Charaxes fabius, Cladobrostis melitricha, Cusiala raptaria, Dasychira dalbergiae, D. mendosa, Dichomeris eridantis, Euproctis scintillans, E. sulphurescens E. virguncula, Hamodes propitia, Heliothis armigera, Hypena iconicalis, Hypoglaucitis bencnotata, Hyposidra talca, Laspeyresia jaculatrix, Leucoptera stenogrnpta, Neptis hylas, Pandesma anysa, Philudora laeta, Plecoptera ferrilineata, P. reflexa, Plusia orichaloca, Sataspes scoti, Thosca cana.*

Orthoptera. *Brachytrypes portentosus, Chrotogonus spp., Gymnogryllus erythrocephalus, G. humeralis, Kraussaria angulifera, Schistocerca gregaria.*

Mammalia. *Bos taurus, Ovis aries, Presbytis entellus.*

60
Campbell, M.A.

Plant Propagation for Reforestation in Nepal

Nepal-Australia Forestry Project, Department of Forestry, Australian National University, Canberra 1981

English

Describes seed storage and nursery plant production methods for *Dalbergia sissoo*

61
Chakravarty, P. and Mishra, R. R.

The influence of VA mycorrhizae on the wilting of *Albizia procera* and *Dalbergia sissoo*.

European Journal of Forest Pathology 1986. 16 (2): 91-97

English

In a greenhouse trial, inoculation of *A. procera* with *Fusarium oxysporum* and of *D. sissoo* with *F. solani* decreased root and shoot length and total biomass compared with uninoculated controls. Inoculation with the VA mycorrhizal fungi *Glomus fasciculatus [G. fasciculatum]* and *G. tenuis [G. tenue]*, however, increased plant growth compared with controls. Pre-inoculation with G. spp. before F. spp. resulted in plant growth

similar to or better than that in the controls, and a significant reduction in percentage root colonization by, rhizosphere population of and disease severity due to F. spp. compared with plants inoculated with F. spp. alone. The phosphorus concentration in the leaves of mycorrhizal plants was higher than in non-mycorrhizal plants and was higher in both in the absence of F. spp. Results suggested that tolerance of F. spp. by mycorrhizal plants is only partly due to improved plant nutrition.

62
Champion, H. G. and Seth, S. K.

The Forest Types of India

Government of India Press, Delhi 1968.

English

Among the forest types of India, the riverain associations of Khair-Sissu are distinctive. The authors note the influence of soil so far exceeds that of climate that the type is obviously the same from the Punjab to Assam as the first tree associations to colonize new deposits. The type resembles the moist rather than the dry deciduous, in that it is in full leaf throughout the hot weather; this is a specific characteristic of the dominant *Dalbergia sissoo* not shared by most of its associates. Distribution, composition and natural succession and soil moisture are discussed.

63
Champion H.G., Seth, S.K. and Khattak, G.M.

Manual of Silviculture for Pakistan

Government of Pakistan 1965

English

The Manual addresses the principles of Silviculture in relation to the management of Pakistan forests and describes the techniques and methodology of their implementation.

Throughout the Manual reference is made to species to illustrate techniques or to define needs. *Dalbergia sissoo* is cited in relation to the establishment of irrigated plantations and to aerial spraying to control a leaf defoliator, *Plecoptera reflexa. D. sissoo* is listed as a species in demand for veneer and plywood production and for tool handles.

64
Chandra, A. and Gupta, R. B.

Treatment of green fence posts by non-pressure processes.

Journal of the Timber Development Association of India 1977. 23 (1): 17-20

English

Fence posts of chir (*Pinus roxburghii*) sal (*Shorea robusta*), mundani (*Acrocarpus fraxinifolius*) and shisham (*Dalbergia sissoo*) were treated with a Cu-Cr-As preservative by (a) steeping for 15-45 days in a 10% solution; (b) standing the ends of the posts in a 10% solution for 24-48 h (sap displacement); or (c) applying it as a paste coating, 0.25-4 cm thick, left in place for 50 or 100 days. The penetration and retention of the preservative in the posts are tabulated. Methods (a) and (b) were both satisfactory, but insufficient penetration was achieved by method (c).

65
Chandra, A. and Pant, S. C.

Building timbers - treatment by non-pressure methods.

Journal of the Timber Development Association of India 1981. 27 (1): 22-29

English

Preservative absorptions are tabulated for: 11 Indian timber species converted into window and door components and treated with 5% aqueous sol. of borax/boric acid (1:1) or Cu/Cr/boric acid (1:1:1) by the hot and cold method; and 4 species treated as poles with CCA by the sap-displacement method.

66
Chandrasekharaiah, A. M. and Prabhakar, A. S.

Growth and its analysis of tree species in agroforestry system.

Journal of Farming Systems 1987. 3 (1-2): 17-21

English

A field study was made to evaluate the ht. growth and dry matter production and its distribution in various parts of 6 tree species (*Leucaena leucocephala* 'K8', *Acacia nilotica* 'Indica', *Dalbergia latifolia, Azadirachta indica, Dalbergia sissoo* and *Derris indica [Pongamia pinnata]*) at Dharwad, Karnataka, during kharif 1979-84. Data are tabulated on ht. growth from 1 to 5 yr old, and for biomass production at 4 and 5 yr old. *Dalbergia sissoo* produced significantly higher totally harvestable biomass per plant (70.01 kg) than other species. This was followed by *L. leucocephala* (47.46 kg), *Acacia nilotica* (27.05 kg), *Azadirachta indica* (15.77 kg), *P. pinnata* (10.17 kg) and *D. latifolia* (3.84 kg).

67
Chaturvedi, A. N.

General standard volume tables for Shisham (*Dalbergia sissoo* Roxb.).

Indian Forest Records, Silviculture 1973. 12 (9): 1-13

English

Presents tables for merchantable timber volumes and smallwood volumes of *D. sissoo*, based on data from Uttar Pradesh, W. Bengal, Punjab and Haryana.

68
Chaturvedi, A. N.

Assessment of biomass production.

Indian Forester 1984. 110 (8): 726-738

English

A study of *Syzygium cumini, Prosopis juliflora, Acacia nilotica*, and *Dalbergia sissoo*, planted at 1.5x1.5 m in semi-arid conditions at Etwah, Uttar Pradesh. Various biomass functions (green wt./girth, green wt./height, green wt./dbh, air-dry wt./girth, air-dry wt./ht., air-dry wt./dbh) were investigated, and regression equations were developed. It was considered too early to draw any definitive conclusions from the study on the suitability of the species tried, but *A. nilotica* gave indications of being the most productive.

69
Chaturvedi, A. N., Bhatt, D. N., Mishra, C. M. and Singh, S. L.

Root development in some tree species on usar soils.

Journal of Tropical Forestry 1986. 2 (2): 119-130

English

Root systems were excavated of 17- to 19-yr-old trees of 15 species, including *Acacia nilotica, A. catechu, A. auriculiformis, Prosopis julifera, Cordia dichotoma* and *Syzygium cumini*, planted in 1965/66 on an area in Uttar Pradesh subject to waterlogging in the rainy season. Stump diam., tree ht., branch development, total above-ground biomass and soil characteristics (depth, Ph, conductivity and density) were recorded for each tree. Species developing good superficial root systems (rather than long tap roots) on these saline/alkaline soils, such as *Albizia procera, A. lebbek, Dalbergia sissoo, Pongamia pinnata, Eucalyptus 'hybrid' [E. tereticornis]* and *Terminalia arjuna*, grew well, while those that failed to develop healthy lateral roots (*Madhuca longifolia, Tamarindus indica* and *Azadirachta indica*) showed poor growth.

70
Chaturvedi, A. N., Sharma, S. C. and Srivastava, R.

Water consumption and biomass production of some forest trees.

Commonwealth Forestry Review 1984. 63 (3): 217-223

English

Results are presented from lysimeter studies at Kanpur, Uttar Pradesh, India, of seedlings of

Albizzia [Albizia] lebbek, Acacia auriculiformis, Dalbergia sissoo, Pongamia pinnata, Syzygium cuminii and *Eucalyptus hybrid*. After 1 yr, *P. pinnata* had consumed least water (679 liters), had produced least biomass (520 g) and had the highest av. consumption of water per g of biomass (1.3 liters); *Eucalyptus* had consumed most water (2662 liters), had produced most biomass (5209 g) but had the lowest av. consumption of water per g of biomass (0.51 liters).

71
Chaturvedi, A. N., Sharma, S. C. and Ramji Srivastava

Water consumption and biomass production of some forest tree species.

International Tree Crops Journal 1988. 5 (1-2): 71-76

English

Rates of water consumption and biomass production are important considerations in the choice of tree species for agroforestry systems, particularly in dry areas. This paper reports lysimeter measurements of such rates for *Azadirachta indica, Prosopis juliflora, Pithecellobium dulce* and *Acacia nilotica* and compares them with rates previously reported for *Albizia lebbek, Acacia auriculiformis, Dalbergia sissoo, Pongamia pinnata, Eucalyptus hybrid [E. tereticornis]* and *Syzigium cuminii [Syzygium cumini]*. Both sets of experiments were carried out with seedlings planted in locally fabricated lysimeters. Water consumption, ht. and root collar diam. were recorded over 1 yr and air-dry wt. measured at the end of the experiment. The results confirm the strong relation between biomass production and water consumption. Of the 10 species tested, *E. tereticornis* was found to be the most efficient and
Pongamia pinnata the least. *Albizia lebbek* and *Syzygium cumini* compared favorably with *E. tereticornis*.

72
Chaturvedi, M. D.

The friendly shisham

Indian Fmg. 6 (20) pp 19-20 1956

English

Abstract: Not available

73
Chaudhry, M. I. and Ashiq Ahmad

Population studies and insecticidal control of shisham leaf miner, *Leucoptera sphenograpta* Myer. Lyonetiidae, Lepidoptera.

Pakistan Journal of Forestry 1986. 36 (4): 211-214

English

A survey showed that *L. sphenograpta* appeared in epidemic form in shisham (*Dalbergia sissoo*)-growing areas of North West Frontier Province and at Mianwali in Pakistan. Detailed studies were made of the extent of infestation of 1-yr-old plants in a nursery at Peshawar in April [1985?, and also in other areas]. Infested leaves were counted on 20 plants [in an area] and the mined portion of 100 leaves dissected to record larval populations. Pupal population counts were made on 100 leaves with webs. Almost every leaf was found to be infested, and all stages of the pest were abundant. There were 1-5 larvae per leaf under the mine. Premature leaf-shedding had occurred in most plants. Pupal cocoons had formed below the webs on about 30% of plants, with about 2-8 pupae per leaf. Fresh infestations could be recognized by pinches on the leaves which later expanded to irregular blotches, followed by leaf curling and stunted growth.

Control by sprays of Dimecron [phosphamidon] 100% EC, Ekalux [quinalphos] 25% EC, Thiodan [endosulfan] 25% EC, hebaycid [fenthion] 5% EC and Bidrin [dicrotophos] 85% EC at 0.01, 0.05 and 0.1% was tested in the nursery. Percent larval mortality was recorded after 24, 48 and 72 h. All the insecticides were effective, giving a complete larval kill in 72 h. Fenthion was the most effective, giving 100% mortality in 24 h at 0.05%. In a laboratory test with pupae it was again the most effective, being the only agent (at 0.1%) to give 100% kill. Field-scale trials confirmed these results.

74
Chaudhry, M. I. and Hanif Gul

Shisham defollator control.

For. Ent. Br. Bio,1. Res. Divn. Leaflet No. 9 Peshawar. pp 4

English

Abstract: Not available

75
Chaudhry, M. I. and Hanif Gul

Efficacy of antimoultants against poplar defollator *Ichthyura anastomosis* Steph. and shisham defollator *Plecoptera reflexa* Guen.

Pakistan Journal of Forestry 1985. 35 (4): 181-186

English

Poplar shoots were sprayed with 0.01, 0.02 or 0.04% Dimilin [diflubenzuron] or Alsystin [triflumuron] in the laboratory and larvae of *I. anastomosis* [*Clostera anastomosis*] added. After 96 h mortality was 80-100% of insects exposed to 0.04% Dimilin or Alsystin, compared with 13-23% mortality in untreated controls. Plots containing populations of *P. reflexa* (32 larvae/tree on av.) at Rashakai (Mardan NWFP) were given the same treatments as above. Population counts were made 5, 12 and 23 days later. After 23 days there were no larvae on plots given 0.02 or 0.04% treatments of either product compared with 22 or 40 larvae/tree on untreated plots.

76
Chaudhry, M. I. and Shah, B. H.

Preliminary studies in the biology and control of Shisham bark borer, *Agrilus dalbergiae* Thery.

Pakistan Journal of Forestry 1974. 24 (4): 383-392

English

The life cycle of *A. dalbergiae* on Shisham [*Dalbergia sissoo*] in Islamabad is briefly described. The insect completed its life cycle in one year. *Tetrastichus* sp. was found parasitizing 15-35% of the larvae. Results are given of trials with various insecticides applied by spraying, painting, injection or as granules to kill larvae in the trees or by spraying to prevent attack. Painting systemic insecticides on infested parts of the stem and branches was the best method of killing larvae. In the preventative trials, BHC at 1.0 to 1.5% gave 100% protection with an annual spray in June.

77
Chaudhry, M. I. and Shah, B. H.

Efficacy of some systemic insecticides against shisham bark borer grubs, *Agrilus dalbergiae* Thery. (Buprestidae: Coleoptera).

Pakistan Journal of Forestry 1976. 26 (1): 35-37

English

Six insecticides, at concentrations of 0.5-1.5%, were applied as sprays to stems and branches of shisham [*Dalbergia sissoo*], newly infected with *A. dalbergiae*, in Islamabad, in Sept. 1975. Folidol and methyl parathion at 1.5% were the most effective, giving resp. 92 and 83% grub mortality. It is emphasized that the spray should be applied not later than the first week of Sept., before the grubs bore too deeply into the bark. Previous trials, performed in Oct. had failed to kill the grubs in the deeper bark layers.

78
Chaundhry, M. I., Malik, N. K. and Arshad, M.

Natural resistance of various timbers to the attack of *Coptotermes heimi* (Wasm.).

Pakistan Journal of Forestry 1978. 28 (2): 123-126

English

The resistance of 12 common Pakistan timbers was estimated by determining the time for which *C. heimi* workers and soldiers survived when kept in jars of sawdust of the different species with no other food. *Cedrus deodara* and *Tectona grandis* were the most resistant, and *Picea smithiana,*

Abies pindrow and *Salmalia malabarica* [*Bombax malabaricum*] the least.

79
Chopra, R. N.

Indigenous Drugs of India

The Art Press, 20 British India St. Calcutta 1933.

English

Includes *Dalbergia sissoo* as Indian Medical Plant and notes its uses as: leaves bitter, stimulant, useful in gonorrhea.

80
Choudhury, K.A. and Gosh, S.S.

Indian Woods, their identification, properties and uses.

Manager of Publications, Printed by The Northern Circle, Survey of India. Vol. 1. 1958

English

The earliest recorded use of wood goes back only to the protohistoric period (from 3,000 BC) to early historic era; in this period we find men of the Indrus valley civilization using wood for many purposes. At Harappa, a full fledged Bronze Age civilization, and at Hastinapura, a Copper Age civilization the variety of uses to which wood was put infers an experience of thousand of years must have been behind these people to give them such an insight into the properties of different timbers; in many cases they seem to have made the most efficient use of timber judged according to modern standards. Remains at Hastinapura do not clearly indicate whether they were used as firewood or charcoal but there is little doubt that the people of this Copper Age civilization had some idea of the woods that have high calorific value. Two timbers Sissoo (*Dalbergia sissoo*) and Kurchi (*Holarrhena antidysentrica*) recovered from this excavation are considered even today to be good fuel woods.

81
Cornelius, D. R., Bhatt, B. N. and Pathak, R. L.

Windbreak plantation on sandy land in northern Gujarat.

Indian Forester 1977. 103 (4): 251-259

English

The results of a trial, started in 1968, to find suitable windbreak species for the region, where damage by soil blowing is estimated to affect approx. 320 000 ha. Seedlings of 30 taxa were tested in nursery beds, and those that survived were transplanted as single- line windbreaks in 1969-71. Data on survival and performance are given for 18 species, with additional notes on 12 of them. Seedlings raised in polythene bags showed higher survival than bare-rooted seedlings.

All-round performance was best for *Acacia tortilis, Albizia lebbek, Dalbergia sissoo, Eucalyptus camaldulensis*, and a *Eucalyptus hybrid.*

82
Council of Medical Research (Indian)

Medicinal Plants of India

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English

Parts of *Dalbergia sissoo* used in medicine are: bark, roots, leaves and mucilage. Its Ayurvedic description, properties and action/ uses are given. The medicinal properties and uses are: bark or wood raspings are alternative while the roots are astringent and leaves bitter and stimulant. A decoction of leaves is found useful in gonorrhoea. The wood has been found useful in leprosy, boils, eruptions and to allay vomiting. The chemistry (extracts) of stem-bark yielded dalbergenone, dalbergin and methyl dalbergin and a new compound 4-phenyl chromene, dalbergiahromene. Reinvestigations of the heartwood showed that in addition to the known compounds the plant also contained dalbergichromene, nordalbergin and isodalbergin as minor constituents. Pharmacological and clinical studies involving other *Dalbergia* spp. are included.

83
Council of Scientific & Industrial Research, New Delhi

The Wealth of India, a dictionary of Indian raw materials and industrial products.

C.S.I.R. New Delhi, Vol 111 D-E, 1952

English

Dalbergia sissoo is described as a deciduous tree often with a crooked trunk and light crown. It has a riverain habitat, grows gregariously in alluvial forests and is extensively cultivated and has use in road sides and in tea gardens. Silvicultural characters are discussed as are the propagation techniques; plantation methods are covered in stump planting and in direct sowing; *D. sissoo* is susceptible to wilt and fungal diseases; mistletoe (*Dendrophthoe falcata*) can prove fatal. Plantations are managed in coppice with standards. Growth rates and timber availability are discussed; timber use and properties are included and reference is made to wood components, fodder values and medicinal uses.

84
Council of Scientific & Industrial Research, New Delhi.

The Useful Plants of India

Publications and Information Directorate, C.S.I.R. New Delhi 1986

English

Describes *Dalbergia sissoo* as high class furniture and cabinet wood and with other uses. Yields a fixed oil; leaves used as food; excellent fuel wood, also very suitable for charcoal making.

85
Cowan, A. M. and Cowan, J. M.

The Trees of Northern Bengal, including Shrubs, Woody Climbers, Bamboos, Palms and Tree Ferns.

Bengal Secretariat Book Depot, 1929

English

Notes the species *Dalbergia sissoo* as principally in the river beds of the Terai and Duars; ascending to 3,000 feet, frequently planted.

86
Crane, E., Walker, P. and Day, R.

Directory of important world honey sources.

International Bee Research Association, Cardiff U.K. 1984.

English

The book is a digest of some 452 nectar and 15 honeydew producing plants reported to be a major source of honey. *Dalbergia sissoo* is listed; it's distribution is given as tropical and subtropical Asia, native to the foothills of Himalayas. It blooms March-April (India) and April-May (Pakistan), with a nectar flow of 2 weeks. It carries a warning that even light winds blow flowers from branches reducing the nectar available in windy seasons/areas. The honey yield (kg/colony/season) is moderate 4-9; the honey is 18.75% water; glucose 34.6; fructose 39.1; sucrose 1.04; ash 0.18. The honey has a strong flavor and is amber to dark amber.

87
Dash, V. B.

Materia Medica of Indo-Tibetan Medicine

Classics India Publication, 1987, reprint 1989.

English

Lists the Sanskrit name for *Dalbergia sissoo* as simsapa. The text describes the medicinal values and uses, attributing these properties: simsapa relieves kapha, it cures pinsasa (chronic rhinitis, svitra (leukoderma), kustha (obstinate skin disease including leprosy), prameha (obstinate urinary diseases including diabetes) and suppurated ulcers. It causes abortion.

88
Dastur, F. N. I.

Useful Plants of India and Pakistan

D.B. Taraporevala Sons & Co. Bombay 1964, reprint 1985

English

Describes the tree *Dalbergia sissoo* and its Himalayan distribution. The text continues with the general uses of the wood and mentions it is excellent for making charcoal.

89
Dasuki, U. A.

Some aspects of the biology and silviculture of the genus *Dalbergia L.* (Leguminoseae) in Java.

BIOTROP, SEAMEO Regional Center for Tropical Biology. Bogor, Indonesia. 1975.

English

A useful summary of experience of *Dalbergia sissoo* as an exotic. It is cultivated on Java and Bali; the vernacular name is sono siso or sono wasesso. The tree form and floral parts are described; it appears to flower Oct./Nov. and March/May producing seed after 2-3 years age and with abundant crops each year. Germination and the seedling stage is treated in detail. Sono siso is noted as a strong light demander and tolerant of sites where teak and *Swietenia macrophylla* and *Eucalyptus alba* did not grow well. Direct sowing is practiced, 3-5 seed per place and at 3x1m to reduce heavy branching; thinning is advised after 5-8 years age. It is noted root-cutting, stem-cutting and root-suckers were possible reproduction measures. The wood is hard, strong and durable and makes excellent charcoal; it is used for furniture, carving, handicrafts etc. The chemical components are given as: dalbergin, o-methyl dalbergin, isodalbergin, nordalbergin and dalbergichromene; the durability for which the wood is valued may be partly due to the presence of quinones of dalbegineid group (e.g., dalberginone).

90
Datta, S. K. and Datta, K.

Auxin induced regeneration of forest tree - *Dalbergia sissoo* Roxb. through tissue culture.

Current Science 1983. 52 (9): 434-436

English

Plantlets were successfully grown over 60 days using nodal explants taken from a mature tree and cultured in MS (Murashige and Skoog) medium supplemented with IAA or IAA and NAA. IPA (indolepropionic acid) and 2,4-D did not stimulate callus or plantlet formation.

91
Datta. S. K. and Pramanik, T. K.

Xylogenesis in *Dalbergia sissoo* Roxb. A model system in elucidating cytodifferentiation and regeneration of plants through tissue culture.

Journal of Tree Sciences 1983. 2 (1/2): 49-53

English

Nodal explants (10-15 mm long) were collected from a mature tree in an active stage of growth and after sterilization, inoculated into MS medium supplemented with various combinations of auxins and cytokinins. Callus initiation occurred after 7-20 days, and initiation of xylem tissue (the formation of tracheary cells) at varying intervals after this. The most effective auxin for inducing xylogenesis was 2,4-D, followed by IAA, IBA and NAA. NAA gave an early response - after 8 days of culture. In almost all the auxin treatments xylogenesis was inhibited after 40 days because of de-differentiation; with NAA the inhibition occurred at 30 days. The most effective cytokinin for inducing xylogenesis was BAP [BA] which was effective after 14 days, kinetin was less effective. TIBA [a growth inhibitor] induced hardly any xylem cells. Both auxins and cytokinins induced shoot and root formation. Root formation was more frequent where there was a high percentage of tracheary cells.

92
Datta, S. K. and Pramanik, T. K.

In vitro response of exogenous growth regulators on endogenous IAA induced xylogenesis and regeneration potentiality of timber tree - *Dalbergia sissoo* Roxb.

In Sudo, S. 1984. Proceedings, Pacific Regional Wood Anatomy Conference, October, 1-7, 1984, Tsukuba, Ibaraki, Japan. 126-128

English

Nodal explant calluses were grown on a medium containing 2,4-D, BAP (benzylaminopurine), 2,4-D plus BAP, TIBA (triiodobenzoid acid) or a combination of BAP and TIBA. Xylogenesis was stimulated by both 2,4-D and BAP. However, some tracheary cells were present in the controls, which received no exogenous growth regulator and it is concluded that endogenous IAA may have induced some xylogenesis. TIBA, an anti-auxin, reduced xylogenesis and also seemed to reduce the amounts of endogenous IAA measured in the culture.

93
Dent, T. V.

Seed storage with particular reference to the storage of seed of Indian forest plants.

Indian Forest Rec. (New Series), Silviculture 7 (1). Manager of Publications, Delhi, 134 p. 1948

English

Abstract: Not available

94
Dhillon, M. S., Surjit Singh, Atwal, A. S. and Singh, S.

Developing agri-silvicultural practices: effects of *Dalbergia sissoo* and *Acacia nilotica* on the yield of adjoining crops.

Indian Journal of Ecology 1984. 11 (2): 249-253

English

Effects of *D. sissoo* and *A. nilotica* planted in E.-W. and N.-S. directions on yields of wheat and rice grown on the S., E. or W. aspects of the tree rows were studied. There was less reduction in wheat yield on the S. aspect than on other aspects and more loss in paddy yield on the W. aspect than on other aspects. *A. nilotica* caused more reduction in yield than *D. sissoo*.

95
Dhukia, R. S., Lodhi, G. P., Jatasra, D. S. and Ram, S.

Productivity of forage and food crops in agroforestry system under shisham and siris trees.

Indian Journal of Range Management 1988. 9 53-57
English

This paper was presented at the National rangeland symposium held at Jhansi on 9-12 Nov. 1987. In the rabi [winter] seasons of 1984-87, four fodder crops (*Trifolium alexandrinum*, oats, *Vicia faba* and *Trigonella foenumgraecum*) and 2 field crops (wheat and *Cicer arictinum*) were grown under *Dalbergia sissoo* and *Albizia lebbek* plantations. Among fodder crops, the highest fresh fodder and DM yields under both plantations were given by *T. alexandrinum* followed by oats. The yields decreased in 1986-87 under 4-year-old trees compared with those in 1985-86 under 3-year-old trees. Wheat gave higher yields than *C. arietinum* under both plantations. Yields decreased with increasing age of trees. Yields of all crops under *D. sissoo* plantation were higher than under *A. lebbeck* plantation.

96
Dinerstein, E.

An ecological survey of the Royal Karnali-Bardia Wildlife Reserve, Nepal. Part I: vegetation, modifying factors, and successional relationships.

Biological Conservation 1979. 15 (2): 127-150

English

Six major vegetational associations (including forest, savanna and grassland) were identified in this newly-created sanctuary for tiger, one-horned rhinoceros, etc., in the Terai of SW Nepal.

Profiles are given of the three main forest types: *Shorea robusta/Buchania latifolia; Dalbergia sissoo/Acacia catechu;* and *Ficus glomerata/ Mallotus phillippinensis/Eugenia jambolana.* Three other habitat types are also described: *Bombax ceiba* savanna; ecotonal secondary open forest; and *Saccharum spontaneum/Tamarix dioica* flood-plain thickets. The major modifying factors affecting vegetational composition in the Terai include: total rainfall; length of monsoon; seasonal flooding; and former land-use practices of grazing, burning, clearing for cultivation, lopping for fodder etc. A scheme is proposed of successional changes in the reserve.

97
Duthie, J. F.

Flora of the Upper Ganges plain and of the Siwalik and Sub-Himalayan Tracts.

Botanical Survey of India, Vol. 1 Calcutta, 1960

English

Describes *Dalbergia sissoo* tree form, leaves and flowers. It is wild in the area, in gravelly beds, Baluchistan to Upper Assam, to 4000'; extensively planted throughout India as a roadside tree and for its excellent timber. The tree thrives best on low lying sandy tracts. New leaves appear in Feb. and flowers open between March and May. Pods ripen in the cold season and remain on the tree for a long time. The strong wood seasons well and is largely used as furniture; the tree is lopped for fodder and near towns the fallen leaves are frequently collected for fuel by confectioners.

98
Dutt, A. K. and Urmila Pathania

Effect of different doses of gypsum on the growth and nodulation of *Dalbergia sissoo* seedlings in alkaline soils.

Nitrogen Fixing Tree Research Reports 1984. 2 2

English

In studies in India, seeds were sown in clay pots containing 1 kg of alkaline (pH 8.2) soil treated with gypsum at 0, 5, 10, 15, 20 or 25 g/pot. After 5 months, seedling ht. and root length, and numbers of nodules were greatest in pots treated with 10 g gypsum (pH 8.1). Stem diam., seedling dry wt. and fresh wt. of nodules were greatest with 15 g gypsum (Ph 8.0).

99
Dutt, U. C.

The Materia Medica of the Hindus

Mittal Publications, Delhi. 1989

English

Lists the Sanskrit name of *Dalbergia sissoo* as Sinsapa.

100
Eidman, F. E.

Stekken en stumps (Stumps, stem and root cuttings)

Indonesian Forestry Abstracts, Dutch literature until about 1960. Centre for Agricultural Publishing and documentation. Wageningen. 1982. Tectona 26:618-679, 1933

English (1982)

Describes results of trials of stump. stem and root cuttings of 55 species including *Dalbergia sissoo.* The study included reference to: survival %; height growth; the effect of the length of the material; the effect of the diameter of the stump or cutting; the effect of the position of the cutting in the ground; the date of the first sprouting.

101
El-Hemaesy, A. H.

A short note on the desert subterranean termite, *Amitermes desertorum* (Desneux), attacking and damaging live trees in Upper Egypt.

Agricultural Research Review 1976. 54 (1): 193-195

English

A survey conducted in Quena, Aswan and Red Sea Governorates of Egypt in 1974-75 showed that sisso trees (*Dalbergia sissoo*) at Aswan, Egyptian acacia (*Acacia arabica var. nilotica*) at Luxor, Aswan and Eastern Desert, date palms (*Phoenix dactylifera*) at Luxor, tamarisk salt trees (*Tamarix articulata*) at Luxor and Aswan, and Egyptian small lime (*Citrus limonum*) at Luxor had been attacked by *Amitermes desertorum* (Desn.). The subterranean termite attacked living shrubs and trees of any age. A description is given of the damage caused by the termite, which was considered to be of minor economic importance.

102
Farooq, M. and Beg, M. U.

Effect of aqueous sulphur dioxide on the membrane permeability of common Indian tree leaves.

New Botanist 1980, publ. 1982. 7 213-217

English

The effect of aq. SO2 on the release of soluble sugar from leaf disks of 15 Angiosperm tree spp. are tabulated. The method proved quick and promising for primary screening of large numbers of trees. Highest resistance was shown by *Eucalyptus citriodora*, *Ficus rumphii*, *Dalbergia sissoo* and *Cordia dichotoma*.

103
Farooq, M., Jalal-ud-Din

Soils and their management requirements in Bahawalpur irrigated plantation.

Pakistan Journal of Forestry 1975. 25 (1): 14-18 + 1 map

English

Describes the general nature of the soils in the 500-ha Bahawalpur irrigated plantation of *Dalbergia sissoo*, identifies some of the problems (chiefly local salinity/alkalinity) that adversely affect the use of the soils for plantations, and makes suggestions for their improvement. About 400 ha of the area presents no problem in soil management.

104
Food and Agricultural Organization of the United Nations (FAO)

Tree Planting Practices in Tropical Asia

Forestry Development Paper No 11 FAO Rome, 1957

English

The Paper provides general information on *Dalbergia sissoo* with regard to: seed, nursery, planting practices and species characteristics. The habitat data is erroneous; direct seeding is stated as the most practical method of establishment.

105
Food and Agricultural Organization of the United Nations (FAO)

Tree Planting Practices in African savannas

Food and Agricultural Organization. Forestry Development Paper No. 19, Rome 1974.

English

Dalbergia sissoo has been included in tree plantings in west Africa for more than half a century in sub desert climates where soil moisture was available in the dry season. Trials in Ghana, north Nigeria, north Cameroon and Togo were not considered successful; while it was capable of survival in dry sandy soils growth was very poor. It showed some promise in the Sudan on silty soils with 500 mm rainfall. Stem form is generally poor; branches are persistent; viable seed is carried after 4-5 years; commonly root suckers; subject to mistletoe and various fungal diseases and defoliators. Provides excellent fuel and charcoal and strong short posts; sapwood susceptible to boring insects; heartwood durable. Under savanna conditions it seems unlikely to produce anything more than fuel and small poles.

106
Food and Agricultural Organization of the United Nations

Forest Tree Seed Directory

FAO Rome 1975

English

Provides advice on when to order *Dalbergia sissoo* seed, quotes seed per kg in a range of 12,000-52,800 (possibly whole pod cf depodded seed) and advising seed can be procured from: Cyprus, India, Kenya, Pakistan, and Sudan.

107
Forest Resources Survey Section, Nepal

Tree Volume Tables for Nepal

Forest Resources Survey Section, Department of Forests, In Co-operation with U.S.-Aid, Nepal 1967

English

Natural forest tree volume tables for *Dalbergia sissoo* in Nepal; volume in cft; variables d.b.h. and height.

108
Fox, Robin Lane

Alexander the Great

Penguin Books 1973

English

This history notes (Chapter 28) that Alexander the Great in his return from the Indrus along the Makran coast (325 B.C.), held hopes of colonizing the shore and easing the journeys of future sailors, trading between the Persian gulf and the Indian ocean. It recalls that when the grand palace was built at Susa (Darius c.a. 500 B.C.), sissoo wood (*Dalbergia sissoo*) was shipped from the Punjab for its pillars, down the very sea route that Alexander now planned to investigate.

109
Gamble, J. S.

A Manual of Indian Trees

Sampson Low, Marston and Co. London 1902

English

Dalbergia sissoo is described as a large deciduous tree to 60 ft. height and to 6 ft. girth; the bark exfoliates in narrow longitudinal strips. The wood is very hard and close grained; the heartwood brown, with darker longitudinal veins; the sapwood is small, white. Annual rings not distinctly noted; pores, moderate to large size, scanty, often filled with resin. Medullary rays pale, very fine, numerous. The species is distributed in sub-Himalaya tracts and valleys up to 3000 ft. Indrus to Assam, gregarious in forests on banks of sandy, stony torrential rivers. The bole is often twisted and the butt irregularly buttressed, natural forests are an early successional phase. Widely planted, the plantation timber a considered inferior to natural grown timber. The wood is very durable and seasons well and does not warp or split. As a furniture wood and for carving it is probably the finest wood in India. Formerly much esteemed for gun carriage use; it is excellent fuel and charcoal; the wood ash constituents are given and also it's weight and transverse strength.

110
Gangwar, V. S. and Prasad, S. N.

Biology of *Xylodiplosis sissua* infesting terminal buds of *Dalbergia sissoo* Roxb. (Cecidomyiidae: Diptera).
Cecidologia Internationale 1984. 5 (1/2): 9-18

English

Xylodiplosis sissua develops in the terminal buds of saplings of *Dalbergia sissoo* in nurseries in Allahabad, India. Studies showed that the eggs were laid in groups of 3-16 inside the growing vegetative bud, and the larvae fed within these tissues, causing the buds to become swollen and pale yellow; the new flush withered, with considerable damage to the saplings. The fully fed 4th-instar larvae jumped out of the buds to pupate in the soil. It appeared that 4-5

overlapping generations developed during the rainy season.

111
Gangwar. V. S. and Prasad, S. N.

Biology of *Contarinia dalbergiae* infesting leaves of sheesham (*Dalbergia sissoo* Roxb.) (Cecidomyiidae: Diptra).

Cecidologia Internationale 1984. 5 (1/2): 27-40

English

The authors describe all stages of *Contarinia dalbergiae*, which produces pod-shaped galls on the flowers and leaves of *Dalbergia sissoo* near Allahabad, India, and give details of studies on its biology. Adults emerged in February-March and in August-September; the full fed larvae entered diapause in the soil and were activated by rainfall. *Eupelmus sp.* and *Systasis sp.* were also found in many of the galls, the larvae feeding on those of *Contarinia*.

112
Ghosh, R. C. and Singh, S. P.

Trends in rotation.

Indian Forester 1981. 107 (6): 336-347

English

The general trend towards shorter forest rotations in response to growing timber needs and the ability to utilize smaller-diam. timber is discussed. Information is given on rotations currently used for major Indian timber species including teak, chir, sal, deodar, *Abies pindrow*, *Bombax ceiba [B. malabaricum]*, *Dalbergia sissoo*, *Michelia champaca* and *Chukrasia velutina*. Some fast-growing species that show promise for short rotation forestry are briefly considered, with particular emphasis on *Eucalyptus* and exotic pines.

113
Ghouse, A. K. M. and Hashim, P. U.

Tracheary cell dimension in *Dalbergia sissoo* in relation to tree age.

Journal of Tree Sciences 1984. 3 (1/2): 131-133

English

Stained sections and macerates were prepared from sapwood samples collected at ht. 1.5 m from trees in 5 age groups growing around Aligarh, Uttar Pradesh. Measurements were recorded of vessel lengths and radial and tangential widths, and fibre lengths. Statistical analyses showed that av. length and radial width of vessel segments were positively and linearly correlated with stem girth (range 9-300 cm). Tangential width of vessels and fibre length increased with girth in younger trees but was less related in older trees as increases in these parameters slowed down.

114
Ghouse, A. K. M., Khan, F. A. and Pasha, M. J.

Effect of air pollution on wood formation in *Dalbergia sissoo*, a timber tree of Gangetic Plain.

Journal of Tree Sciences 1984. 3 (1/2): 140-142

English

Samples of wood deep enough to include 2 growth rings were taken at ht. 1.5 m from trees on sites 0.5 and 20 km SE of a coal-burning thermal power plant in Uttar Pradesh. Five trees of the same age (30 yr) were sampled at each site. Stained sections and macerates were prepared from the wood samples and data recorded on annual diam. increments for 1981 and 1982 and on vessel and fibre length and width. The av. loss in wood formation at the polluted site was 48.3% and there were significant reductions in vessel width and fibre length, but not in vessel length or fibre width.

115
Ghouse, A. K. M. and Yunus, M.

An example of the stratified cambium among the indigenous tropical trees.

Current Science 1972. 41 (15): 569-570

English

Briefly describes and illustrates the storeyed arrangement of fusiform initials (as seen in longitudinal tangential section) in the wood of *Dalbergia sissoo*.

116
Ghouse, A. K. M. and Yunus, M.

Some aspects of cambial development in the shoots of *Dalbergia sissoo* Roxb.

Flora, German Democratic Republic 1973. 162 (6): 549-558

English

The formation of vascular cambium, and subsequent changes in the structure of cambial initials, were studied in shoots of various ages. The cambial cylinder is storeyed and is composed of fusiform and ray initials. In young shoots, the fusiform initials occupy ca. 80% of the total area of cambium, while in the stems of older trees they constitute only ca. 60% of the total area.

117
Gill, H. S., Abvol, I. P. and Sandhu, S. S.

Mesquite excels other tree species in highly alkali[ne] soils.

Indian Farming 1987. 37 (5): 26-27, 28

English

Robust saplings of mesquite (*Prosopis juliflora*), siris (*Albizia lebbek*), neem, shisham (*Dalbergia sissoo*), shahtoot (*Morus indica var. alba*), *Populus deltoides* 'D-28', jaman (*Syzygium cumini*), and jamoa (*S. fructicosum*), aged respectively 6, 8, 6, 18, 18, 12, 8 and 9 months, were planted in shallow (60 cm deep) or deep (120 cm) post holes 30 cm wide. The holes were dug with a mechanical post hole digger in highly alkaline (pH 10) soils at Karnal, Haryana. They were filled with a mixture of soil, farmyard manure (8 kg), gypsum (2 kg), N (as urea, 25 g) and rice husk (in a ratio 3:2 by volume of soil); this mixture had previously been found appropriate for establishment of other species on the same soils. Spacing was 3 m between rows and plants. Plants were spot irrigated for 4 months after planting when the ratio of irrigation water depth to cumulated pan evaporation reached 1; 25 g N was applied to each plant 180 days after planting. Survival data are given for 15, 75, 360, 540 and 720 days after planting. Poplar plants were all dead by 75 days after planting, and shahtoot and jaman by 540 days. All the *D. sissoo* and 87% of the mesquite survived to 720 days in both depths of hole. Siris, neem and jamoa survived respectively 75, 75 and 50% (in shallow holes) and 62, 50 and 50% (in deep holes) after 720 days. Data on oven-dry biomass (aerial + roots) at 720 days show that mesquite grew much better than all other species, followed by siris, neem, *D. sissoo* and jamoa. Mesquite growth was nearly twice as good in deep as in shallow holes. *D. sissoo* growth was also better in deep holes but growth of neem and siris was markedly less. Mesquite also grew best in terms of ht. and diam. growth, although these measurements gave slightly different rankings and post hole depth results.

118
Giridhar, G., Santosh and Vasudevan, P.

Anti termite properties of *Calotropis* latex.

Pesticides 1988. 22 (1): 31-33

English

The vulnerability of wood from different species of tree to termite attack, and the efficacy of *Calotropis procera* latex and commercial pesticides (aldrin, BHC [HCH] and DDT) against termites were evaluated. *Cedrus deodara* and mango were more prone to termite attack (100% loss in weight) than *Dalbergia sissoo* (9.3%), *Pinus excelsa* [*P. wallichiana*] (11.1%) or *Tectona grandis* (11.0). Impregnation of the wood with latex significantly reduced termite attack especially in the susceptible species (10.6-11.9% loss in weight), but chemical control was slightly more effective (8.2-10.9%).

119
Goel, V. L.

Performance of some firewood species in nursery of alkali wastelands.

Indian Forester 1987. 113 (12): 792-797

English

Two hundred seeds of each of 6 species (*Acacia auriculiformis, A. nilotica, Dalbergia sissoo, Eucalyptus hybrid [E. tereticornis], Prosopis juliflora* and *Terminalia arjuna*) were sown in perforated polythene bags (15x22 cm) filled with nursery (alkaline) soil, sand and FYM (1:1:1). Four seeds were sown per bag, except for Eucalyptus where the seeds were mixed with sand first because they are so small. The bags were kept in sunken nursery beds at the Biomass Research Centre, Lucknow, and watered every day in the summer and 2-3X per week in the winter (except during the rains). Weeding was done when necessary. Seedlings were thinned to 1 per container at 2 month old, when root characteristics were recorded. Ht. growth, fresh wt., m.c., ash content, biomass/ash ratio and calorific value on an ash-free dry wt. basis were measured at 1 yr old. Germination and seedling survival were best in *A. auriculiformis*, followed by *P. juliflora*. Ht growth was best, and m.c. lowest, in *P. juliflora*; biomass was also greatest in this species (followed closely by *A. nilotica* and *E. tereticornis*) Ash content was lowest and biomass/ash ratio highest in *E. tereticornis*, but *P. juliflora* performed almost as well. All species had similar calorific values (16-17 kJ/g).

120
Gosh, R. C.

Handbook on Afforestation Techniques

FRI Press, Forest Research Institute and Colleges, Dehra Dun, 1977.

English

Dalbergia sissoo is found on new sandy alluvial, well drained and moist soil. The tree avoids stiff clay, pebbles and boulders and has a wide adaptability to different climatic zones. Its hardiness and high value of the wood make it an ideal species for afforestation. It is widely used and is the chief species for irrigated plantations in the arid zone. Detailed descriptions are given of: seed collection and storage; germination and nursery practices. Field establishment through seed sowing, transplanting, stump planting and root sections. Branch cuttings are said to strike without much difficulty. Weeding treatments are specified.

121
Gosh, S. S. and Rao, K. R.

Occurrence of tension wood and its effect on properties of some Indian timbers

Indian Forester Vol 84 No 11 1958 684-686

English

The paper deals with some abnormal aspects of growth and its affect on cell structure and properties of hardwoods. Defects and odd behavior of wood were found to be related to the presence of tension wood as indicated by a pronounced development of gelatinous fibre. Two main types of gelatinous fibre (sometimes overlapping) could be recognized: large concentric bands or tracts of fibers become gelatinous - perhaps occupying the entire ring width both in early and late wood; in the second type gelatinous fibers are not so well developed, occurring singly or in small groups or sporadic patches irregularly distributed through the growth ring. Sometimes an intermediate type or a combination of both these may occur in some samples of *Dalbergia sissoo*. Seasoning problems with some *D. sissoo* may be caused by development of tension wood. The occurrence of tension wood does not seem to be related to the density of woods though the development may be more pronounced in certain families eg *Leguminoseae*. Gelatinous fibers appear to be of more frequent occurrence in trees planted along canals and road sides eg *D. sissoo*. The fact that not all trees planted in the same environment produce tension wood suggests that hereditary and genetic factors may have something to do with its formation.

122
Goswani, K. V. and Singh, S. B.

Cost-benefit analysis of afforestation in deep ravines of Gujarat.

Indian Journal of Agricultural Economics 1976. 31 (1): 48-55

English

Evaluates investment in afforestation of deep ravines with Bamboo, *D. sissoo* and Teak as additional sources of income for farmers. Data were obtained from experiments covering 15 years for Teak and *D. sissoo* and 10 years for Bamboo. Costs and returns were estimated from average prices during the past 3 years and were discounted at 12%. The economic rotation was taken as 30 years. Financial analysis showed that *D. sissoo* had the highest benefit/cost ratio of 2.9, the highest internal rate of return of 20% and the shortest pay-back period of 10 years. Bamboo had the next shortest pay-back period but the internal rate of return of 12.45% was little higher than the computed discount rate.

123
Greaves, J. H. and Khan, A. A.

The status and control of porcupines, genus *Hystrix* as forest pests.

Commonwealth Forestry Review 1978. 57 (1): 25-32

English

Observations in Feb. 1975 in irrigated forests and nurseries in Punjab, Pakistan, showed that (a) *Melia azedarach*, (b) *Morus alba* and (c) *Dalbergia sissoo* were the preferred food of the porcupine *H. indica* which attacked the basal bark. In heavily infested forest (2-5 porcupines/ha) damage to (a) was 71%, (b) 51% and (c) 3%. Infestations of porcupines and mesquite (*Prosopis juliflora* were associated. The world-wide pest status of *Hystrix* spp. (and related genera) is reviewed. Burrow fumigation is a proven control method, and poison baiting (KCN in apple) is promising. Trapping and chemical repellents are less successful.

124
Grierson, A. J. C. and Long, D. G.

Flora of Bhutan including a Record of Plants from Sikkim. Vol. 1 Part 3.

Royal Botanic Garden, Edinburgh 1987

English

Records the occurrence of *Dalbergia sissoo* in Phuntsholing, Sarbhang and Gaylephug districts of Bhutan and from Sikkim; river banks, 300 m. Sometimes cultivated as a decorative wayside or shade tree and also prized for its useful timber.

125
Gul, H. and Chaudhry, M. I.

Studies on the application of Dyar's rule to the larval stages of shisham bark borer *Agrilus dalbergiae* Thery (Buprestidae: Coleoptera).

Bulletin of Zoology 1983. 1 27-31

English

Head-capsule measurements on larvae of *Agrilus dalbergiae* Thery collected on *D. sissoo* in Pakistan indicated that there were 5 larval instars, with mean head-capsule widths of 0.43, 0.68, 1.08, 1.73 and 2.77 mm, respectively.

126
Gul, H., Chaudhry, M. I., Farooq, M. and Rahmatullah Jan

Preliminary studies on antitermetic properties of common woods of Pakistan and their extractives.

Pakistan Journal of Forestry 1988. 38 (3): 167-173

English

For testing the natural resistance of timber to termites, 25x4x4 cm stakes of 13 species (*Pinus wallichiana, P. roxburghii, Platanus orientalis, Dalbergia sissoo, Melia azedarach, Salmalia malabarica [Bombax malabaricum], Acacia nilotica, Albizia lebbek, Eucalyptus camaldulensis, Populus euramericana [P. canadensis], Juniperus*

excelsa, Cedrus deodara and *Morus indica*) were installed in 8 areas of termite activity in different ecological zones during 1985-86. Observations recorded [after a few months] indicated that *Platanus orientalis, Melia azedarach, Dalbergia sissoo* and *Cedrus deodara* showed antitermitic properties at Peshawar, National Park Lal-Soharna (Bahawalpur) and Changa Manga. Wood extractives of *Cedrus deodara* and *P. roxburghii* heartwood and sapwood and *Abies webbiana* and *Platanus orientalis* heartwood were made by extracting sawdust with petroleum ether and acetone. Laboratory trials for each species were carried out in petri dishes with 50 worker termites supplied with 5 g extracted or unextracted sawdust of the test species, blocks of semul [*Bombax malabaricum*] treated either with the extraction solvent or the extractive, and an untreated semul block (control). Data are reported for the acetone extractives only. The trials showed that termite longevity was reduced most by sawdust or extractive of *Platanus orientalis* and *Cedrus deodara*, while for *Abies webbiana* there was no difference between treatments. Field trials were carried out with the same treatments in earthen pits covered with tin plates at the Pakistan Forest Institute, Peshawar, with a further 2 species (*Dalbergia sissoo* and *Melia azedarach*) included. The only treatments consumed by termites were those of *Melia azedarach* (except the extracted treated semul block and the unextracted sawdust) and *Pinus roxburghii* (except the sapwood and heartwood extractive treated blocks).

127
Gupta, A. C. and Karnik, M. G.

Chemical components of sal (*Shorea robusta* Gaertn. F.) and shisham (*Dalbergia sissoo* Roxb.) woods.

Proceedings of the Eleventh Silvicultural Conference, Dehra Dun, May 15th to May 25th, 1967. Volume III. 1983, recd. 1984. 583-586

English

Abstract: Not available

128
Gupta, R. B. and Chandra, A.

Fence-posts preservation by the sap-displacement method.

Journal of the Timber Development Association of India 1972. 18 (4): 5-9 + 2 photos

English

Describes a procedure for treatment of green posts with a water-soluble preservative by standing the posts vertically in the preservative solution. The effects of duration of treatment and preservative concentration on the uptake of preservative by posts of *Shorea robusta, Acrocarpus fraxinifolius, Pinus roxburghii* and *Dalbergia sissoo* were studied, using a Cu-Cr-As preservative, CuSO4 and ZnCl2. With proper treatment a service life of 10-15 years can be obtained.

129
Haines, H.H.

List of trees, shrubs and economic herbs of the Southern Forest Circle of the C.P.

Indian Forester Vol XL No 5 1914

English

The list notes *Dalbergia sissoo* is not indigenous but growing remarkably well when sown or planted on ground free of weeds and is largely introduced into Nagpur.

130
Haque, M. S., Kapoor, M. L. and Sharma, V. K.

Effect of ethylmethanesulphonate in M1 population of *Dalbergia sissoo* Roxb.

Indian Forester 1982. 108 (5): 323-328

English

Seeds were treated with 0.15-0.45% ethylmethanesulphonate (EMS) in 1966, and seedlings raised after treatment (including controls) were planted in the field. Pollen fertility, pod characters and chromosomal abnormalities scored at anaphase of meiosis are reported for trees of the 'M1' population. Pollen

fertility was over 90%. Slight differences in pod characters were not statistically significant. There was a decrease in % germination of 'M2' seeds at higher dosages of EMS.

131
Hawkins, T.

***Dalbergia sissoo* provenance trial**

Forest Research Project, Adabhar Trial Site Research Results 1980-1986. Forest Research and Surveys Office, Dept. of Forests, Kathmandu, Nepal. Feb. 1986.

English

A trial to compare the survival, growth and form of nine provenances of *Dalbergia sissoo*, seven provenances from Nepal, two from Pakistan. The trial showed significant differences between the Pakistan and Nepal provenances with the Pakistan provenances clearly not adapted to the Nepal climate. The Pakistan provenances were damaged by insects and diseases which did not affect the Nepal provenances. While there was no difference in survival, a significant difference in height occurred with a local provenance showing best height. The report concluded that seed should be collected from good trees preferably in stands from the local area.

132
Hawkins, T.

Volume and weight tables for *Eucalyptus camaldulensis, Dalbergia sissoo, Acacia auriculaeformis* and *Cassia siamea* in the central Bhabar Terai of Nepal

Banko Janakari, Forest Dept. Kathmandu, Nepal. Vol 1 No 2. Summer 1987.

English

The tables provide green and oven dry weight in 1 cm diameter classes for 1-21 cm dbh of: stem, branch, stem plus branch and volume in cubic meters to 2 cm top diameter, over and under bark for dia. classes 1-21 cm. dbh.

133
Hawkins, T.

Biomass and volume tables for *Eucalyptus camaldulensis, Dalbergia sissoo, Acacia auriculiformis* and *Cassia siamea* in the central Bhabar-Terai of Nepal.

OFI Occasional Paper, Oxford Forestry Institute, University of Oxford 1987. (No. 33): 43 pp.

English

The Occasional Paper gives preliminary biomass and volume tables of the four most important Nepal Terai plantation species for estimating the early yield of short rotation tree crops. The Paper discusses selection and validation of the biomass equation and volume estimation techniques. Single entry biomass tables of oven dry and fresh weight, based on the equation Ln Weight = a+b Ln DBH are presented for *E. camaldulensis, D. sissoo* and *A. auriculaeformis*. Oven dry and green weight single entry tables are given for *C. siamea* using dia. at ground level as the predictor variable. Single entry tables are given for *E. camaldulensis* and *D. sissoo* using dbh as the predictor variable. *E. camaldulensis* and *C. siamea* were the most productive with oven dry MAI at age 4.5 years and 2.5 years of 14 and 10 tons per ha respectively; *D. sissoo* produced 2.3 tons at age 9.5 years on a dry site and 6.3 tons at age 5 years an a good site. *D. sissoo* heartwood at 10-11 years was 536 kgs cu.m. and sapwood at 1.5 years was 510 kg cu.m.

134
Hooker, J. D.

The Flora of British India, Vol 2

L. Reeve & Co, 5 Henrietta St. Covent Garden. 1879

English

Describes *Dalbergia sissoo* as an erect tree with finely grey, downy branches with a distribution in the Plains through India proper, ascending to 5,000' in the Central Himalayas and distribution Afghanistan, Beloochistan.

135
Howard, A. L.

A Manual of Timbers of the World

MacMillan & Co London 1948 3rd edn. (1st. edn. 1920)

English

Dalbergia sissoo is one of the most valuable of timbers and in its qualities is practically unique. The grain is so remarkable that the native craftsmen can work the most delicate and intricate carving. The native Princes of India possess works of this character which would astonish the craftsmen of this country. The color is a rich warm brown, sometimes having golden or deeper brown streaks and darkening with exposure. The timber is firm and hard and compact. It is very strong and seasons well without warping, twisting or splitting and takes a beautiful polish. Pores are scarce, the larger connecting with a ring of smaller and making a handsome ripple pattern on the transverse grain. The medullary rays are very fine, numerous and parallel and are crossed at right angles by similar white lines. It is extensively used in India for a variety of purposes. Sissoo gives a handsome appearance when used for parquet flooring. Weight 48 pounds; distribution India.

136
Howland, A. K. and Howland, P.

A Dictionary of the Common Forest and Farm Plants of Nepal

Forest Research and Survey Office, Dept. of Forest, Kathmandu, Nepal 1984

English

Lists *D. sissoo* and Sisam as the local (Nepal) names of *Dalbergia sissoo*.

137
Hussain, R. W. and Abbas, S. H.

Volume Tables for shisham (*Dalbergia sissoo*) in irrigated plantations in the Punjab.

For. Mens. Br. Div. of For. Res. leaflet No 26, PFI, Peshawar: 30. 1974

English

Abstract: Not available

138
Hussain, R. W. and Abbas, S. H.

Estimation of diameter at breast height of shisham (*Dalbergia sissoo* Linn.) from stump measurements.

Pakistan Journal of Forestry 1980. 30 (3): 123-133

English

In Pakistan, diameters of *D. sissoo* trees, *Dalbergia sissoo*, were measured at 6 inches (15 cm) interval from ground level up to breast height - 4.5 feet (1.37 meters). Each set of diameters had strong linear correlation with diameter at breast height. Separate straight line regression equations were developed using sets of diameters at different heights as independent variables and diameter at breast height as the dependent variable. Estimations of diameter at breast height were made from these equations against diameters ranging from 5 to 40 inches (1 cm to 100 cm) at different heights along the stem from ground level up to 4 feet(1.22 meters).

139
Hussain, R. W. and Glennie, E. B.

Provisional Yield Tables for Shisham in irrigated plantations in the Punjab.

For. Mens. Br. Div. of For. Res.: 19. 1978

English

Abstract: Not available

140
Hussain, R. W. and Qazi, I. A.

Optimum stand density for Shisham (*Dalbergia sissoo* Linn.f.) - interim report.

Pakistan Journal of Forestry 1973. 23 (3): 290-298

English

Describes a trial begun in irrigated plantations of *D.sissoo* in the Punjab, in 1966, in which first or second thinnings were made in plantations aged 5-6 years and 11-12 years respectively. Three intensities of thinning were applied: removal of 15, 30 or 45% of the original b.a.; treatments were carried out when the b.a. of the plantations reached certain fixed limits. The experiment was not adequately replicated and therefore could not be satisfactorily analyzed by statistical methods, but results indicated that thinning to 70% of the original b.a. was the best treatment.

141
Jackson J.K.

Manual of Afforestation in Nepal

Department of Forest, Kathmandu Nepal. 1987

English

Describes the geography, topography and geology of Nepal and soils, climate and vegetation types. Discussion follows on: forest plantation policy and planning and on related matters as: seed, nurseries, plantation establishment techniques and disease protection. Plantation species are given individual attention in description of silvicultural characteristics, and uses, nursery and plantation techniques.

Dalbergia sissoo in Nepal ascends to 1400 m and is commonest on bouldry alluvium soils adjoining rivers; it has a sub Himalayan range from Bengal to Kashmir. It's silvicultural characteristics are described; at certain stages it is frost susceptible and is intolerant of fire damage; it coppices freely and root suckers are abundant. It weighs 780 kg. cu. m. and has a calorific value of 21,700 kJ/kg; it makes good charcoal and is a valuable fodder tree. The leaves have a crude protein content of 15-16 % and a digestibility content of approximately 56 %; the crude protein content varies considerably, higher in young than in older leaves; silage treatment removes digestive disorders; the leaves and bark are used medicinally.

D. sissoo is noted as a MPTS for fuel wood, timber and fodder. Its nursery technique -- as container seedling or bed stump plant -- is given; vegetative propagation by stem cutting and mass propagation by tissue culture is noted. Plantations may be established by direct sowing or by stumps or seedlings; attention is directed to the importance of weeding. A mean annual increment of 18.1 cu. m. ha. yr. is quoted on a superior site and a height/ age relationship established. A range of pathogens -- insect and fungal -- are mentioned. Little difference was noted in seven Nepalese origin provenances but two Pakistan provenances were markedly inferior; variation in growth and form in plantations and potential for tree breeding improvement is noted.

142
Jain, J. C. and Tewari, M. C.

Indigenous substitutes for Japanese wood for buffing wheels for polishing stainless steel watch cases.

Journal of the Timber Development Association of India 1977. 23 (1): 24-26

English

Adina cordifolia (haldu or yellow teak) and *Dalbergia sissoo* (sissoo) were found to be satisfactory Indian substitutes for making the wheels (previously imported ready-made).

143
Jain, N. C., Rajawat, M. S., Bagga, J. K. and Shukla, L. N.

Slicing characteristics of Indian timbers. Part II.

Holzforschung und Holzverwertung 1975. 27 (3): 49-52

English

A continuation of previous work. The effects of slicing conditions on veneer quality (thickness variation, smoothness, tensile strength) were

examined for a further six species, viz. *Juglans regia, Holoptelea integrifolia, Michelia champaca, Pterocarpus dalbergioides, Dalbergia sissoo* and *Terminalia alata var. nepalensis.*

144
Jain, N. C., Rajawat, M. S., Bagga, J. K. and Shukla, L. N.

Peeling characteristics of Indian timbers. Part 15. *Dalbergia sissoo.*

Holzforschung und Holzverwertung 1976. 28 (2): 41-42

English

Optimum conditions for peeling, as related to cutting resistance and veneer quality, were determined: wood temperature 75-85 deg C, cutting speed - no effect, knife angle 90-92 deg .

145
Jaitley, V. P., Avtar Singh and Pant, B. C.

A note on pattern knife for evaluation of turning qualities of timbers.

Indian Forester 1985. 111 (10): 802-811

English

A discussion of a profiled wood-turning knife and its performance in comparison with hand turning. Operation of the knife requires less skill and is very fast. Samples of 8 Indian timbers (*Tectona grandis, Artocarpus hirsutus, Dysoxylum malabaricum, Cedrus deodara, Dalbergia sissoo, Holoptelea integrifolia, Terminalia belerica* and *T. bialata*) were turned with the profiled knife and by hand and the results compared. Good results were obtained with all except *A. hirsutus* and *T. belerica* which showed torn edges.

146
Jalal-ud-Din and Farooq, M.

Soil variations in relation to forest management in Lalsohanra irrigated plantation.

Pakistan Journal of Forestry 1975. 25 (1): 5-13

English

The main kinds of soils and their problems are identified and described. Some reclamation measures are suggested. The soils are predominantly loamy and are homogeneous. At places they are clayey and stratified. These soils occur in the valleys locally known as 'dhars'. About 50 per cent of the area is occupied by sand dunes having irregular relief. Salinity, sodicity, high density and sandy texture are the main problems that adversely affect the suitability of the area for *D. sissoo* and other tree species under irrigation. Under the existing conditions of arid climate and shortage of irrigation water the problem soils could better be used for original flora or drought salt resistant tree species. If, however, sufficient water is made available for intensive forestry, the reclamation of saline-sodic soils could be undertaken by using gypsum and growing high delta crops. The dense soil mass could be improved by subsoiling and green manuring. The sand dunes cannot be used for irrigated cropping. They could be developed as range land, or used for wild life. It is recommended that the poorer soils should be used for the natural flora or for tree species resistant to drought and salt. After reclamation with irrigation and cultivation of agricultural crops it may be possible to grow *Eucalyptus* spp.

147
Japing, H. W.

Cultuurproeven met wildhoutsoorten in Gadoegan 111. (Cultivation trials with non teak tree species in Gadungan 111)

Indonesian Forestry Abstracts, Dutch literature until about 1960. Centre for Agricultural Publishing and Documentation, Wageningen 1982.

English

Dalbergia sissoo (sono siso) demands much light, is thinly crowned and heavily branched. A narrow planting distance is desirable for achieving better shaped boles and room for selection. Very sensitive to root fungi. On good soils the yield of wood is comparatively rather low. Recommended for poor, physically not too bad soils.

148
Jha, R. C., Maurya, K. R. and Pandey, R. D.

Influence of mulches on the yield of ginger in Bihar.

Indian Cocoa, Arecanut & Spices Journal 1986. 9 (4): 87-90

English

In 3-year trials with the *Zingiber officinale* cv. Jorhat, the 3-budded rhizomes were planted at 30 X 30 cm on 5 dates between 23 May and 23 July. The plots were mulched with shisham [*Dalbergia sissoo*] or mango leaves or rice straw; the control plots were unmulched. The highest mean yield of fresh rhizomes (160.72 q/ha) was obtained from plots planted on the earliest date and mulched with *D. sissoo* leaves. Plots mulched with mango leaves gave the next best results.

149
Jha, R. C., Sharma, N. N. and Maurya, K. R.

Effect of sowing dates and mulching on the yield and profitability of turmeric (Curcuma longa).

Bangladesh Horticulture 1983. 11 (1): 1-4

English

In 3-year trials planting was carried out on 5 dates at 15-day intervals starting on 23 May. The plants were mulched with *Dalbergia sissoo* or mango leaves or rice straw. Planting on 23 May and mulching with *D. sissoo* leaves gave the highest yield (323.1 q/ha) of fresh rhizomes on non-irrigated calcareous soil and the highest returns, compared with later planting and mulching with mango leaves or rice straw.

150
Joshi, I. J.

Studies on the rhizosphere mycro flora of certain trees.

Acta Societatis Botanicorum Poloniae 1982. 51 (3/4): 493-501

English

Two soil types, 1 supporting *Prosopis juliflora* and another *Dalbergia sissoo*, were selected to study the mycro flora associated with soil, rhizosphere and rhizoplane during winter and rainy seasons in Madhya Pradesh. The results are tabulated.

151
Joshi, M. R.

Preliminary estimates of the productivity of plantation grown *Tectona grandis* and *Dalbergia sissoo* at Sagarnath, Nepal

Forest Survey and Research Office Publication No 36 1982

English

The studies described were carried out at Sagarnath Experimental Station Janakpur Forest Division, Nepal during 1982 with the objective of providing preliminary long-term crop performance data for plantation grown *Tectona grandis* and *Dalbergia sissoo* when managed: 1) to optimize fuelwood production, and/or 2) to maximize timber yields. A lack of experimental replication within the trial however, requires the data should be treated cautiously. Current crop parameters are described (stocking, height, diameter, etc) and first (seedling) rotation fuelwood yields presented. Freshly felled solid volume yields were estimated at 14.5 m^3/ha/yr for 10.5 year old teak and 18.1 m^3/ha/yr. for 9.5 year old *D. sissoo*. However, site qualities are regarded as being above average for the locality.

152
Joshi, S. C.

Aerial seeding for environmental conservation.

Indian Forester 1986. 112 (1): 1-5

English

A report of trials in areas of 863.5 ha in Agra district, Uttar Pradesh and 1000 ha in Dholpur district, Rajasthan, both in the Chambal ravine area, which were aerially sown with seeds of *Prosopis juliflora, Acacia nilotica, A. catechu, Dalbergia sissoo* and *Holoptelea integrifolia* in June 1982. Surveys 2.0 and 2.5 yr after sowing

showed that the av. number of surviving seedlings was 1038 and 1534/ha in Agra and Dholpur respectively, mostly of *P. juliflora.*

153
Joshi, H. K. and Kumar, A.

On the occurrence of fungal diseases in some fodder trees.

Nitrogen Fixing Tree Research Reports 1986. 4 18-19

English

Fungi associated with *Albizia lebbek* (1 fungal species), *Dalbergia sissoo* (3 spp.), *Leucaena leucocephala* (7), *Sesbania grandiflora* (5) and *S. sesban* (1) at the Indian Grassland and Fodder Institute. Jhansi.

154
Joshi, M. R. and Wyatt-Smith, J.

Some preliminary indications from research for forest management guidance in the hills of central Nepal.

Nepal Forestry Technical Bulletin (NEFTIB) 1982. (No. 7): 7-22

English

The results are summarized of trials of pine, eucalypt and miscellaneous species at 6-7 yr old. Data are presented in tables giving provenance, locality, alt., survival at 2-3 and 6-7 yr, number of trees more than 199 cm tall, mean ht. and d.b.h. of these trees, and m.a.i. (d.b.h.). Pinus species were *P. caribaea var. hondurensis, P. elliottii, P. kesiya, P. patula, P. roxburghii* and *P. wallichiana.* Eucalyptus species were *E. camaldulensis, E. tereticornis, E. bancroftii, E. citriodora, E. dalrympleana ssp. heptantha, E. deanii [deanei], E. macarthurii, [macarthuri] E. nova-anglica, E. saligna, E. urophylla and E. viminalis.* Other species were *Acacia flavescens, A. mangium, Acer oblongum, Alnus nepalensis, Angophora costata, Anthocephalus cadamba [chinensis], Bauhinia purpurea, B. variegata, Betula alnoides, Bridelia retusa, Casuarina cunninghamiana, C. glauca, C. littoralis, C. torulosa, Dalbergia sissoo, Litsea polyantha* and *Prunus cerasoides.*

155
Kapur, S. N.

A Manual of air-seasoning Indian timber

Manager of Publication, Delhi. 1934

English

Dalbergia sissoo is considered one of the most docile woods with regard to seasoning. Green conversion should be the chief method of seasoning; no great benefit can be expected from girdling of trees or water immersion of the logs, logs stored during dry weather would benefit from protection from too rapid surface drying. Degrade was less if the timber was converted and stacked just after the rains. Open stacking with crossers was more suitable than close crib piling. Thin planks and scantling can be converted any time of the year provided the converted material is immediately stacked under cover and well protected against rapid drying; planks up to 2 inches thick can be air seasoned in one year.

156
Karki, M. B.

Impact of multipurpose trees on small-farm systems of Nepal: a case study of Karmaiya village.

In Withington, D., MacDicken, K.G., Sastry, C.B. and Adams, N.R. 1988. Multipurpose tree species for small-farm use. Proceedings of an international workshop held November 2-5, 1987 in Pattaya, Thailand. 151-155

English

An assessment of the effects of the Farm Forestry Research and Development Project (FPP, jointly funded by Tribhuvan University, Nepal and the IDRC) on the farming systems of Karmaiya, a village in the central Terai of Nepal at 200 m alt. Seedlings of multipurpose trees were supplied to the villagers in 1983 and planted as border, block, streamside, roadside and mixed plantations every year from 1983. The area had been previously cleared of forest for agriculture. Major crops were maize, rice, millet, wheat and mustard, with major livestock buffalo, cows and goats. A 20% sample of households (34) was

surveyed in 1987 with questionnaires about on-farm plantations and the impact of such plantations on small-farm systems. Generally, on an average land holding of 1.08 ha, small farmers planted and maintained an average of 60 trees, of which *Dalbergia sissoo* and *Leucaena leucocephala* constituted an average of 58.3 and 26.7% of the total, respectively. Other species planted were *Eucalyptus camaldulensis, Acacia catechu, Cassia siamea, Garuga pinnata,* and *Bauhinia* and *Albizia* species. Ninety-one percent of sample households reported no need to change their cropping system to accommodate trees on their farms; 79% said that tree plantings allowed them better control of overgrazing and reduced dependency on forests. Farmers also noted better control of streams (82%) with no change in requirements for irrigation water (100%). Opinion was divided on the impact of on-farm trees on farm yields, with 53% saying that trees contributed to a reduction. Nevertheless, most farmers (79%) reported that tree planting helped improve the general quality of life and perceived greater benefit than harm from on-farm multipurpose trees.

157
Kashyap, R. N.

Shoots on shisham and mulberry branches and billets.

Indian Forester Vol L111 (1927):676-677

English

A correspondence note advising of shoots 3-4 feet long growing profusely on firewood billets and logs of shisham (*Dalbergia sissoo*) after coppice felling of February in Changa Manga 1911-12. Also 90% of *D. sissoo* plants 8-10 feet long cut out in cleanings and used as props to support plants took roots and proved useful in replacing such plants as failed.

158
Kassimani, M. A.

Observations on the trials of some exotic species in Somalia.

Somali Range Bulletin 1983. (No. 14/15): 71-78

English

Abstract: Not available

159
Katiyar, K. M. and Sharma, V.

Seasonal mortality of *Prolatus aciculata* Sharma, a larval parasitoid of *Sinoxylon anale*, due to hyperparasitoids.

Transactions of Indian Society of Desert Technology 1987. 12 (1): 27-28

English

In a survey in Jammu, India, in 1983-84, the chalcidid *Brachymeria*, the eurytomid *Eurytoma* and the ichneumonid *Diaglyptidea* were observed parasitizing the braconid *Prolatus aciculata*, a larval parasitoid of the bostrichid *Sinoxylon anale* on caged wooden logs of *Dalbergia sissoo*. The rate of parasitism was 18.2% in October, 50.7% in November and 85% in December. The hyperparasitoids appeared 1-2 weeks later than the parasitoids.

160
Kaushik, P., Vij, S. P. and Sehgal, R. N.

Comparative study of wood of some trees.

Journal of Tree Sciences 1984. 3 (1/2): 146-148

English

Comparative data are tabulated from measurements made on sections taken from freshly felled trees of 8 species (*Melia azedarach, Mangifera indica, Dalbergia sissoo, Acacia arabica, Eucalyptus lanceolatus, Ficus religiosa, F. virens* and *Anthocephalus cadamba [A. chinensis]*) from the Punjab plains. Data given are stem diam., heartwood radius and ring number, sapwood breadth and ring number, ranges of earlywood, latewood and bark breadth, and age of tree. Heartwood and sapwood were well differentiated in all species except *Ficus religiosa* and *F. virens* but distinction was difficult in *Melia azedarach*.

161
Kaushik, R. C.

Use of pregerminated seed of *Dalbergia sissoo* in nurseries.

Proceedings of the Tenth Silvicultural Conference, Forest Research Institute and Colleges, Nov.1961 Dehru Dun. 411-413

English

The author notes distinct advantages in the early (March) seed sowing with *Dalbergia sissoo* and promotes the use of a pregermination technique to hasten germination and to provide other benefits. Germination is retarded by low temperatures, temperature being the limiting factor in obtaining germination early in the growing season. The pregermination technique is: 1) seed is soaked 36-48 hours in standing water; 2) spread 6-8 inches deep under cover on a bed of grass and leaves, and covered with gunny bags and grass. Seed start to germinate 4-5 days and is 50% complete within a week. Seed is bed sown 3-4 days after starting the cover treatment; care being taken with the watering process; night cover with grass was found useful to maintain higher temperature and minimize rain damage. Complete germination takes place in one week compared to the 3-4 weeks under normal practice. Benefits from sowing in March are: a higher yield of stumps; lower production costs; lower production time; early sowings more drought tolerant and the effect of rain damage is minimized. While cotyledons are frost tender early sown seedlings stand late frosts and mechanical damage by rain drops.

162
Kayastha, Baban P.

Silvics of the Trees of Nepal

Community Forestry Development Project, July 1985, Kathmandu, Nepal.

English

Dalbergia sissoo is described as a large deciduous tree of the Terai, Bhabar and the Duns; it grows gregariously on fresh alluvium along river banks and it typically prefers alluvial soil, coarse or fine. It is typically absent from the forest areas in Sarlahi, Dhanusha and Sindhuli Districts. It is being introduced in large scale plantations; it is extensively planted on waste land, farm boundaries, and river banks in the Terai. It is a preferred tree of villagers; branches are easily lopped as fuelwood; leaves are used as fodder; the timber is strong and durable, is excellent for making furniture, doors, windows, panels and carvings. The species is established by direct sowing, entire planting, stump planting, branch cutting, or root cutting. Fruiting occurs Dec. Jan., and 53,000 seeds/kg are quoted. Propagation methods are discussed.

163
Kayasta, Bandana P.

Animal Nutrition and Pasture Fodder Management, the case of Mahespur (Nepal)

HMG-USAID-GTZ-IDRC-FORD-WINROCK Project, Natural Resource Paper Series No 5 Nov. 1987

English

The Paper deals with provision of fodder in an important centre of livestock farming of fresh milk supply to an urban market. Part of the fodder is from farmer owned fodder trees as *Dalbergia sissoo*; however the author points out this is negligible and the trees are often considered more valuable for other purposes. It is further pointed out that the local people are asking the Forestry Division to plant trees as Sal (*Shorea robusta*) and *D. sissoo* because of their high commercial value.

164
Kedharnath, S.

Studies on the response of some selected forest tree species to chemical and physical mutagens.

Proceedings of the Joint Symposia for Forest Tree Breeding of Genetics Subject Group, IUFRO, and Section 5, Forest Trees, SABRAO. Tokyo, Japan, Government Forest Experiment Station of Japan. 1972. D-10(V), 1-8

English

In a study with different concentrations of EMS (ethyl methanesulphonate), seeds of *Dalbergia sissoo* and *D. latifolia* were more sensitive (in terms of reduction of germination by 50%) than *Pinus roxburghii* at pH 5. At pH 9, sensitivity was greatly increased in *P. roxburghii* and *D. sissoo* but not in *D. latifolia*. In another study, on seeds of 5 conifer species (*Abies pindrow, Picea smithiana, Pinus wallichiana, P. roxburghii* and *P. kesiya*) and 5 hardwoods (*D. sissoo, D. latifolia, Shorea robusta, S. talura*, and *Santalum album*), the conifers appeared to be more sensitive than the hardwoods (except for the two *Shorea* spp.) to gamma-radiation. The Pines were the most resistant conifers and *P. kesiya* the most resistant Pine. Though the two *Dalbergia* species had the same somatic chromosome number and similar ICV (interphase chromosome volume), *D. sissoo* was twice as tolerant to radiation as *D. latifolia*.

165
Keerio, G. R.

Effect of windbreaks on the growth and yield of agricultural crops.

Pakistan Journal of Botany 1982. 14-23

English

Cotton yields were increased by up to 5% and wheat yields, by 7.5% due to the effect of windbreaks as compared with open fields. *Eucalyptus camaldulensis* was more effective as a windbreak than *Dalbergia sissoo*.

166
Khan, A.A.

Study of Root Development in *Dalbergia sissoo* Roxb. Raised from Stumps in Irrigated Plantations of Leiah Forest division

Pakistan Journal of Forestry Vol 15 (April 1965):172-184

English

The study concentrates on the development of roots of *Dalbergia sissoo* in irrigated plantations on sandy, well aerated soils. The rise of the water table reduces the volume of soil, free of water logging, for root development. An effective remedial action is proposed to the reduction of the water table through the installation of one tube well, 1 cusec capacity for 1000 acres.

167
Khan, A. A.

A note on the choice of silvicultural system for canalside plantations.

Pakistan Journal of Forestry 1972. 22 (3): 249-252

English

Briefly discusses the management of canal-side plantations (in which the main species, both strong light-demanders, are *Dalbergia sissoo* and *Acacia nilotica subsp. indica*) in the Punjab by the selection system (a) and the clear-felling-with-standards system (b) [not further described], concluding that, despite some earlier failures, (b), is likely to prove superior.

168
Khan, A. A.

A note on nutritive value of forages for nilgai.

Pakistan Journal of Forestry 1979. 29 (3): 199-202

English

The blue bull, or nilgai, (*Boselaphus tragocamelus*) is almost extinct in Pakistan. The contents of fat, protein, carbohydrate, fibre and moisture were determined for 18 species of forage (11 woody) preferred by the animal. The results are tabulated.

169
Khan, A. A. and Malik, M. N.

A note on the appraisal of causes of mortality of Shisham and Mulberry seedlings in the nursery from the physico-chemical analysis of soil.

Pakistan Journal of Forestry 1973. 23 (4): 393-397

English

Analyses of irrigation water and soil from a nursery at Kalar Kahar, in the Noorpur Forest Range, showed that whereas the concentrations of salts in the water were within permissible limits, the soil was distinctly alkaline (pH 8.4-8.8). It is suggested that the presence of an unusually high concentration of CaCO3 may restrict the availability of P and other nutrients, resulting in a high mortality rate for seedlings of *Morus* spp. and *Dalbergia sissoo*.

170
Khanduja, S. D., Chandra, V., Srivastava, G. S. and Jain, R. K.

Chapter III. 3. Utilization of alkali soils on the plains of northern India - a case study.

In Prinsley, R.T.; Swift, M.J. 1987. Amelioration of soil by trees: A review of current concepts and practices. 54-61.

English

Investigations conducted for the past 30 yr at the Banthra Research Station of the National Botanical Research Institute, Lucknow, on the utilization of alkaline soils without prior treatment with chemical amendments, are reviewed. Plants of agricultural, horticultural and silvicultural interest, and also species suitable for woody biomass production, which are adaptive to alkaline soils have been identified. The ameliorative effect of tree canopy cover is shown in reduced soil Ph and exchangeable Na and increased organic C. A pronounced increase in Ca/Na ratios under dense canopies has been recorded. Changes in chemical characteristics of the soil in the rooting zone are discernible after prolonged tree growth and depend on the amount and composition of litter fall. Data on soil amelioration under canopies or in the rooting zone are given for 12 species or species combinations: *Acacia nilotica; Albizia procera; Bauhinia variegata; Dalbergia sissoo; Ficus bengalensis [F. benghalensis]; Prosopis juliflora; Sesbania aegyptiaca [S. sesban]; Syzygium cumini; Terminalia arjuna; F. benghalensis + S. cumini; Acacia nilotica + T. arjuna*; and *A. nilotica + D. sissoo + F. benghalensis + Phyllanthus emblica + S. cumini.*

171
Khanduja, S. D. and Goel, V. L.

Pattern of variability in some fuelwood trees grown on sodic soils.
Indian Forester 1986. 112 (2): 118-123

English

Seedlings of 12 species (including *Acacia auriculaeformis [A. auriculiformis]* and *Albizia procera*) were planted out in alkaline (usar) soils in Uttar Pradesh. Survival, ht, and diam. were recorded after 3 yr. Survival ranged from 47.3 to 95.7%, av. ht. from 69.1 to 433.8 cm, and av. diam. from 0.69 to 3.46 cm. The highest survival was shown by *Terminalia arjuna*, while *Leucaena leucocephala* failed to grow after the first year. The best ht. growth was shown by *Prosopis juliflora*, followed by *Eucalyptus 'hybrid' [E. tereticomis]*, both of which also showed great variation in ht. The best diam. growth was given by *Acacia nilotica* and *P. juliflora; A. nilotica* and *Dalbergia sissoo* showed the greatest variability. *Albizia lebbek, Azadirachta indica, Pithecellobium dulce* and *Pongamia pinnata* showed little variation, reducing the potential for selecting fast-growing variants adapted to alkaline soil.

172
Khattak, G. M.

Rooting cuttings of "Shisham"

The Pakistan Journal of Forestry 1961. Vol 11:353-355

English

A trial of 72 cuttings was made from each of 4,7,10 and 13 year old *Dalbergia sissoo* trees; side and upper branches provided the material for the cuttings which were 9 inches long and a half inch in diameter. The lower ends of half (36) were dipped in "Rootone" a proprietary brand of growth promoting plant hormones.

The effect of age of the trees was not significant at the .05 level but "Rootone" had a highly

significant effect at the .01 level on rooting. The overall effect was to strike 32.6% of cuttings treated with the hormone as compared to 12.5% untreated. The treated cuttings produced a better developed root system compared to the controls.

173
Khattak, G. M.

Rooting semi hardwood shoot cutting of shisham.

The Pakistan Journal of Forestry Vol 13 (January 1963):49-52

English

Actively growing branch cuttings, 6 inches long and 1 inch diameter, from eleven trees 10-20 inches diameter were treated with hormone powders Rhizopogon and Seradix 1,2,3, and planted in sand boxes and kept moist. After 51 days cuttings treated with Rhizopogon showed little difference from the control approximating 25% strike success. While the Seradix 2 and 3 formulations also gave a 25% success, this trial was impacted by the local environment. Better root development was noted in treated cuttings; semi hard wood cuttings can be developed in 6 weeks cf 12 weeks for dormant hardwood cuttings.

174
Khattack, G. M.

History of forest management in Pakistan - III. Irrigated plantation and riverain forests.

Pakistan Journal of Forestry 1976. 26 (4): 231 241

English

The irrigated plantations of the Punjab have been managed under the 2-storeyed high forest system, with an understorey of shisham (*Dalbergia sissoo*) and mulberry (*Morus alba*) and an overstorey of *D. sissoo*; those of Sind are still in the formative stage, with babul (*Acacia arabica*) as the principal species. The riverain forests of the Punjab comprise scattered areas of uncultivable land; the main species are *D. sissoo* and bahan (*Populus euphratica*), with some *A. arabica*. It is proposed to convert these areas either to irrigated plantations or to high forest. The riverain forests of Sind are managed under the clear-felling system; the major species are *A. arabica* and kandi (*Prosopis spicigera*). The subtropical broadleaved forests of Pakistan are also described. The main species are kau (*Olea cuspidata*) and phulai (*Acacia modesta*); they have always been managed under the selection coppice system.

175
Khattak, G. M. and Sheik, M. I.

Effect of forest trees on the yield of agricultural crops.

Pakistan Journal of Forestry 1980. 30 (3): 139-141

English

Seedlings or cuttings of (a) *Dalbergia sissoo*, (b) *Eucalyptus citriodora* (c) *Populus deltoides* and (d) *Salmalia malabarica [Bombax malabaricum]* were planted at 4.3x4.3-m spacing in Jan.-Feb. 1978 in Peshawar. Wheat was sown in Nov. 1979 in drills 45 cm apart between the lines of trees with the nearest drill 80 cm from a line of trees. The wheat was harvested in May 1980 when the trees were (a) 3-5, (b) 3-7, (c) 6-10 and (d) 2-3 m ht. There was n.s.d. between grain or straw yields in plots with different tree species, nor between grain yields in drills at 80-215 cm from the base of the trees.

176
Kinhal, G. A.

Early planting and critical watering - an effective method of wasteland afforestation.

Advances in Forestry Research in India 1988. 1 125-134

English

Seedlings of 6 species (*Dalbergia sissoo, Acacia auriculiformis, Pongamia pinnata, Bassia [Madhuca] latifolia, Albizzia [Albizia] procera* and *Azadirachta indica*) were planted in 30x30x30 cm pits at a spacing of 3x2 m on waste land in the

Katangi Range of South Balaghat Division, Madhya Pradesh, in 1986. The 11-ha experimental area was surrounded by a cattle-proof trench, and one of the gullies was plugged to store winter rainwater. Four plots were laid out: plots A, B and C were planted early, in May 1986 (almost 2 months before the monsoon) and plot D [? 2 months] later [during the monsoon season]. Plots A and B were watered every evening with respectively 1 and 0.5 liter water per seedling; plots C and D were not watered. Ht. measurements were made in July 1986 and 1987 and in Sep. 1986, and the data were analyzed statistically. In nearly all cases early planting with irrigation (plots A and B) resulted in increased vigor and height of seedlings (compared with plot D). Seedlings not responding so well to the treatment were those of *Pongamia pinnata* and *M. latifolia*. All seedlings in plot C died.

177
Kirtikar, K. R., Basu, B. D. and An, I. C. S. 1935

Indian Medical Plants

2nd Edition, revised, enlarged, mostly rewritten Blatter, E., Caius, J.F. and Mhaskar, K. S.

Lalit Mohan Basu M. B. 29 Leader Rd. Allahabad, India

English

Dalbergia sissoo medical properties are described: the bark, wood are bitter, hot, acrid, aphrodisiac; abortifacient, expectorant, antipyretic, antithelmintic, appetizer; allays thirst, vomiting, burning sensation; cures skin diseases, troubles of the anus, ulcers, diseases of the blood, leucoderma, dyspepsia, dysentery. The juice of the leaves is good for diseases of the eye. The roots are said to be so astringent that they are neither eaten by rats or ants. The oil is applied externally in cutaneous affections. The wood is considered alternative; useful in leprosy, boils, eruptions and to allay vomiting.

178
Krishna, S. and Ramaswami, S.

Calorific values of some Indian woods

For. Bull. No 79 (C.S.) Govt. Publn. Branch, Calcutta. 1932

English

Abstract: Not available

179
Krishnaswamy, V. S.

The Life of Stumps of some Forest Species Under Moist Dry Conditions.

The Indian Forester, No 7 July 1955. pp 408-410

English

The test concluded that while *Dalbergia sissoo* stumps, planted as soon as they were cut, gave the best results, stumps may be stored for over 3 weeks after they are prepared when they are kept under shelter and kept moistened with water.

180
Krishnaswamy, V. S. and Mathauda, G. S.

Phenological behavior of a few species at New Forest, Dehra Dun.

Indian Forest Records Vol 9 No 2 1954

English

The record covers the concluded phenological studies on 17 species which commenced in 1928. The study notes that climatic factors appear to be the most important in controlling variations in the time of occurrence of phenological behavior; while there is good evidence to believe fluctuations in dates of occurrence of the leaf, flower and fruit phytophases can be correlated with the main climatic forces, the measure and the direction of influence of the latter varies with the species and phenomenon in question. Higher mean temperatures in the short period preceding the normal date of occurrence of the phenomenon tend to advance new leafing and flowering; low rainfall and low relative humidity appear to exercise a similar effect. High temperatures appear to quicken fruit ripening in *Cedrela toona* and probably in *Shorea robusta*; heavy rainfall and high humidity also appear to

advance fruit ripening in some cases. Fruit ripening in the case of *Dalbergia sissoo* and *Mangifera indica* does not show any clear relationship with temperature, rainfall or humidity at Dehra Dun.

For *D. sissoo*: the average dates of leafing are: new leafing, commencing day 56, completion day 108; leaf fall, average commences day 328 and completion day 36. The average date of flower commencing is day 111 with an average flowering period of 28 days. Fruits: average date of first ripe fruit is day 311 and for most fruits ripe day 342; average day of all seeds/fruits fallen is 107.

181
Kulkarni, S., Siddaranaiah, A. L. and Lingaraju, S.

A new root rot disease of *Dalbergia sissoo* Roxb.

Current Research 1979. 8 (1): 3

English

Rhizoctonia bataticola [Macrophomina paseolina] was isolated from dying seedlings, 6-9 months old, in a forest nursery at Dharwad.

182
Kumar, A. and Bhatnagar, H. P.

Effect of temperature and substratum on the germination of *Dalbergia sissoo* Roxb. seed.

Indian Forester, Vol 102, No 9, Sept 1976) pp 608-613

English

Laboratory studies were conducted to determine the effect of different temperatures and substrates on the seeds of *Dalbergia sissoo* Roxb. These two factors significantly influence the germination behavior of this species. Among all the treatments, the maximum and quicker germination was obtained at 30 degrees C in "In between paper" (BP) in nine days time for both fresh and one years old seed lots. The alternate temperature between 20-30C, 25-30C and 30-40C were also found to be equally effective for germination of seeds. Temperatures at 40C and 35-40C were not favorable for germination in comparison to other temperatures. These studies have also brought out that storage of the seeds up to at least one year does not appreciably change the germination behavior provided the storage conditions are good.

183
Lahiri, A. K.

Trial on intensive cultivation of fuelwood for maximum biomass production.

Indian Agriculturist 1986. 30 (4): 281-285

English

Nursery seedlings (3.5 month old) of 6 species (*Leucaena leucocephala, Albizzia [Albizia] procera, Casuarina equisetifolia, Acacia auriculiformis, Dalbergia sissoo* and *Cassia siamea*) were planted in July 1982 on a grassy blank at Mahatpur, in the central alluvial tract of West Bengal, as part of a larger spacing trial in various agroclimatic regions of the state. Four spacings (30x30, 45x45, 60x60 and 100x100 cm) were used; the site was prepared by hoeing and the seedlings were planted in pits. NPK (1:1:1) at 30 g/plant was applied in the first 2 yr, and weeding and cleaning were done 4X in year 1 and 3X in year 2. Half the plants from each treatment were uprooted in Jan. 1984, separated into root, stem, leaves and twigs, and dried in the sun to const. wt. Data are tabulated on mean annual and total biomass production per ha for each species and spacing, and on solar energy conversion efficiency for each species at the opt. spacing. *L. leucocephala* performed best at all spacings (except for *Cassia siamea* at the largest spacing), producing 63.37 t/ha at 45x45 cm spacing. *Acacia auriculiformis* was the next best species. These 2 species also ranked top in energy conversion efficiency. Calculations indicated that 200 m^2 of land could supply the annual requirement of fuelwood for a rural family of 5, when planted with *L. leucocephala* at 45x45 cm on a 3-yr rotation.

184
Lalman and Misra, A.

Dry matter production by some tropical forest tree seedlings.

Van Vigyan 1981. 19 (1): 1-13

English

From authors' summary: A study of seedlings 0-12 month old of 5 species growing in experimental plots at Balrampur, Uttar Pradesh in April 1978-March 1979. Standing biomass of stem and root increased during development in all species. An initial increase in leaf biomass was followed by a decrease at 8-9 month old at leaf fall. In *Diospyros melanoxylon* root biomass was higher than that of leaf or stem during the whole period. In *Dalbergia sissoo, Terminalia arjuna* and *Tectona grandis* there was an inverse relation between leaf and root dry weight. At 12 month old max. DM was in the order *Dalbergia sissoo* more than *Terminalia arjuna* more than *Tectona grandis* more than *Tamarindus indica* more than *Diospyros melanoxylon*. Net primary productivity of all species increased with age. Litter production was in the order *Dalbergia sissoo* more than *Tectona grandis* more than *Terminalia arjuna* with very little production by *Tamarindus indica* and *Diospyros melanoxylon*.

185
Lalman and Misra, A.

Nutrient utilization in some tropical forest tree seedlings.

Indian Forester 1985. 111 (6): 368-384

English

The concn. of N, P, K, Ca and Na in seedlings of *Dalbergia sissoo, Tamarindus indica, Diospyros melanoxylon, Terminalia arjuna* and *Tectona grandis* was evaluated in field plantings in Uttar Pradesh, from the age of 1 to 12 months (April 1978 to March 1979). In all species, concn. of Na in leaves was higher than that of K, Ca and P (highest in *D. melanoxylon*) and was higher in leaves than in roots and stems. Concn. was found to increase with age of leaves up to 8-9 months (at the time of yellowing), after which N, P and K contents decreased rapidly. N, P and K content of stems and roots showed steady increase with age, but Ca and Na, after showing increases up to 8-10 months showed a slight reduction in the 11th and 12th months.

186
Lander, P. E. and Dharmani, L. C.

A new fodder (siloed Shisham leaves) for dairy cows

Agric. Res. Inst. Pusa, Bull. 158, 11 p, 1925

English

Abstract: Not available

187
Lander, P. E. and Singh, B. B.

Silage experiments on shisham leaves

J. Anim. Husb. and Dairying in India. 1 (1) 33-41, 1927

English

Abstract: Not available

188
Laurie, M.V.

Fodder trees in India

Ind. For. Leaf. 82. (Silv.). F.R.I., Dehra Dun, 17 p 1945

English

Abstract: Not available

189
Limaye, V. D.

Variation in the Properties of *Dalbergia sissoo* from different localities of India.

The Indian Forester, July 1936, Vol No pp 409-411

English

An investigation of the strength and working properties of: plantation, roadside and natural forest timber of *D. sissoo* from 6 locations in India and 1 in Nepal over various geographical sites and altitudes. The study concluded that:

* *D. sissoo* from the foot hills of the Himalayas has been found in general to be superior in strength to *D. sissoo* from the plains outside the Himalayan belt

* *D. sissoo* from Dehra Dun and the eastern part of India has so far been found to be easier to work than sissoo from the more western regions.

190
Limaye, V. D.

Grouping of Indian timbers and their properties, uses and suitability

Indian Forest Records, Vol. 1 No. 1 Manager, Government of India press, Delhi 1957

English

The Record gives: 1) grouping of timbers according to their suitability values for each property, 2) the properties and uses of each timber species, 3) average weight and the maximum and minimum weights of each species, 4) charts showing the suitability of each species by means of stick diagrams.

Dalbergia sissoo. Very heavy, strong, tough, steady, extremely hard, having tendency to interlock, medium coarse density wood. Suitable for construction work, doors, window frames, high class furniture and cabinet making, wheel work, plywood, picture frames, set squares, T-squares, etc. Seasons well with care. Easy to work and finish. Extremely durable.

191
Little, E. L.

Common Fuelwood Crops: a handbook for their identification

McClain Printing Company, Parsons, West Virginia, USA

English

A concise compilation of data on *D. sissoo*. The species is noted as fast growing, salt tolerant, drought resistant, frost hardy, and intolerant of shade. *D. sissoo* is characterized by pinnate leaves, with 3-5 rounded, abruptly short-pointed leaflets, many small white or yellowish pea-shaped flowers and oblong, flat, thin pods. The natural distribution is given as the lower Himalayas Pakistan, India, Nepal mostly below 900 m, sometimes to 1300 m. The tree and wood are described; *D. sissoo* ranks among the four primary timbers of India and among the finest cabinet and furniture woods. Its climate is tropical (seasonal) monsoon, 500-2000 mm annual rainfall, and long dry season. Soils vary from pure sand and gravel to rich river alluvium. The species colonizes landslides and exposed mineral soil; adapted to the dry savannah woodland.

192
MacDicken, K. G.

Regional Plan for *Dalbergia sissoo* Research

Farm Forestry News 1990 Vol. 3(4):5

English

Dalbergia sissoo is widely recognized as an important multipurpose tree species in parts of India, Nepal and Pakistan. It is a highly valued timber and also provides a range of other products as fodder, fuelwood, and medicine. It has been inadequately studied and as a result little progress has been made to improve its cultivation and management. A meeting of scientists from involved countries met in 1989 to review *D. sissoo* research and to prepare a draft regional plan for consideration by national research programs. An integral part is a series of international provenance trials; first seed is to be distributed in 1990; the plan includes development of an annotated bibliography and research to identify problems not yet evident.

193
Macmillan, H. F.

Tropical Gardening and Planting.

Macmillan & Co London 1952

English

This comprehensive planting reference lists *Dalbergia sissoo* as a possible tree for arid condition planting.

194
Madan, M. and Mohindra, P.

Cellulolytic activity of some fungi associated with decaying wood.
Geobios, India 1981. 8 (1): 26-28

English

When 15 fungal isolates from decaying *Dalbergia sissoo* wood shavings were screened, max. cellulolytic activity (both C1 and Cx) was recorded in *Trichoderma longibrachiatum*. Max. enzyme production was usually observed after 10-15 days' incubation.

195
Mahmood, T.

Prevalence of some incitants causing dieback and timber decay of hardwoods.

Journal of Turkish Phytopathology 1972. 1 (2): 50-53

English

Fungi causing dieback and timber decay on mulberry and *Dalbergia sissoo* in Pakistan are listed.

196
Maithani, G. P., Bahuguna, V. K. and Singh, H. P.

Effect of size of containers and different soil media, on the germination behavior and growth of *Acacia nilotica*, *Albizia procera* and *Dalbergia sissoo*.

Indian Journal of Forestry 1988. 11 (1): 56-59

English

Seeds of all 3 species were sown in 3 sizes of polypots (S1, 30x15 cm, 200 gauge; S2, 23x13 cm, 150 gauge; and S3, 15x8 cm, 150 gauge). Four growing media were used, viz. 3 sand/soil/FYM mixtures (T1, 1:2:1; T2, 1:3:1; and T3, 1:1:1) and forest soil (T4). Watering was done when required and shade provided in the summer. Records were made of germination, ht. and girth over 6 months. For *Acacia nilotica* best germination was found in S1, followed by S2, and best growth in S1; there were slight, but not significant, differences between germination and growth in sand/ soil/FYM mixtures, which gave better results than forest soil. For *Albizia procera* germination was similar in all 3 containers but higher in T4 and T3 media than in T2 and T1; growth was best in S1, followed by S2, and there were no differences between media. For *D. sissoo*, S1 and S2 also gave the best germination and growth, while T4 and T3 gave better germination than T1 and T2, and T1 and T3 gave better growth than T2 and T4. There was very little interaction between container and soil treatments. Since S1 containers only give slightly better results than S2 overall it is suggested that these may be preferred as being of lower cost.

197
Manandhar, N. P.

Useful Wild Plants of Nepal

Nepal Research Centre Publications No. 14, Franz Steiner Verlag Weisbaden GMBH, Stuttgart. 1989

English

The book is written to stimulate interest in useful plants of Nepal. *Dalbergia sissoo* is described as a large deciduous tree nearly 20 m high; it is found (in Nepal) up to 1300 m. The wood is useful for all purposes; young twigs and leaves are lopped as cattle fodder; medicinal uses are quoted.

198
Mani, M. S.

Plant galls of India

MacMillan, Madras, 600002, India 1973

English

The work lists these galls of *Dalbergia sissoo*:

Leaf bud gall	*Sissudiplosis chatterjeei*
Leaf galls	*Eriophyes sp.;? E. cheriani*
Flower gall	*Conterinia dalbergiae*

199
Marsden, R. E.

Comparative yearly volume increments of certain Indian tree crops

Indian Forester Vol XLIV No 1 1918 10-12

English

The annual increment over a five year period (solid volume cft) of 32 year old *Dalbergia sissoo* at 98 stems/acre at Gorakhpur was 62 cft.

200
Mathur, M. and Mukerji, K. G.

Antagonistic behavior of *Cladosporium spongiosum* against *Phyllactinia dalbergiae* on *Dalbergia sissoo*.

Angewandte Botanik 1981. 55 (1/2): 75-77

English

P. dalbergiae was markedly suppressed when conidia of the hyperparasite *C. spongiosum* were sprayed on the leaves.

201
Mishra, J. and Prasad, U. N.

Agri-silvicultural studies on raising of oil seeds like *Sesamum indicum* Linn. (til) *Arachys hypogea* Linn. (groundnut) and *Glycine max* Merrill. (soybean) as cash crops in conjunction with *Dalbergia sissoo* Roxb. and *Tectona grandis* Linn. at Mandar, Ranchi.

Indian Forester 1980. 106 (10): 675-695

English

Results after 1 yr are reported of a taungya agroforestry project on a clear-felled sal forest site in Bihar. A series of contour bunds was constructed across the slope and trees established at 3x3 m spacing with rows of cash crops along the contours. Rock phosphate and NK fertilizers were added according to the requirements of the cash crop. Til gave negative returns with both trees, whereas soy and groundnut gave good returns; both of these can be grown successfully with *D. sissoo*, but share a common pest with teak, *Diacrisia obliqua* [Lepidoptera, Arctiidae]. Soil N and P increased after all crops but K decreased. Ht. growth of both trees was n.s.d. with and without intercropping.

202
Mishra, S. C., Vijay Veer and Avinash Chandra

***Aristobia horridula* Hope (Coleoptera:Lamiidae) a new pest on shisham (*Dalbergia sissoo* Roxb.) in West Bengal.**

Indian Forester 1985. 111 (9): 738-741

English

This stem-borer was found in plantations in Cooch Behar, West Bengal, attacking about 10% of trees in 1-yr-old and 80-90% of trees in older plantations (up to 85 cm b.h. girth). Damage occurred up to 4 m on the stems.

203
Mital, S., Akram, M. and Saxena, S. K.

Viability and germination of conidia of *Phyllactinia dalbergiae* on glass slides.

Acta Botanica Indica 1984. 12 (1): 114-116

English

Conidia of the powdery mildew pathogen of *Dalbergia sissoo* germinated best at 17-20C and at RH 95-100%. They failed to germinate in free water.

204
Nadkarni, K. M.

Indian Materia Medico 1954

English

Dalbergia sissoo is reported to be a stimulant used in folk medicine and remedies [from Sheikh, M. I. 1989]

205
Nagpal, Raman and Puri, S.

Effect of auxins on air-layers of some agro-forestry species.

Indian Journal of Forestry 1986. 9 (3): 232-236

English

Trials were carried out at Bilaspur [Himachal Pradesh] (600 m alt) from May 1978 to April 1979 on 4 species (*Dalbergia sissoo, Morus alba, Ficus carica* and *Acacia catechu*). Air layers were made during the second week of each month and treated with 10 or 100 p.p.m. IAA, IBA or NAA. Rooting and/or callus formation was enhanced or initiated by growth regulator treatment by varying amounts in all species. Rooting occurred in all species except *A.catechu* during the period May to Aug. (or Sep.). In *A.catechu* it occurred only in the July layers. The May-Aug. period is probably suitable for layering because of the high temp. and RH at this time.

206
Nagpal, R. and Sehgal, R. N.

Propagation of some agro-forestry species by air-layering.

Indian Journal of Forestry 1985. 8 (3): 161-165

English

Bark rings were removed every month in 1978 from current branches of 5 species growing in Bilaspur, Himachal Pradesh and half of them were treated with Seradix-B3 (containing beta-IBA) before they were wrapped in sphagnum moss and polythene. Branches were observed after 30, 45, 60, 75 and 90 days. The hormone enhanced root formation in *Morus alba, Dalbergia sissoo, Ficus carica* and *Grewia optiva* and induced rooting in *Acacia catechu*. May to Aug. was the opt. period for rooting.

207
Napier, I. A.

Vegetative Propagation of Fodder Trees. Preliminary Research Results and Practical Recommendations.

Banko Janakari, Forest Research and Information Office Dept. of Forestry and Plant Research, Kathmandu, Nepal. Vol. 2, No. 1. 1988

English

The paper gives percentage survivals of *Dalbergia sissoo* cuttings taken from farm trees sixteen weeks after setting viz

1983	1984	1985
94	72	78

208
Napier, I. and Robbins, M.

Forest Seed and Nursery Practice in Nepal

Forestry Research Division, Department of Forestry, Kathmandu, Nepal 1989

English

This work is a practical guide to those with an interest in community forestry nurseries and is written with a view to meeting day-to-day needs of technician staff. *Dalbergia sissoo* is an important species in such nurseries and advice is given in detail on: seed season; seed harvesting - the seed yield per tree varies, a tree may yield 1-6

kg of pods, 18,500 seeds/kg (i.e., a tree may yield 18,500-111,000 seeds); extraction; storage; pregermination. For *D. sissoo* stump production: sowing, germination, cultural techniques and time in nursery. Other methods of seed propagation are discussed.

209
Narayana, H. S., Monga, A. K. and Singh, B. P.

Mycoflora of rhizosphere and non-rhizosphere soil of shisham.

Geobios 1979. 6 (2): 93-95

English

The incidence of fungi in relation to age of *Dalbergia sissoo* seedlings are tabulated.

210
National Academy of Sciences

Tropical Legumes: Resources for the Future

National Academy of Sciences, Washington, D.C. 1979

English

Dalbergia sissoo is a very adaptable tree, indigenous to northern India, Nepal and Pakistan; it grows fast; adapts well to widely varying sites: parks, streets, door-yards, windbreaks, dry ridges, filled areas, and river-spoil dumps, ranging from lowlands to over 1000 m altitude. It is salt tolerant, pest resistant, and can survive temperatures from below freezing to over nearly 50 degrees C. It is a tree particularly for dry savanna woodlands (annual rainfall 700-2,000 mm) and withstands droughts of 3-4 months even during the hottest season in Sudan. In India and Pakistan it is planted in areas too dry for teak; is used extensively to afforest barren land, coastal sand dunes and wasteland. In the United States it is one of the most desirable shade trees for streets and back yards (Arizona and Florida). The tree reproduces vigorously by suckers; coppices readily and can be planted using large stump like cuttings. Over 100,000 ha of irrigated plantations are reported in India and Pakistan; it has grown well in the sewerage irrigated green belt around Khartoum, Sudan. The trees are noted to have: poor form; wood excellent for many purposes; foliage and young branches eaten by livestock.

211
National Academy of Sciences

Firewood Crops: Shrub and Tree Species for Energy Production Volume 2.

National Academy Press, Washington, D. C. 1883

English

Dalbergia sissoo is a moderately fast growing tree that adapts well to semi arid conditions and produces first class firewood. Its timber is highly valued for construction and general utility purposes. Its use as an exotic is quoted. Under savanna conditions the trunk is usually crooked, but is much sought for furniture, ship building and fuel. The tree description and distribution is given; it is classed as an excellent fuel, sapwood and heartwood calorific values are 4,900 and 5,200 per kg, respectively. The wood is also suitable for making charcoal. As fuelwood, it is grown on 10-15 year rotations; the tree produces profuse root suckers and coppices well enough to be grown on a short rotation. Stumps after two or three rotations lose vigor (Nigeria, Zaire). Other uses in wood, fodder, erosion control, and ornamental situations are described. The environmental and pest and disease damage are noted. Fire and animal browsing protection are required.

212
National Academy of Sciences (Ruskin, F. R. editor)

Firewood crops. Shrub and tree species for energy production. Volume 2.

National Academy of Sciences 1983. vii + 92 pp.

English

A further report of an ad hoc panel of the Advisory Committee on Technology Innovation,

Board on Science and Technology for International Development, Office of International Affairs, funded by the Agency for International Development. After an introduction, there are 3 main sections describing, in alphabetical order, further fuelwood species for the humid tropics (11 species), the tropical highlands (8 species), and for arid and semiarid regions (8 species). Each species is described and illustrated and its distribution, use as firewood, yield, other uses, environmental requirements, establishment, pests and diseases, and limitations are briefly discussed. There are 4 appendices: Summary of characteristics by climatic zones (for both volumes); Selected readings (by species); Research contacts; and Index of plants.

213
Nautiyal, A. R. and Purohit, A. N.

Superiority indices of some multipurpose trees from the central Himalaya.

In Withington, D., MacDicken, K.G., Sastry, C.B. and Adams, N.R. 1988. Multipurpose tree species for small-farm use. Proceedings of an international workshop held November 2-5, 1987 in Pattaya, Thailand 254-260

English

The major and minor uses of 84 tree species were reviewed and 20 selected for further study. These were: *Toona ciliata, Grewia optiva, Ougeinia dalbergioides, Bauhinia retusa, Dalbergia sissoo, Sapindus mukorossi, Terminalia tomentosa, Ficus bengalensis [F. benghalensis], Cordia myxa, Holoptelea integrifolia, Bombax ceiba [B. malabaricum], Eugenia jambolana [Syzygium cumini], Cornus capitata, Quercus glauca, Q. incana, Fraxinus micrantha, Celtis australis, Aesculus indica, Prunus cerasoides* and *Alnus nepalensis*. Data are tabulated for the 20 species giving utility indices for 10 uses. Further tables give av. values for extension growth, photosynthesis and transpiration rates, water and light use efficiencies and characters related to fuelwood energy potential (calorific value, density and ash, moisture and nitrogen %); the 20 species are ranked for each of these characters, and also given an overall ranking. It is noted that this ranking should be considered in conjunction with the utility value ranking. When this is done the best species for the valley to middle altitudes (about 1828 m) in the central Himalayas from socioeconomic, ecological and biological perspectives, are *Dalbergia sissoo* and *Ougeinia dalbergioides*.

214
Nazir, M. and Zarif, R. M.

Most efficient mixture of Shisham and Mulberry in irrigated plantations.

Pakistan Journal of Forestry 1974. 24 (4): 374-382

English

Data on the production of timber and firewood from *Dalbergia sissoo* and *Morus alba* during the last rotation at Changa Manga were used to estimate the most profitable ratio of the two species in mixtures. A pure crop of *M. alba* would be the most profitable; this species is used for sports goods and now claims an equal importance to *D. sissoo*.

215
Negi, S. S.

Some aspects of erosion in Paonta area of Himachal Pradesh.

Indian Journal of Forestry 1983. 6 (1): 85-88

English

Four types of erosion are found in this area of sal forest (on southern slopes), chir pine (on northern aspects) and khair/*D. sissoo* (*Acacia catechu/Dalbergia sissoo* along riverbeds): erosion along raus [? torrents]; rill and gully erosion (primarily due to overgrazing and felling of sal, chir and sisham [*D. sissoo*] forests); erosion in cultivated areas; and slope failure.

216
Neil P.E.

Preliminary provenance testing of *Dalbergia sissoo*

Banko Janakai Vol 2(2) 1988. Forest Research Division Dept. of Forestry, Kathmandu, Nepal

English

Author's summary: *Dalbergia sissoo* is a very important multipurpose tree in the terai/bhabar terai of Nepal, but little provenance research has been done on it. Trials have shown that *D. sissoo* seedlots from Pakistan are unlikely to be suitable for planting in Nepal. At Adabhar, in the Bara district, the provenance from the district to the north, Makwanpur, performs the best. This suggests that seed should be collected from superior trees in the same area that they are to be planted. Proposals have recently been made to greatly expand the *D. sissoo* plantations by using vegetative propagation. This seems premature when so little provenance has been done and the extent of natural variation is unknown sampling and systematic testing of provenances throughout Nepal should be carried out before these proposals are put into effect.

217
Nimbkar, B. V., Nimbkar, N. and Zende, N.

Desertification of western Maharashtra: causes and possible solutions. I. Comparative growth of eight tree species.

Forest Ecology and Management 1986. 16 (1-4): 243-251

English

Results are reported from fertilizer (0, 50 or 100 kg/ha NPK) and spacing (5x0.6 or 3x1 m) trials with 8 species (*Acacia albida, A. nilotica, Albizia lebbek, Cassia siamea, Dalbergia sissoo, Leucaena leucocephala, Melia azedarach, Prosopis juliflora*) on a degraded vertisol typical of wasteland areas in the Phalton area of Maharashtra, India. At 15 months, basal diam. of *L. leucocephala* and *M. azedarach* were superior to all other species, ht. of *L. leucocephala* (2.38 m) was greater than all other species. Fertilizer improved performance significantly but there was little difference between doses of 50 and 100 kg/ha. *L. leucocephala* and *M. azedarach* performed better at 5x0.6 m, and *D. sissoo* and *P. juliflora* at 3x1 m. *C. siamea* showed lowest survival (62%).

218
Pachkhede, A. U., Vyawahare, S. V. and Shreemali, J. L.

Species of *Fusarium* and *Drechslera* reported from certain new hosts for India.

Indian Botanical Reporter 1984. 3 (1): 91

English

These include *F. equiseti* on various hosts, *F. acuminatum [Gibberella acuminata]* on *Ipomoea fistulosa* and *Sesbania aculeata, F. moniliforme [G. fujikuroi]* on *Cassia tora* and pigeon pea, *Drechslera papendorfii* on *Bauhinia diphylla* and *Cochliobolus hawaiiensis* on *Dalbergia sissoo*.

219
Padmanabha, H. S. A., Nagaveni, H. C. and Rai, S. N.

Influence of host plants on growth of sandal.

Myforest 1988. 24 (2): 154-160

English

Six-month-old sandal plants of known seed origin were transplanted into earthen pots with separately raised host plants (30 forest species) planted alongside. Fifteen plantings were established for each host species; sandal plants and the host species were also grown alone. The plants were maintained for 24 months. Old soil to a depth of 15 cm was replaced every 4 months with a fresh mixture of manure, sand and red earth. The host plants were pruned periodically. Ht. of the sandal was recorded at the beginning of the study, and ht., biomass and numbers of haustorial connections at the end. Leaves were also analyzed at the end of the study for minerals, chlorophyll and photosynthetic activity. Field studies were also carried out with the same 30 host species: 49 plants of each were planted with sandal in a plot at Srinivasapura, Kolar District [Karnataka], at 3-m spacings. Ht. increment over 24 months was recorded. Data are tabulated from pot studies. There was a large variation in the amount of parasitism with different hosts, which could be classified as poor, medium or good depending on the nature of the sandal growth, and the amount of biomass and number of haustoria produced. Well-developed shoot

growth was proportional to root system development and coupled with high production of haustoria. There was a correlation between ht. and biomass production of sandal; this ratio was 1.25 with good host plants and 1.6 with poor host plants, although it did not show a progressive increase with host type. In association with good host plants, mineral concentrations were higher in sandal leaves (and correspondingly reduced in host leaves); chlorophyll content and photosynthetic activity were also higher with good host plants. The best host species were: *Casuarina equisetifolia, Melia dubia [M. azedarach], Acacia nilotica, Wrightia tinctoria, Pongamia pinnata, Terminalia arjuna, T. alata, Dalbergia sissoo, Cassia siamea* and *Bauhinia biloba*.

220
Pain, S. K. and Rao, B. K.

A comparative study of the root forming effect of indole propionic acid (IPA), indole butyric acid (IBA) and naphthalene acetic acid (NAA) on the stem cuttings of *Dalbergia sissoo* Roxb.

Indian Forester 1981. 107 (3): 151-154

English

The 3 hormones were applied by the quick dip method at 1000 p.p.m. in summer (April-May) and (IPA only) at 500 and 1000 p.p.m. in winter (Jan.-Feb.) to 30-cm cuttings from 7-yr-old trees. Best results for summer-planted cuttings were with IBA (5 out of 5 rooted), then NAA (4) and IPA (3), with one cutting rooting in the untreated control. In winter, 5 cuttings rooted with 1000 p.p.m. IPA and 4 with 500 p.p.m.

221
Pain, S. K., Rao, B. K. and Dey, S. P.

Vegetative propagation by stem cuttings of *Dalbergia sissoo* Roxb. with IBA, NAA and salicylic acid.

Geobios, France 1983. 10 (5): 200-203 Referativnyi Zhurnal, 55 (Rastenievodstvo), 1985, 1.55.863.

English

Treatment with IBA + salicylic acid (SA) [rates unspecified] gave 100% rooting and with NAA + SA 80% rooting.

222
Paliwal, G. S., Sajwan, V. S. and Prasad, N. V. S. R. K.

Seasonal variations in the size of the cambial initials in *Polyalthia longifolia*.

Current Science 1974. 43 (19): 620-621

English

Presents graphs of the seasonal variation in the length and breadth of fusiform initials and the breadth of ray initials in the wood of *P. longifolia* in Delhi in 1968, and compares the results with those for *Dalbergia sissoo*.

223
Pandey, D.

Yield models of plantations in the tropics.

Unasylva 1987. 39 (3-4): 74-75

English

Data are presented for 19 species on rotation, yield (m.a.i.), stems/ha, altitudinal range, mean annual rainfall and number of dry months. Seven species belong to the humid tropics, 4 to tropical high land and 8 to semi-arid areas.

224
Panday, K. K.

Fodder Trees and Tree Fodder in Nepal

Swiss Development Corporation, Berne, Switzerland; Swiss Federal Institute of Forestry, Birmendsorf, Switzerland. 1982

English

The author explains the livestock and fodder situation in Nepal and shows a way to improvement of the fodder base and the ecology.

Fodder trees are described, their nutritional value, their propagation and utilization; promotion of fodder trees is suggested. In a discussion of the Terai region, native fodder species as *Dalbergia sissoo* are noted but are more valuable for other purposes and it is stated "very generally tree fodder is not utilized in the plains.

Chemical composition and nutritive constituents of *D. sissoo* are:

Dry matter	in % of dry matter				
% of fresh matter	Crude protein	N-free extract	Ether extract	Crude fibre	Total ash
40	16.65	49.4	3.18	22.23	8.56

225
Pandey, P. N.

Effects of *Dalbergia sissoo* Roxb. on development, growth and reproduction of *Utetheisa pulchella* Linn.

Zeitschrift fur Angewandte Zoologie 1976. 63 (4): 445-449

English

The leaves of *Dalbergia sissoo* have been reported to have harmful effects on insects, and their effect on the larvae of *Utetheisa pulchella* (L.), a pest of the green-manure plant *Crotalaria juncea* in India, was therefore investigated. The larvae did not feed on the leaves, even after starvation for 12 h, and an aqueous leaf suspension therefore made and smeared on leaves of *C. juncea*. Larvae that fed on these in petri dishes suffered 46.6% mortality as compared with 6.6% on untreated leaves, and pupal mortality was also high, 37.5%, as compared with 7.1%. Larvae that died after feeding on the material appeared to be dehydrated, as is characteristic of poisoning. When development was completed, it required 6 days longer than normal, indicating some delaying factor, and larval weights were low. Females resulting from treated larvae laid 242 eggs, as compared with 352, and the percentage hatching was reduced from 96 to 64. These differences were highly significant and indicated a sterilising effect.

226
Pandey, P. N.

Effects of *Dalbergia* fruit on development and growth of *Utetheisa pulchella* (L.).

Zeitschrift fur Angewandte Zoologie 1978. 65 (3): 321-324

English

During investigations carried out in India, it was found that the pod of *Dalbergia sissoo* affects the survival and growth of *Utetheisa pulchella* (L.). A crude water filtrate of the pod was obtained and applied to leaves of *Crotalaria juncea*, the preferred food-plant of the insect. Larval survival was reduced to 40%, pupal survival to a lesser extent, and adult emergence to 30%. Growth was also much poorer in larvae feeding on treated leaves than in those feeding on untreated ones.

227
Pandey, P. N.

Survival of *Utetheisa pulchella* L. (Lep, Arctiidae) against fractions of *Dalbergia* root.

Zeitschrift fur Angewandte Zoologie 1978. 65 (4): 445-447

English

Earlier work by the author and others had shown that the root of *Dalbergia sissoo* possesses insecticidal properties for the larvae of Utetheisa pulchella (L.), but little was known of the active agent. Investigations were therefore carried out. These showed that the root possesses two principles effective against the larvae, one soluble in methanol and the other in acetone. The first causes about 100% mortality at 2% concentration, and the other about 57% at the same concentration. The second was much the less effective of the two at 1%.

228
Pandey, P. N.

Effects of *Dalbergia* stem on growth and development of *Utetheisa pulchella*.

Zeitschrift fur Angewandte Zoologie 1978. 65 (2): 135-138

English

Earlier work [not noticed in FA] showed that the leaf and roots of *D. sissoo* had an adverse effect on the reproduction, growth and development of *U. pulchella* (Lep., Arctiidae), a pest of sunn hemp *Crotalaria juncea* and paddy. A crude filtrate of the stem of *D. sissoo* was obtained and smeared on the leaves of *C. juncea* which were then fed to *U. pulchella* larvae: mortality was 85% and surviving larvae showed poor growth.

229
Pandey, P. N., Ansari, M. H. and Dubey, A.

Influence of *Dalbergia* root on development and growth of *Utetheisa pulchella* L.

Zeitschrift fur Angewandte Zoologie 1977. 64 (4): 453-457

English

No adults were obtained from larvae of *Utetheisa pulchella* (L.) that had been fed on leaves of *Crotalaria juncea* smeared with a crude water filtrate of root of *Dalbergia sissoo*. Treatment prolonged the larval period and reduced the rate of pupation.

230
Pant, P. C.

Plants of Corbett National Park, Uttar Pradesh.

Journal of the Bombay Natural History Society 1976. 73 (2): 287-295

English

In the *Dalbergia sissoo/Acacia catechu* riverside savanna at Dhikala, there was a large area with dense growth of *Themeda arundinacea*, bordered by *Thysanolaena maxima* and *Vetiveria zizanioides*. After annual burning of the dense dry grass the new growth was food for hog deer (Para) and spotted deer (Chital); *Desmodium spp.* and *Crotalaria spp.* were conspicuous. Grasses widespread at other sites were *Eulaliopsis binata* (used for paper making), *Apluda mutica*, *Oplismenus compositus* and *Eragrostis unioloides*. A list of 232 spp. present is given.

231
Parker, R. N.

Irrigated plantations in the Punjab

Indian Forester 1918 Vol XLIV (9):388-393

English

The paper details the development of an establishment technique (1911-1915) to raise *Dalbergia sissoo* irrigated plantations on sands with water tables at 60 feet. Alkalai soil patches are injurious to *D. sissoo* survival and growth and the alkali makes the soil impervious to water. Over time the patches will disappear; each irrigation improves the water penetration and when favorable grass cover develops, *D. sissoo* can be planted and with grass control eventually the grass will be shaded out.

232
Parker, R. N.

Common Indian Trees, and How to Know Them

Manager of Publication, Delhi, 1933. Reprinted by Forest Research Institute and Colleges, Dehra Dun 1948.

English

The shisham (*Dalbergia sissoo*) is the favorite road-side tree in upper India, and for this purpose has many advantages. It is easily grown and fairly rapid in growth, in full leaf in the hot weather and almost immune from lopping, barking and other forms of wanton damage as the leaves are not used for fodder and the bark is not used for tanning or medicine. It is indigenous along river banks from the Indrus to Assam and extending some distance into the plains. Seed is distributed down streams and is stranded on mud or sand banks where they germinate; a technique to simulate this is recommended.

233
Parihar, D. R.

Field observations on the nature and extent of damage by Indian desert termites and their control.

Annals of Arid Zone 1978. 17 (2): 192-199

English

The incidence of termite damage was assessed on grasses, forest trees and agricultural crops around Jodhpur, Rajasthan. Natural predators of termites were also recorded. Badly affected trees (roots, stems and bark infested) included *Prosopis cineraria, Dalbergia sissoo, Delonix regia, Parkinsonia aculeata* and *Eucalyptus camaldulensis*. Of 13 insecticides tested, 0.02% endrin was the most effective in preventing *Odontotermes brunneus* infestation of *Dalbergia sissoo*.

234
Parihar, D. R.

Termite problem in desert plantations.

Annals of Arid Zone 1980. 19 (3): 329-334

English

Species known in the Rajasthan desert and plants attacked, damage and termite predators (birds and mammals) are briefly described. An outline report is included on the control of termites attacking 10-yr-old *Dalbergia sissoo*, dealt with in more detail in a previous paper.

235
Patel, S. I.

Propagation of some rare tropical plants.

Combined Proceedings, International Plant Propagators' Society 1983, publ. 1984. 33 573-580

English

Short descriptions and advice on vegetative and seed propagation are given for 19 species of ornamental trees and shrubs including *Arecastrum romanzoffianum, Bucida buceras, Chrysobalanus icaco, Clusia rosea, Dalbergia sissoo, Tamarindus indica* and *Zamia floridana [integrifolia]*.

236
Pathak, P. S. and Patil, B. D.

Growth of *Leucaena leucocephala* compared to 4 native species in India.

Leucaena Research Reports 1985. 6 46

English

Growth measurements taken in 1983 from a trial established in 1981 indicated the relative superiority of *L. leucocephala* var. K8 in ht. and diam. growth compared with *Emblica officinalis [Phyllanthus emblica], Holoptelia integrifolia, Dalbergia sissoo,* and *Pongamia pinnata.*

237
Pearson, R. S.

Commercial Guide to Forest Economic Products of India

Superintendent Government Printing, Calcutta, India 1912

English

Dalbergia sissoo is described as a moderate sized deciduous tree of the sub Himalayan tracts, extending from the Indrus to Assam, not often above 3,000'; much cultivated in other parts of India but is probably not indigenous except in the north. The wood quality, end use, outturn and price (in Dehra Dun sawn planks 1" thick and 1 foot broad/2-3 annas per running foot) are discussed. The author notes there are no minor products of real importance.

238
Pearson, R. S. and Brown, H. P.

Commercial Timbers of India, Vol 1 (1932)

A.J. Reprints Agency, 24 B/5 Desh Bandhu Gupta Rd Karol Bagh, New Delhi 1981

English

This monumental work describes the natural distribution, supplies, anatomical structure, physical and mechanical properties and uses of the commercial timbers of India. *Dalbergia sissoo* is described as a large tree in favorable growing localities to 100ft. in height and 8 ft. in girth and with 35 feet of clear cylindrical stem. Its natural habitat is sub Himalayan -- Indrus to Assam -- to 3,000', sometimes ascending to 4,500'. Extensively planted along roads and canals; large irrigated plantations in the Punjab; supplies are discussed.

The structure of the wood (growth rings, vessels, parenchyma, substitute fibres, fibres, rays, ripple marks, pith flecks) are described in depth. Mechanical properties (wt. at 12% M.C. is 50-53 lbs./c.ft.); transverse strength; seasoning; durability and adaptability to treatment; working qualities; uses are fully discussed.

239
Pokhriyal, T. C., Raturi, A. S., Nautiyal, H. O. and Joshi, S. R.

Standardization of in-vivo nitrate reductase activity in *Albizia lebbeck, Acacia nilotica* and *Dalbergia sissoo.*

Indian Forester 1988. 114 (3): 166-167

English

Details are given of the correct phosphate buffer concn. and pH and substrate (KNO3) concn. to use for in vivo assays of nitrate reductase in leaves of *Albizia lebbeck [A. lebbek], Acacia nilotica* and *Dalbergia sissoo.* The reagents described give the max. rate of nitrate reductase activity obtainable.

240
Pokhriyal, T. C., Raturi, A. S., Pant, S. P., Pande, S. K. and Bhatnagar, S.K.

Nitrogen fixation in *Albizia, Acacia, Dalbergia* and *Leucaena leucocephala.*

Indian Forester 1987. 113 (5): 366-369

English

Polypotted plants of *Albizia lebbeck [A. lebbek], Acacia nilotica, D. sissoo* and *L. leucocephala* were transferred to 12-inch diam. earthen[ware] pots filled with well-sieved soil and grown for 3 months in a glasshouse. Four plants of each species were then uprooted and measurements made of ht., fresh wt. and numbers of nodules, and nitrogenase activity (using the acetylene reduction assay). Max. values were observed for *L. leucocephala* for all parameters, followed by *A. lebbek, A. nilotica* and *D. sissoo.*

241
Pradhan, I. P.

Preliminary study of rainfall interception through leaf litter.

Indian Forester 1973. 99 (7): 440-445

English

Leaf litter of *Tectona grandis* (a), *Dendrocalamus strictus* (b), *Albizia lebbek* (c), *Dalbergia sissoo* (d) and *Acacia arabica* (e) was placed on wire-mesh trays in the open at the Soil Conservation Research Farm, Vasad, in May 1970. Subsequent measurements showed that interception was greater in (a) and declined in the order (e) > (d) > (b) > (c). During the rainy season, litter decomposition was greatest for (a) and least for (e).

242
Puri, Sunil and Nagpal, Raman

Effects of auxins on air-layers of some agro-forestry species.

Indian Journal of Forestry 1988. 11 (1): 28-32

English

Air layers of 4 species (*Dalbergia sissoo, Morus alba, Ficus carica* and *Acacia catechu*) were made each month from May 1978 to April 1979 at Bilaspur (alt. 600 m), Himachal Pradesh. The air layers were either left untreated, or were treated

with 10 and 100 ppm IAA, IBA or NAA. Callus and root formation was recorded after 45, 60, 75, and 90 days. Meteorological data were recorded throughout the period. Percent callus and root formation are tabulated for each month, species and treatment. Rooting occurred in untreated air layers made in May-Aug. for *D. sissoo*, May-Sep. for *M. alba* and *F. carica*, but not at all in *A. catechu*. Callus formation occurred in air layers made in nearly every month for the first 3 species, but only in Sep. in *A. catechu*. Growth regulator treatments enhanced (or induced) root and callus formation in nearly all cases for *D. sissoo, M. alba* and *F. carica*, in some cases promoting rooting in months where it had not occurred; some treatments promoted root formation in July air layers of *A. catechu*, and callus formation in Sep. It is concluded that May-Aug. is a suitable period for air layering all the species except *A. catechu*.

243
Puri, Y. N. and Khan, S. N.

Natural decay resistance of Indian timbers. V1. Decay resistance of Sissoo (*Dalbergia sissoo* Roxb) and Sandan (Ougenia oojeinensis Roxb. Hochreut)

Indian Forester 1968. Vol 94 (9):686-693

English

Heartwood samples from a wide range of diameters were collected from 6 localities in 2 widely separated regions and tested with seven wood rotting fungi selected on the basis of common occurrence in a variety of timber species and their ability to cause severe decay in converted wood. Laboratory evaluations are compared with field grave yard tests after 42 months. *D. sissoo* heartwood is classed as uniformly "very resistant," there being little if any radial variation in natural decay resistance. Timber is equally resistant to both brown and white rot test fungi and can be used under conditions of maximum decay hazards.

244
Qazi, I. A. and Hussain, R. W.

Site index curves for Shisham (*Dalbergia sissoo* Linn.f.).

Pakistan Journal of Forestry 1974. 24 (2): 137-143

English

Presents site-index curves and tables based on height measurements of dominant and co-dominant trees (aged 5-23 years) on 269 yield plots in various irrigated plantations of the Punjab.

245
Quazi, I. A., Hussain, R. W. and Cheema, M. A.

Numerical check on thinnings in Shisham (*Dalbergia sissoo*).

Pakistan Journal of Forestry 1973. 23 (1): 33-37

English

On the basis of data obtained from irrigated plantations of *D. sissoo* in the Punjab, for mean dbh and b.a./acre before thinning, a regression equation is developed for estimating the number of stems per acre by diameter classes, after thinning. Formulae relating spacing to stem diameter are also given to assist field staff to carry out thinnings at correct intensities.

246
Qureshi, I. M. and Srivastava, P. B. L.

Foliar diagnosis and mineral nutrition of forest trees

Indian Forester Vol 92 No 7 1966 447-455

English

The authors note the added significance of mineral nutrition problems where factors as limited forest area, increased demand for forest produce, increased productivity and afforestation of difficult sites, etc., affect forestry practices. They advocate the use of foliar analysis for a quick assessment of nutritional imbalances and mineral requirements of forest trees. The paper describes some of the aspects to be considered when using this method. For example, in determining the time of sampling they note that many forest trees produce large quantities of

flowers, fruits and seeds (*Shorea robusta, Tectona grandis* and *Dalbergia sissoo*), and this could not be without heavy drain on reserves or without the use of nutrients in considerable quantity.

247
Raddi, A. G.

Integration of forage forestry in afforestation programme of Maharashtra State.

Indian Journal of Range Management 1981. 2 (1/2): 81-85

English

Integration of forage production with ecological recovery of the degraded condition of forest areas in low rainfall regions of Maharashtra is discussed. *Cenchrus ciliaris, Stylosanthes hamata, S. scabra* and the fodder trees *Leucaena leucocephala, Hardwickia binata, Albizia lebbek, Azadirachta indica* and *Dalbergia sissoo* are suitable for cultivation in these areas.

248
Rahman, K. A. and Singh, S.

Nectar and Pollen Plants of the Punjab.

The Indian Bee Journal 1941. 4 (3/4):32-35

English

The authors note familiarity with 144 different kinds of plants which bees visit for pollen or nectar. Of these, four are the most important as they yield enough nectar for the bees to store surplus honey; one of these four species is *Dalbergia sissoo*. The authors note the tree is common in the plains of India and in the Punjab it is distributed up to an altitude of 4,000 ft. above sea level. It flowers in the first and third weeks of April in the plains and hills, respectively. It is of major importance as a nectar source in the plains and in the Kangra valley.

249
Rajasingh, G. J.

Evolution of dry zone afforestation in Madras state

Indian Forester 1968. Vol 94 (2):147-162

English

Records the use of *Dalbergia sissoo* in the evolutionary development of dry zone forest management systems where direct spot sowing gave way to pot planting in cleared strips, in turn supplanted by intensive site preparation and the use of polypots.

250
Rajbhandary, S. B.

Rooting of Tissue Culture-Produced Plants in Non-sterile Sand

Agricell Report; A Plant Tissue Culture Newsletter Agritech Consultants Ltd April 1990

English

Reports a procedure that allows skipping the in vitro rooting step of tissue culture plant production, (including *Dalbergia sissoo*). The technique used in over 25 species directly plants proliferated shoots into non-sterile sand under polythene in the greenhouse. The technique can substantially reduce the costs of tissue cultured propagules.

251
Rajbhandary, S. B.

In vitro propagation of *Dalbergia sissoo*

Banko Janakari, Forest Research and Information Centre, Dept. of Forestry and Plant Research, Kathmandu, Nepal. Vol 2 (1), Autumn 1988.

English

The paper describes the in vitro shoot proliferation of *Dalbergia sissoo* in Murashige and Skoog solution with additional casein hydrolysate and benzylaminopurine. The shoots obtained were rooted in non-sterile sand with more that 80% success June/July with av. day/night temperatures of 34/15 degrees C and 70-80%

Relative Humidity. The roots developed within ten days. The rooted plants were established in the field at Sagarnath and the tissue cultured plants seem to be performing similar to traditionally propagated plants.

252
Rajvanshi, R. and Gupta, S. R.

Mineral cycling in a tropical deciduous *Dalbergia sissoo* Roxb. forest.

Acta Oecologica, Oecologia Plantarum 1985. 6 (3): 247-262

English

Data for a *Dalbergia sissoo* forest showed that average concentrations of nutrients varied in different forest components being highest in actively growing plant parts. Mean relative concentrations were highest for nitrogen (0.5 to 3.9%). The nutrient pool (kg ha-1) in the aboveground vegetation components was: N, 605; P, 13; Ca, 657; Mg, 275;K, 167; Na, 78; 63 to 88% of the nutrient pool was contained in *Dalbergia* boles and branches. The nutrient pool in soil was 1.2 to 11.5-fold higher than in aboveground vegetation. Nutrient uptake (kg ha-1 yr-1) was: 279 N, 8.7 P, 267.8 Ca, 106.5 Mg, 130.8 K and 66.3 Na. The annual return of nutrient elements in litterfall (93.1 N, 1.5 P, 71.4 Ca, 26.8 Mg, 17.7 K and 4.2 Na kg ha-1) and canopy flux (8.9 N, 2.8 P, 47.6 Ca, 23.3 Mg, 69.1 K and 42.3 Na kg ha-1) formed 39 to 70% of the total uptake. The retention of various nutrients was in the order Ca N Mg K Na P, and the leachability was in the order Na K Mg Ca P N. The relative turnover rate was highest for Na and lowest for N.

253
Ram, Prasad and Pandey, R. K.

Methyl-isocyanate (MIC) hazard to the vegetation of Bhopal.

Journal of Tropical Forestry 1985. 1 (1): 40-50

English

A survey of the effects of MIC gas (an intermediate product) which escaped from the Union Carbide pesticide factory on 2/3 Dec. 1984. Damage to leaves, flowers and fruit of 48 species was visually assessed in 4 localities and results tabulated. *Azadirachta indica* was found to be the most sensitive, showing defoliation and blackening of the foliage. Other species severely affected were: *Ficus religiosa; Santalum album; Zizyphus jujuba [Ziziphus mauritiana]; Dalbergia sissoo; Punica grantum; Ocimum sanctum; Cactus sp.; Rhaphanus sativus; Brassica oleracea*; and *Lycopersicum esculentum*. Unaffected species included: *Ailanthus excelsa; Emblica officinalis [Phyllanthus emblica?]; Musa paradisiaca; Phoenix sylvestris; Coleus blumai; Bougainvillea sp.; Hibiscus rosa-sinensis; Mangifera indica; Clerodendron inerme; Eucalyptus spp.; Lawsonia inermis*; and *Polyalthia longifolia*. However, even the most sensitive species were producing new leaves. Two months after the gas escaped there was no visible injury.

254
Ram, Prasad and Shukla, P. K.

Reclamation and revegetation of coal mine over burdens in Madhya Pradesh.

Journal of Tropical Forestry 1985. 1 (1):79-84
English

Trials are reported of 18 species at Dhanpuri near Shahdol, established in 1982-84. Tree ht. and diam. were recorded in Dec. 1984. The best results were given by hybrid Eucalyptus (ht. 5.48 m in 1984), *E. camaldulensis* (5.21 m) and *Acacia auriculiformis* (4.57 m). Other species, especially *Dalbergia sissoo, A. nilotica* and *Pongamia pinnata* grew well, with av. ht. 2.19-2.78 m. Bamboo (*Dendrocalamus strictus*), interplanted with the other species at 4x4 m spacing, also gave good results, producing 3-4 culms per clump with an av. ht. of 3.14 m in 1982.

255
Rana, U., Gairola, M. and Nautiyal, A. R.

Seasonal variation in rooting of stem cuttings of *Dalbergia sissoo* and auxin effects on it.

Indian Journal of Forestry 1987. 10 (3):220-222

English

Stem cuttings were collected at 2-month intervals from May 1984 to Jan. 1985 from 10-yr-old trees. Uniform cuttings of length 23 cm and diam. 0.6 cm were selected and divided into groups of 50 which were treated with 100 and 500 p.p.m. IAA or IBA (4 groups) or not treated (control group). Treatment was by dipping 7-cm basal cut ends in auxin sol. for 24 h; control cuttings were dipped in water. Cuttings were planted in polybags containing garden soil, sand and FYM (1:1:1) at the Naithana experimental nursery and watered regularly. Rooting was recorded at 2-wk intervals for 4 months and max. and min. temp. recorded daily. Rooting % of untreated cuttings was 8% in those taken in Jan., 20% in May and 14% in July, with none in Sep. and Nov. All auxin applications promoted rooting in Sep. cuttings, and IAA at 100 p.p.m. stimulated rooting in Nov. cuttings. For cuttings taken in other months auxin applications both increased and reduced % rooting (or had no effect) at both concentrations used, with the effects varying between IAA and IBA, and with month the cutting was taken. It is suggested that the effect of exogenous auxin is controlled by its endogenous concn.

256
Rao, K. R. and Purkayastha, S. K.

Indian Woods: Their Identification, Properties and Uses. Volume 111.

Manager of Publications, Forest Research Institute and Colleges, Dehra Dun, August 1972

English

Dalbergia sissoo A large tree in favourable places reaching 30m in height and a girth of 2.4m with a clear bole of over 10m. The bole is rarely straight, usually curved or somewhat crooked and very often irregularly buttressed. The tree occurs in the sub Himalayan tract and up to 1500m, often gregarious on new alluvial lands or low banks of rivers. It is extensively planted in many parts of India. General properties are described together with gross structure and strength properties; seasoning is discussed, with durability, insect and fungul attack, preservative treatment - heartwood refactory, sapwood easily treated - and working qualities well covered. The supply side is commented on as are a wide range of end uses.

257
Rao, H. S.

Vegetative propagation and forest tree improvement

Indian Forester 1953. Vol 79 (3):176-183

English

The speed and success of tree improvement for large scale afforestation depends on vegetative multiplication to a large measure. In a survey of Indian forest tree species it was found that 74 species reproduce by cuttings, 11 by layers and 104 by root suckers. Coppicing ability is also an indication of the faculty for vegetative reproduction. *Dalbergia sissoo* was noted as responding particularly well to propagation by cutting and layers, root suckers, and coppicing.

258
Rao, H. S.

Problems in Indian plant breeding

Indian Forester 1959. Vol 85 (9):515-527

English

The article provides a general survey of applied forest genetics in India. The author notes one category of species immediately suggests itself as of genetical significance ie the habitually self-pollinated species. Continued self-pollination has established "pure lines," the surviving population now enjoying a relative genetic purity and uniformity. Plants of the family Papilionaceae, in general, are structured so that self-useful pure line selections available of *Dalbergia sissoo, D. sissoides and D. latifolia.*

259
Rashmi Rajvanshi and Gupta, S. R.

Biomass, productivity and litterfall in a tropical *Dalbergia sissoo* Roxb. forest.

Journal of Tree Sciences 1985. 4 (2): 73-78

English

Biomass and aboveground net primary productivity were estimated in a tropical dry deciduous *D. sissoo* forest at Kurukshetra, Haryana, for which vegetation analysis data are also presented. The dominant tree was *D. sissoo* but there were also low densities of *Melia azedarach* and *Acacia nilotica*. Aboveground tree biomass was estimated using allometric regression equations based on diameter and averaged 56.41 t/ha of which the contributions of branch and stem biomass were 42% and 58%, respectively. Herbs contributed a significant role and their biomass averaged 1.33 t/ha p.a. Annual litter fall of the forest was 4.79 t/ha. Aboveground net primary productivity of the forest was 17.95 t/ha p.a. - 15.47 for trees and 2.48 for herbs; for trees, productivity of branches (37% of the total) and stems (32%) was greater than that for leaves (18%).

260
Rawat, B. S., Rajput, S. S. and Pant, B. C.

Studies on working qualities of Indian timbers II.

Holzforschung und Holzverwertung 1974. 26 (2): 37-41

English

The working qualities of *Acrocarpus fraxinifolius, Albizia procera, Dalbergia sissoo, Michelia champaca* and *Syzygium cuminii*, were determined and compared with those of *Tectona grandis*. Defects observed after planing, turning, boring and mortising are recorded, and a working quality index for the over-all comparison of species has been worked out.

261
Rehman, M. A.

Wood Seasoning, The Seasoning Behaviour of Indian Woods. Part 11, Kiln Drying Schedules.

Indian Forest Bulletin No. 170, 1953. Office of the Geodetic and Training Circle, Survey of India

Reprinted from The Indian Forester, Vol. 79 (7) 1953

English

Provides forced air kiln drying schedules developed by the author over 22 years and recommends the use of Schedule 1V for the kiln drying of *Dalbergia sissoo*.

262
Rehman, S. and Hussain, A.

Growth and heritability estimates among six-year-old three geographical sources of shisham (*Dalbergia sissoo* Roxb.) in Pakistan.

Pakistan Journal of Forestry 1986. 36 (2): 67-72

English

Seeds from 54 families were planted in March/April 1977 in nursery beds in Peshawar. Forked and weak seedlings were rejected and cuttings taken from the remainder and planted out in April 1978. Diam. was recorded in Nov. 1984. Significant differences were found among the provenances, with plants from Chichawatni producing the greatest diam.: 7.1 cm compared with 7.0 and 6.4 cm for those from Changa Manga and Mardan, respectively. Broad sense heritability was 0.83.

263
Relwani, L. L., Lahane, B. N. and Gandhe, A. M.

Performance of nitrogen-fixing MPTS on mountainous wastelands in low rainfall areas.

In Withington, D., MacDicken, K.G., Sastry, C.B. and Adams, N.R. 1988. Multipurpose tree species for small-farm use. Proceedings of an international workshop held November 2-5, 1987 in Pattaya, Thailand. 105-113

English

The introduction to this paper summarizes the results of highly successful earlier trials on fodder and wood production by *Leucaena leucocephala* carried out at the BAIF Central Research Campus on the mountainous Deccan waste lands of India. The most uccessful provenances were the Hawaiian Giants K8, K29, K67 and K72. The rest of the paper describes the

results of the current trials with a large number of other nitrogen fixing and dry zone multipurpose tree species (MPTS) under rainfed, irrigated, and hand watering systems, with an annual rainfall of 350-400 mm over the experimental period (1982-87). Under rainfed conditions, *L. leucocephala* achieved the best growth, followed by *Acacia tortilis* and *Acacia senegal*. With improved soil depth, moisture, and fertility (i.e. on lower slopes), *Acacia nilotica, Pithecellobium dulce* and *Dalbergia sissoo* also performed well. Among the new introductions, *Acacia deamii [A. deanei]* and *Sesbania formosa* were promising. Under protective irrigation, *L. leucocephala* and *S. grandiflora* were outstanding, closely followed by *L. diversifolia, Gliricidia sepium, D. sissoo*, and *Erythrina indica*. In the hand watering treatment, *S. sesban, L. leucocephala, Acacia nilotica var. cupressiformis, Gliricidia sepium, Parkinsonia aculeata* and *Albizia procera* performed well. *L. leucocephala* showed superior performance in all treatments.

264
Robinson, P. J.

Trees as fodder crops.

In Cannel, M.G.R. and J.E. Jackson (eds). Attributes of Trees as Crop Plants, Institute of Terrestrial Ecology, Midlothian, Scotland. 592pp. 1985

English

Abstract: Not available

265
Rowntree, J. B.

An introduction to the vegetation of the Assam valley

Indian Forest Records 1954. Vol. 9 (1)

English

The Record notes the presence of the *Acacia catechu - Dalbergia sissoo* Associes on the banks of the rivers of the type where the waters usually go underground during the dry season. The Associes is also common in the old silted up beds of rivers which have changed their courses. The Associes is restricted to the north banks of the Brahmaputra from the Sankosh to the Bhoreli rivers near the hills.

Dalbergia sissoo extends to the eastern part of the Sadiya Frontier Tracts.

266
Roxburgh, William

Flora Indica or Descriptions of Indian Plants

Printed at the Mission Press, Serampore, ed. W. Carey, 1820-1824. Reprinted literatim from Careys edition by Today & Tomorrow' Printers & Publishers 22 B/5 Original Rd. New Delhi 5. 1971

English

Roxburgh notes *Dalbergia sissoo* Roxb. is native to Bengal and the adjoining provinces to the northward; flowering time the beginning of the hot season; the seed ripens about the close of the year. The tree trunk is generally more or less crooked, high and of great thickness, often from three to four feet in diameter. The botanical description is given. The tree yields the Bengal ship-builders their crooked timbers and knees; it is tolerable light, remarkable strong, but is unfortunately not as durable as could be wished; it answers well for various other purposes. He goes on to comment:

> Upon the whole I scarcely know any other tree that deserves more attention, for when its rapid growth in almost every soil, its beauty, and uses are taken into account, few trees can be compared to it.

267
Roy, R. D. and Pathak, P. S.

Silvipastoral studies.

Indian Grassland and Fodder Research Institute, Jhansi: Annual report 1971. undated. 81-82

English

Of 21 fodder tree species planted during the monsoon rainy season, *Albizia amara, A. lebbek,*

Acacia tortilis, A. arabica, A. auriculiformis, Bauhinia alba, B. variegata, Prosopis cineraria, Azadirachta indica, Cassia phyllodenia, Zizyphus spina-cristi, Leucaena glauca [= L. leucocephela], Dalbergia sissoo and *Sesbania grandiflora* showed 80-100% survival and *Hardwickia binata, A. ligulata, S. aegyptiaca, S. microcarpa* and *Colophospermum mopanae* showed 60-80% survival; survival of *Cassia alata* and *Morus alba* was <50%. Information on the growth rates of these species is given.

268
Roy, R. D. and Pathak, P. S.

The establishment and growth of plantation species in an integrated land use pattern.

Indian Grassland and Fodder Research Institute Annual report 1974. undated. 91-93

English

Information on survival and growth rate of fodder trees *Albizia amara, A. richardiana, Hardwickia binata, Acacia tortilis, A. arabica, Azadirachta indica, Leucaena leucocephala, Dalbergia sissoo, Dichrostachys glomerata, D. mutans* and *Terminalia arjuna* and on establishment and herbage production in *Cenchrus ciliaris, Sehima nervosum* and *Chrysopogon fulvus* grown between the rows of some of these trees is given.

269
Saeed Wagan, M.

Some observations on the developmental biology of *Trigonocorypha unicolor* (Phaneropterinae: Tettigoniidae).

Pakistan Journal of Zoology 1985. 17 (1): 110-111

English

The biology of *Trigonocorypha unicolor* was studied in the laboratory using an individual collected in Pakistan. A description is given of the eggs, which were deposited singly along the leaf margin of *Dalbergia sissoo*. The number of eggs deposited on successive days were 6, 8 and 3. At a temperature of 32-35 deg C during the day and 20-25 deg C during the night, eggs started hatching 23 days after oviposition.

270
Sajwan, S. S.

Ground flora and their distribution in forest plantations in Jamuna Ravine.

Indian Forester 1975. 101 (5): 269-275

English

Tabulates results of a survey of the ground flora in five plantations at the Soil Conservation Research, Demonstration and Training Centre, Agra. The ground flora was minimum, as regards both number of species and density, in plantations of *Prosopis juliflora* and *Dendrocalamus strictus* and maximum in plantations of *Dalbergia sissoo*. Regeneration of *Dalbergia sissoo* was found in all plantations except those of *P. juliflora*. Regeneration of other species is also recorded.

271
Sanyal, S. N., Pandey, C. N., Jain, V. K. and Kukreti, M. C.

A preliminary note on gamma ray absorptions in some timbers.

Journal of the Timber Development Association of India 1980. 26 (2): 14-17

English

Radiation techniques using gamma-rays are used in determinations of wood density, m.c. and decay. Data are presented on the linear absorption coeff. (mu) and wood density of: *Tsuga dumosa, Toona ciliata, Betula spp., Mangifera indica, Pinus roxburghii, Fraxinus spp., Dalbergia sissoo* and *Shorea robusta*. There was a linear correlation between mu and wood density.

272
Sapkota, M.

Multipurpose tree species for small farm use in Nepal.

In Withington, D., MacDicken, K.G., Sastry, C.B.

and Adams, N.R. (eds.) 1988. Multipurpose tree species for small-farm use. Proceedings of an international workshop held November 2-5, 1987 in Pattaya, Thailand. 48-52

English

Selected data are reported from multipurpose tree trials carried out in various agro-climatic regions of Nepal as part of the Farm Forestry Project supported by the International Development Research Centre of Canada, and the Nepal Institutes of Agriculture and Animal Science and of Forestry. Studies have included intercropping trials, species elimination trials, spacing experiments, and feeding studies on goats and buffalo calves. Promising species are cultivated and distributed to farmers. Species mentioned as of particular use are *Leucaena leucocephala, Dalbergia sissoo, Eucalyptus camaldulensis, Cassia siamea*, and *Acacia auriculiformis*. Popular local species include *Artocarpus lakoocha, Bauhinia purpurea, B. variegata*, various *Bambusa species* and *Acacia catechu*.

273
Saraswat, B. L., Singh, K. S. and Sachdeva, K. K.

A study on the chemical composition of shisham (*Dalbergia sissoo*) pods at different stages of maturity.

Balwant Vidyapeeth Journal of Agricultural and Scientific Research 1972. 14 (1): 12-15

English

Pods obtained from *D. sissoo* trees from August to November contained on average protein 11.94, ether extract 2.04, fibre 36.25, N-free extract 41.27, carbohydrate 77.40, ash 8.58, Ca 1.60 and P 0.38% of DM. The pods were considered a good feed for goats and sheep and may be given to cattle and buffalo during emergency.

274
Saxena, P. K.

Enhancement of protoplast regeneration by cold-conditioning of the donor tissue.

Journal of Plant Physiology 1935. 119 (5): 385-388

English

Enzymatic digestion of cotyledons of *Dalbergia sissoo* using a mixture containing 2% cellulase Onozuka "R-10" and standard isolation conditions produced large numbers of viable protoplasts which were capable of cell-wall synthesis and cell division. Exposure of the cotyledons to 8 $\pm$1 degC for 48 h prior to protoplast isolation had a marked promotory effect on callus formation, 32% of protoplasts forming colonies after treatment vs. 5% with no treatment, 10% after treatment with growth regulators and 30% after treatment with growth regulators + temperature treatment.

275
Sekhar, A. C., Sanyal, S. N. and Sarin, S. P.

Dynamic modulus of elasticity and pulse constant of wood by pulse transmission technique.

Journal of the Timber Development Association of India 1972. 18 (4): 19-24

English

The dynamic moduli of elasticity and pulse constants of five Indian species (*Tectona grandis, Dalbergia sissoo, Mangifera indica, Pinus roxburghii* and *Morus alba*) were determined by measuring the velocity of ultrasonic pulses along the grain. The ratio of dynamic to static modulus of elasticity was found to be 1.07-1.26. Data are given for the pulse velocity in *Tectona grandis* parallel and perpendicular to the grain.

276
Seth, S. K. and Mathauda, G. S.

Preliminary trials with gibberellic acid

Indian Forester 1959. Vol 85 (9): 528-537

English

Reports results of trials of the effect of gibberellic acid on tree seedlings. In the majority of cases height growth was accelerated, generally strongest

solutions gave greatest growth; *Dalbergia sissoo* made positive response; the extra growth with 1% solution treatment was associated with reduced root development, but this was not the case with weaker strengths and the latter treatments produced better root development.

277
Seth, S. K., Raizada, M. B. and Waheed Khan, M. A.

Trees for Vana Mahotsava.

Forest Institute and College, Dehra Dun 1962

English

The book provides general notes on seed collection and methods of propagation and detailed notes on sixty eight species including *Dalbergia sissoo*. The natural distribution, climatic conditions and soil types of *D. sissoo* are described. It is cultivated as an avenue tree and much used throughout India in afforestation works. In tea gardens it provides beneficial light shade and enriches the soil. It is frost hardy, sensitive to drought and not fire resistant. It is browsed by cattle and wild animals; rats gnaw through the tap root.

278
Shafee, S. A. and Fatma, A.

Taxonomic notes on Indian species of *Echthroplexis* Forster (Hymenoptera, Encyrtidae), with descriptions of two new species.

Mitteilungen der Schweizerischen Entomologischen Gesellschaft 1984. 57 (4): 371-376

English

Echthroplexis longipedicellus sp. n. is described from females reared from coccinellid larvae feeding on *Aonidiella orientalis* on *Dalbergia sissoo* in Uttar Pradesh in 1981, and *E. tumkurensis* sp. n. is described from a female reared from a coccinellid larva feeding on *Coccus sp.* on mango in Tumkur, Karnataka. Notes are included on some other species of the genus from India.

279
Shah, R. S.

Compression loss in plywood - experiments on Dalbergia sissoo.

Indian Forester 1984. 110 (10): 1053-1059

English

The compression loss percent in plywood (3-, 5-, 7- and 9-ply) of *Dalbergia sissoo* was measured in relation to the pressure used, density of plywood, m.c. of plywood and thickness before gluing.

280
Shahid, M. and Qayyum, A.

Bee flora of the N.W.F.P. [North-West Frontier Province, Pakistan].

Pakistan Journal of Forestry 1977. 27 (1): 1-10
English

A list is given of 122 plants (wild and cultivated) visited by bees, with their distribution in the province, and time of flowering. The 13 plants classified as major sources of nectar and pollen include the trees shisham (*Dalbergia sissoo*), phulai (*Acacia modesta*) and ber (*Zizyphus [Ziziphus] jujuba* and *Z. hysudrica*), and the shrubs bhaikar (*Adhatoda vasica*) and ghain (*Plectranthus rugosus*).

281
Shakya, Ramesh

Indigenous nitrogen-fixing trees in the farmlands of Nepal.

In Withington, D., MacDicken, K.G., Sastry, C.B., and Adams, N.R. (eds.) 1988. Multipurpose tree species for small-farm use. Proceedings of an international workshop held November 2-5, 1987 in Pattaya, Thailand. 125-130

English

A summary is given of already published data on the number of trees on private land in Nepal which indicated that numbers of trees per rural

household are variable but are often in the region of 15-28. The 13 common indigenous species found are each briefly described and their regional distribution indicated. Species found in the terai (up to 1000 m alt.) are *Acacia catechu, Albizia chinensis, Albizia julibrissin, Albizia lebbek, Albizia procera, Butea monosperma, Dalbergia sissoo, Erythrina suberosa, Erythrina variegata* and *Sesbania sesban*. Species found in the lower hills (up to 1500 m alt.) are *Albizia julibrissin, Albizia lebbek, Alnus nepalensis* and *Erythrina arborescens*. Species found in the high hills (up to 3000 m alt.) are *Albizia julibrissin* and *Alnus nepalensis*. The other species described are *Erythrina stricta*. There are various forestry projects in existence in Nepal and it is suggested that private tree planting on farm land will become more important. The main problems of this are discussed.

282
Shamet, G. S. and Kumar, S.

Rooting studies of *Punica granatum* and *Dalbergia sissoo* cuttings under controlled phyto-environment conditions.

Indian Forester 1988. 114 (6): 331-334

English

Stem cuttings (25 cm) were taken in Aug. 1986 from 1-yr-old branches of 10-12 yr old trees growing near Solan, Himachal Pradesh. Apical tips and leaves were excised and cuttings dipped for 2-3 sec in solutions of IAA, IBA (5000, 10000, 15000 or 20000 mg/liter), NAA (2000, 5000 or 10000 mg/liter), or distilled water (controls). The treated cuttings were planted in sand in polybags and kept in a moist chamber at 20-25degC air temp. and 23-27degC in the rooting bed; RH was 85-95%. Rooting was observed for 45 days. Rooting % of P. granatum was increased by all treatments except 5000 and 10000 mg/litre NAA. Av. root numbers and length were similarly increased. The most effective treatments were 15000 and 20000 mg/litre IAA and all IBA treatments which increased rooting to more than or equal to 40% (compared with 15% for the controls). Rooting %, and av. root numbers and length of *D. sissoo* were increased by all treatments. The most effective treatments were IAA at 5000 and 10000 mg/litre, IBA at 5000 mg/litre and NAA at 2000 mg/litre; all these increased rooting to more than or equal to 40% (compared with 5% for the controls).

283
Sharma, A., Chibber, S. S. and Chaula, H. M.

Caviunin 7-O-gentiobioside from *Dalbergia sissoo* pods.

Phytochemistry 1979. 18 (7): 1253

English

This new isoflavone glucoside was isolated from mature pods of *D. sissoo*.

284
Sharma, A., Chibber, S. S. and Chaula, H. M.

Isocaviunin 7-gentiobioside, a new isoflavone glycoside from [pods of] *Dalbergia sissoo*.

Phytochemistry 1980. 19 (4): 715

English

Abstract: Not available

285
Sharma, D. C., Taneja, P. L. and Bisht, A. P. S.

Biomass, productivity and nutrient cycling in a *Dalbergia sissoo* plantation.

Indian Forester 1988. 114 (6): 261-268

English

A 30x30 m plot was laid out in a homogeneous area of a 24-yr-old plantation in Uttar Pradesh. Dbh of all standing trees was recorded and the diam. range was divided into 3 classes; the av. tree for each class was calculated, and 4 sample trees felled, 1 each in the upper and lower diam. classes and 2 in the middle class. The leaves, twigs and branches were separated and weighed; stem and bark wt. were estimated from measurements made on 5-cm discs cut from the bases of 3-m long stem sections. Root wt. was determined by excavating the complete root system of one of the middle diam. class sample

trees. Litter was measured periodically over 1 yr in 10x10 m plots. Major nutrient concn. were determined in all sample tree components and in litter. Av. crop diam. and ht. were 23.3 cm and 19.7 m, respectively; the corresponding ranges were 15-29 cm and 12-24 m. Total above-ground biomass was 161604 kg/ha and root biomass 24808 kg/ha (15.4% of the above-ground biomass). The stem biomass was 102577 kg/ha (63.5% of the above-ground biomass). Annual litter production was 4164 kg/ha. Data are tabulated on the concn. of N, P, K, Ca and Mg by tree and litter components, and on estimated annual nutrient uptake and return. Nutrient concn. in the whole tree, and in litter, was highest for Ca, followed by N, K, Mg, and P. Compared with annual nutrient uptake, 63% of N, 50% of P, 48% of K, 67% of Ca and 57% of Mg were returned to the soil annually by litterfall.

286
Sharma, K., Dhillon, M. S. and Dhingra, K. K.

Presence of germination inhibitors in the leaf leachates of some farm grown trees.

Indian Forester 1987. 113 (12): 816-820

English

Laboratory studies are reported on the effect of leachates from 4 commonly grown farm tree species (*Acacia nilotica, Eucalyptus hybrid [E. tereticornis], Dalbergia sissoo* and *Morus alba*) on the germination and growth of 4 crops. The crops were wheat (Triticum aestivum), raya (*Brassica juncea*), field pea (*Pisum sativum*) and lentil (*Lens esculenta*) [*L. culinaris*]. Seeds were treated with 0.1% mercuric chloride before germination tests in petri dishes using water (control) or leachates made by soaking 20 g dried tree leaves in 1 litre water for 24 h. Germination was recorded at 24 h intervals for up to 7 days; root and shoot length and dry wt. of seedlings were measured after 15 days. Germination of raya was reduced by all leachates; that of other crops was not much affected. Leachates of *M. alba* had the most toxic effect on all crops. Generally, root and shoot length and vigor index (germination % X seedling length) were reduced by leachates (relative to controls) in the order *M. alba D. sissoo E. tereticornis A. nilotica*. The most sensitive crop was raya, followed by lentils, field peas and wheat.

287
Sharma, N. D.

A new host for *Catenulaster batistae* Agarwal and Sharma.

Current Science 1974. 43 (6): 195

English

The fungus, described, was isolated from fruits of *Dalbergia sissoo*.

288
Sharma, P. L.

Studies on Seasonal Activities of *Apis indica* at Lyallpur

The Indian Bee Journal, March & April 1948 pp 20-23

English

The paper describes management of *Apis indica* the Indian honey bee, indigeneous to hilly tracts of the Punjab, and its possible extension to the plains. Among the requirements for this is plants that would afford pollen. The major honey flow at Lyallbad is from shisham (*Dalbergia sissoo*) and from clovers *Trifolium alexandrium, T. resupinatum* during April and April-May, respectively. From this flow colonies have been recorded to collect up to 60 lbs. of honey. There is an extreme dearth of flora during the period from June to October; there is ample scope for investigation of plants that would afford some nectar or pollen to the bees during this period.

289
Sharma, R. C.

Quality of ground water in Saraswati plantation, District Karnal (Haryana).

Indian Forester 1973. 99 (2): 76-81

English

Difficulties in establishing plantations of *Dalbergia sissoo, Eucalyptus hybrid* and *Acacia arabica [A.*

nilotica subsp. indica] in the Haryana Forest were attributed to the high salinity, heavy texture and impermeability of the soil. Groundwater analyses showed that the pH of all samples was >8.35 and the electrical conductivity very low. The addition of gypsum to the irrigation water is recommended.

290
Sharma, R. P.

Variable density yield tables of *Dalbergia sissoo* (plantation origin).

Indian Forester 1979. 105 (6): 421-435

English

Authors summary: *Dalbergia sissoo* is a species of great economic and commercial value. It is raised both naturally and artificially. Variable density yield tables of the species (plantation) origin have been prepared to facilitate proper management. Data from sample plots laid out in Haryana, Rajastan and Upper Pradesh were collected. Relationships between various crop characters were determined using multiple regression technique. Results of analysis have been given. Tables based on these relationships have been prepared for such crop characters as height, diameter, basal area (main crop), total wood volume (main crop and total wood volume (thinning). These tables are by 5 year age classes from 10 through 50 years for different densities and three site index classes.

291
Sharma, S. N., Askari, M. and Gupta, P. G.

Investigations on indigenous substitutes for imported hornbeam (*Carpinus* sp.) for making cotton loom shuttles.

Indian Forest Leaflet 1977. (No. 196): 11 pp.

English

Service trials were performed with shuttles made of compressed wood of 17 Indian species, and with conventional compressed hornbeam wood shuttles. The results are tabulated. For plain loom shuttles, Indian birch (*Betula* sp.), maple (*Acer* sp.) and rosewood (*Dalbergia latifolia*) gave a service life of two-thirds to four-fifths that of imported hornbeam shuttles, if compressed to a relative density of 1.1-1.3. For Toyoda automatic loom shuttles, bijasal (*Pterocarpus marsupium*) compressed to a relative density of 1.1-1.2 exceeded mill estimates of service life for hornbeam shuttles. The results suggest that imported hornbeam could probably be replaced by indigenous woods.

292
Sharma, S. and Chandra, N.

Organogenesis and plantlet formation in vitro in *Dalbergia sissoo*.

Journal of Plant Physiology 1988. 132 (2): 145-147

English

One cm long hypocotyl explants of *D. sissoo* produced shoot buds when cultured on Murashige and Skoog (MS) medium containing benzylaminopurine [benzyladenine] + IAA/IBA/NAA. Shoot buds were also induced from isolated hypocotyl callus on MS medium with benzylaminopurine + IAA. The isolated shoots could be rooted on MS medium with IBA, NAA, IAA or IBA + NAA.

293
Sharpe, A. L.

Optimum Sowing Times for Important Forest Tree Species in Nepal

Forest Survey and Research Office, Dept. of Forests, Kathmandu, Nepal.

English

Because of climatic variation over short distances, it is difficult to decide when to sow to produce plants for the planting season of the summer rains June-August. For *Dalbergia sissoo*, a growing period of 14 weeks is suggested and that seed sowing be completed in March.

294
Sheikh, M. I.

Optimum water requirement of Shisham, *Dalbergia sissoo* - second assessment.

Pakistan Journal of Forestry 1974. 24 (1): 1-9

English

Describes an experiment established in 1959, in which cuttings were raised under irrigated conditions with five intensities of irrigation, 1.5, 3.0, 4.5, 6.0 or 7.5 ft [per annum ?], at 2-, 3- or 4-weekly intervals either by flooding or by means of a trench system. Results of an interim report after thinning in 1964 are briefly summarized. Data collected after a second thinning in 1970 showed that the maximum increase in volume production occurred when the intensity of irrigation was increased from 3.0 to 4.5 ft [per annum ?]. The most effective frequency of irrigation was at 2-weekly intervals, but the method of irrigation had no effect on volume production. The mean volume of wood extracted from the plots during second thinning was >1000 ft3/acre.

295
Sheikh, M. I.

Effect of spacing on growth of *Dalbergia sissoo*.

Tech. Notes 1-55; Tech. Note 41:82-83, 1984

English

Abstract: Not available

296
Sheikh, M. I

Growth rate of tree species.

Pakistan Journal of Forestry 1986. 36 (1): 17-18

English

Eight-month-old root and shoot cuttings of *Dalbergia sissoo* and *Salmalia malabarica [Bombax malabaricum]* and 1-yr-old seedlings of Eucalyptus citriodora and Populus deltoides 'I-63/51' [P.'Harvard'] were planted out in Peshawar in Feb. 1978. Stands were irrigated and a variety of crops, viz. wheat, maize, *Trifolium* (berseem), Sesamum, etc., were sown between the rows of trees. Ht. and dbh were recorded annually until 1985. P. 'Harvard' produced the greatest ht. (17.87 m in 1985), followed by *E. citriodora* (16.37 m), while *B. malabaricum* produced the greatest d.b.h. (25.2 cm) followed by P. 'Harvard' (23.6 cm).

297
Sheikh, M. I.

Review of research done in Pakistan on *Acacia nilotica, Dalbergia sisso, Eucalyptus camaldulensis* and *Azadirachta indica*.

In, Trees on small farms, Multipurpose Tree Species Research for the Arid and Semi-Arid Tropics. Proceedings of the Network Workshop of the Forestry/Fuelwood Research and Development (F/FRED) Winrock International Institute for Agricultural Development. Nov 1987

English

Dalbergia sissoo is Pakistan's most popular timber species, cultivated throughout the Indrus valley for firewood, furniture and construction timber, fodder and charcoal. It is also the tree most commonly grown with crops; farmers plant it singly, as a windbreak, or in block plantations. It is generally propagated by root shoot cuttings but farmers also sow the seed directly; raising plants in polythene tubes is becoming more popular. Fuelwood and small timber plantations are worked on a 20 year rotation, and larger timber on 60 year rotations. The thinning interval is usually 5-6 years eg 5, 10 and 15 years with final felling at 20-22 years when the trees have an average diameter of 30 cms. This leaves 25 trees/ha to become timber trees on a rotation of 40-60 years. The average total yield for thinnings amounts to 100 m^3/ha with another 90-100 m^3/ha available from the final felling. The MAI m^3/ha at rotation age 20 years for Site Quality 1, 11 and 111 is given as 11.2, 8.4, and 5.9, respectively.

Regarding the tree/crop interface, *D. sissoo* trees did adversely affect wheat yields particularly on plants within 2 m of the trees. In Thar desert trials, windbreaks perpendicular to the prevailing winds at a height of 4m, yields near the trees (0-

3m) were low (1,000 kg/ha) compared to those further away from the trees (2,000 at 35-40m; 1,450 at 55-60 m) the farmer obtained a net increase of one quintal/ha. Average wheat yields decreased with increasing tree size.

The author notes an unidentified variety in NWFP near Peshawar with drooping branches but a clean straight bole and good heartwood, making it prized for furniture.

298
Sheikh, M. I.

Biomass production from Sisham plantation at different spacings.

For. Res. Serv. Tech Note 62:1. 1988

English

Abstract: Not available

299
Sheikh, M. I.

Past and present research in four multipurpose tree species

Pakistan Journal of Forestry 1988. 38 (2): 89-102

English

Dalbergia sissoo (indigenous species), *Azadirachta indica* and *Eucalyptus camaldulensis* (exotics), are reviewed. Topics covered include distribution of the species, nursery and field planting techniques, provenance and species trials, growth and management of the plantations and water requirements. Brief accounts are also given of the development of block plantations of *Acacia nilotica* (or Hurries) by farmers in Sind and the effects of shelterbelts and farmland shade trees of *Acacia nilotica* and *Dalbergia sissoo* on crop yield. Scattered trees of both species have been shown to have a deleterious effect on wheat yield.

300
Sheikh. M.I.

***Dalbergia sissoo*, Roxb.: Its production, Management and Utilization in Pakistan**

Food and Agricultural Organization of the United Nations, Bangkok. August, 1989

English

The monograph reviews the literature and experience of *Dalbergia sissoo* in Pakistan. The sub-Himalayan distribution Assam to Afghanistan is extended to Iraq with an occurrence in Gujaral; its wide spread use as an exotic is reported. The natural ecological occurrence is given as largely gregarious stands on river side alluvials. Growth habit and morphology are discussed.

Silvicultural experience is mostly directed to plantation management with detailed accounts of: seed collection and nursery practices; establishment, and maintenance of plantations including highway, canal side, denuded hill slope and farmland plantings. The effect of scattered trees and shelter belts on crop yields is discussed: water requirements for optimum growth are considered. Numerous pathogens are listed; phanerogams are *Loranthus spp.* and *Cuscuta reflexa*; common fungal plant infections are wilt, *Fusarium solani*; root and butt rot *Ganoderma lucidum* and *Polyoporus gilvus*, a number of leaf spots and rusts are listed; felled wood fungi as *Irpex favus* and *Polystictus proteus* are noted. The widespread *Plecoptera reflexa* is seen as a serious defoliator and control with anti-moultant insecticides is recommended; a range of leaf miners and rollers occur. *Perissus dalbergiae* and *Agrilus dalbergiae* - bark and wood borers - attack weakened trees and powder post beetles are reported problems in sapwood and controls are described; termites damage sapwood and young plants and control is given for planting time protection. Nursery pests as crickets are noted and of cattle, wild boar, hare, porcupine, rat and squirrel in plantations. Wind can cause damage to standards; other edaphic problems are discussed. Plantation growth and yield data are included with yield and volume tables; fuelwood yield and site index curves and values and biomass production from a limited sample is given.

The status of *D. sissoo* genetics and tree breeding are reviewed: heritable variability is accepted in: site adaptability, yield, wood quality and stem form. Prime targets selected for improvement are growth rate and stem form. Phenotype selection

criteria are listed: results of provenance and form trials are provided. Vegetative reproduction (stem cuttings) trials indicate that tree age, type of cutting, season and use of rooting hormones are important; tissue culture research is quoted; seed orchard development is considered.

D. sissoo wood and wood structure is described and physical and mechanical properties given; variability is noted in wood quality from different sources; an extracted wood oil is suitable for heavy machinery lubrication. *D. sissoo* seasons well without difficulty, air or kiln dried. Its heartwood is durable and does not require treatment; sapwood is non-durable and impregnates satisfactorily with pressure preservation treatments of copper-based chemicals, creosote, pentachlorphenol. It has good working qualities and converts easily to sawn timber; it peels and slices readily after steaming. The wood is easy to paint, glue and polish. It has a wide range of uses: in sophisticated areas as inlay, cabinet making, musical instruments, fine furniture, toys, veneer panels, laminate and component constructions, carriage bodies and sleepers. In rural settings, it finds use in agricultural implements carts, handles, troughs, oil crushers, etc. It is an excellent fuelwood and is eminently suitable for charcoal manufacture. The leaves are a good fodder, a comparison of green and silaged values is given; some medicinal uses are quoted.

301
Sheikh, M. I.

Sissoo: The versatile Rosewood

Nitrogen Fixing Tree Association, Waimanalo, U.S.A. NFTA 89-70, Dec. 1989

English

Dalbergia sissoo is best known as a premier timber species of the rosewood genus; it is also an important fuelwood, shade, shelter and fodder tree. The publication summarises its: botany, ecology, and deals with its use as timber, fuelwood and fodder. A biomass production of main stem, branches and leaves and roots of 510, 231 and 244 tones/ha. for a 10 year old irrigated plantation is quoted. Details of seed treatment, plantation establishment and management silviculture are given; provenances are noted, and major pests and diseases indicated. Other uses refer to its amenity, medicinal and erosion control capabilities.

302
Sheikh, M. I., Aleem, A. and Hafeez, M.

Plastic aprons as mulch.

Pakistan Journal of Forestry 1975. 25 (2): 108-119

English

Reports trials with stump plants of *Dalbergia sissoo* at Peshawar and with young plants of *Eucalyptus camaldulensis* at Jallo, Lahore, to determine the effects of plastic sheets ('aprons') of different colors and thicknesses held in place round the plants with pebbles. Data on the durability of the plastic sheets and the height growth and survival of the plants are tabulated. The 'aprons' had no significant effect on survival, but, when durable plastics were used, mean heights of treated plants were significantly greater than those of controls. Clear and perforated plastic sheets were the poorest for this purpose.

303
Sheikh, M. I. and Aleem, A.

Effect of improvement practices on *Dalbergia sissoo* (shisham) planted in Islamabad.

Pakistan Journal of Forestry 1983. 33 (3): 115-121

English

An investigation of the causes of yellowing and death in landscape trees planted around Islamabad. Plantations 6 and 16 yr old respectively 11 and 18 km along the Islamabad-Lahore highway were treated from May 1974 by irrigating with water (in May and June), spraying with 0.5% dieldrin (in June, July and Aug. - as a control against the bark borer *Agrilus dalbergiae* which attacks unhealthy trees) and fertilizing with N and/or P. Data on mortality and growth collected in 1977 and 1978 indicated that fertilizing improved the growth and resistance to disease of 16-yr-old trees, but that

no treatment improved the growth or health of the younger trees.

304
Sheikh, M. I. and Chim, A. M.

Effect of tree rows on wheat crop.

Pakistan Journal of Forestry 1976. 26 (4): 265-267

English

Grain yields were measured along transects perpendicular to tree rows (*Dalbergia sissoo* and *Morus alba*, ht. 5-18 m) in 3 fields near Lahore. No depression of yield was found in the quadrats closest to the tree rows (2.5 m).

305
Sheikh, M. I., Hussain, R. W. and Khan, M.

Comparison of growth of four tree species grown under agro-forestry systems.

Pakistan Journal of Forestry 1985. 35 (1): 13-14

English

Plants of *Populus deltoides* I-63/51 and *Eucalyptus citriodora*, and cuttings of *Dalbergia sissoo* and *Salmalia malabarica [Bombax malabaricum]* were planted at 4x4 m spacing in plots in Peshawar in Feb. 1978. Sesamum indicum, maize and wheat were planted between tree rows. Ht. and diam. were recorded in Dec. 1983. P. deltoides produced the best growth (av. ht. 21.1 m, av. dbh 16.6 cm), followed by *B. malabaricum* (av. ht. 19.8 m, av. dbh 9.2 cm).

306
Sheikh, M. I., Hussain, R. W. and Khan, S.

Wood consumption survey of housing sector in Peshawar Division.

Pakistan Journal of Forestry 1987. 37 (1): 31-36

English

The 2 main categories of housing in Pakistan are defined as pucca (brick or stone houses in the plains or those with a galvanized pitched roof in the hills) or kutcha (all other types of house). In a pucca house, wood is used for doors, windows, ventilators and cupboards; in a kutcha house it is also used for roofing. Data are reproduced from the 1980 Housing Census Report on house construction rates (which increased by 1.5% in rural areas and 3.2% in urban areas in 1973-80), total numbers of houses (377,000), numbers of rooms per housing unit and persons per room, and housing distribution by tenure status (owned, rented or rent-free). Some 162 households were interviewed for this survey. Av. family size was 7-10 and mean monthly income Rs2610 (rural areas) or Rs3390 (urban ureas). Mean wood consumption for house construction per household was 6.11 m^3 and 1.811 m^3 respectively in rural and urban areas, giving per capita consumptions of 0.611 and 0.257 m^3. Based on these data, current annual wood consumption is about 1.677 million m^3 and projections for 1990, 1995 and 2000 are, respectively 1.8, 1.966 and 2.147 million m^3.

307
Sheikh, M. I., Hussain, R. W. and Khan, S.

Tobacco curing in N.W.F.P.

Pakistan Journal of Forestry 1987. 37 (4): 213-215

English

In 1984-85, the total area under tobacco crop in Pakistan was 50200 ha and production was 89.2 million kg; in North West Frontier Province (NWFP) the total area was 29067 ha and production was 58.16 million kg. Four methods are used for tobacco curing, viz. air, sun, flue and fire drying. The tobacco crop grown in NWFP is cured by flue or fire drying methods. The estimated number of kilns (Bhatties) in NWFP is 15000. Data on fuelwood consumption were collected in July and Aug. 1986 from 58 curing units throughout the province, selected by quota non-probability sampling. Av. loading capacity of green tobacco per unit was 1500-2500 kg. Av. consumption of fuelwood per sample unit was 1.26 m^3 per load and each load required 6 to 7 days to cure. Av. price of fuelwood was Rs20, 28 and 35 per 40 kg, respectively, for Malakand,

Hazara and Peshawar Civil Divisions. The species used as fuelwood for curing included *Dalbergia sissoo, Acacia nilotica, A. modesta, Pinus roxburghii, Quercus incana, Morus alba* and *Alnus nitida*; the first 3 of these were preferred.

308
Sheikh, M. I., Hussain, R. W. and Khan, S.

Fuel consumption for brick industry in N.W.F.P.

Pakistan Journal of Forestry 1988. 38 (3): 183-185

English

During the year 1985/86 the total number of brick kilns in North West Frontier Province, Pakistan, was estimated as 458 (complete lists were not available). Total production of baked bricks in the same year was 149 million with an estimated fuelwood and coal consumption of 74654 m^3 and 17000 t, respectively. Data were collected from 60 units sampled by the quota non-probability method throughout the province. An average kiln was loaded 5 times during 1985/86. Mean annual capacity and actual production were 377 and 327 thousand bricks per kiln, respectively. Average annual requirement and actual consumption of fuelwood per sampled unit was 167 m^3 and 163 m^3 respectively, while the corresponding figure for coal was 417 and 373 t. Average wholesale price of fuelwood was Rs28, 40, 29 and 17 per 40 kg for Hazara, Peshawar, Kohat and D.I. Khan Civil Division respectively. The wholesale price for anthracite coal was Rs1400, 1600, 650 and 256 per t for Hazara, Peshawar, Kohat and D.I. Khan Civil Division, respectively; the price in the last 2 cases is rather low as coal is available from the nearby coal mines. The major wood species used in the brick kilns were *Pinus roxburghii, Dalbergia sissoo, Acacia nilotica, Prosopis cineraria, Ziziphus mauritiana, Tamarix aphylla* and *Quercus incana*.

309
Sheikh, M. I., Khaliq, A. and Noor, M.

Effect of tree windbreaks on the yield of wheat in the Thar Desert under irrigated conditions.

Pakistan Journal of Forestry 1984. 34 (3): 137-144

English

A report of studies at 3 farms, 2 with windbreaks of shisham [*Dalbergia sissoo*], 25 and 3 yr old (respectively about 20 and 2 m tall), and 1 with windbreaks of *Populus* 'I-214' (20 m tall) and of *D. sissoo*. Wheat was grown under irrigated conditions; grain yield was sampled in 1-m^2 plots along transect lines on the leeward side in 1984. There was a net gain in yield in the zone up to 65 m from the windbreaks, but a loss in the areas nearest (0-10 m from) the windbreaks. This loss could be minimized by improved cultural practices and weed control. The economic gain from sale of windbreak wood more than compensated for the grain loss near the windbreaks.

310
Sheikh, M. I. and Raza-ul-Haq

Effect of shade of *Acacia arabica* (kikar/babul) and *Dalbergia sissoo* (shisham) on the yield of wheat.

Pakistan Journal of Forestry 1978. 28 (4): 183-185

English

The yields of wheat cv. Chenab 70 at distances of 2, 4, 6 or 9 m from the centre of the trunk of isolated trees of (a) *A. arabica* and (b) *D. sissoo* were measured in 8 compass directions. Grain yield decreased with decreasing distance from the tree from 492 g/0.01 m^2 at 9 m to 418, 387 and 332 g at 6, 4 and 2 m, resp., with (a); corresponding values with (b) were 719, 661, 512 and 475 g. With (a), yields were in the order: W., SW, SE > E., S. > NE, N., NW; with (b) the order was: S., SE, SW > W., E. > NE, N., NW.

311
Sheikh, M. I. and Raza-ul-Haq

Performance of poplars and other species in conjunction with agricultural crops.

Pakistan Journal of Forestry 1982. 32 (2): 72

English

One hundred and twenty plants each of *Populus deltoides* I-63/51 (1 yr old), *Eucalyptus citriodora* (tubed plants), *Dalbergia sissoo* and *Salmalia malabarica* [Bombax malabaricum] (root [or] shoot cuttings) were planted at Peshawar in Feb. 1978. A variety of agricultural crops, including til (*Sesamum indicum*), maize and wheat, were planted one after the other between the rows. Ht. and diam. growth, recorded in Feb. 1982 showed wide variations. Best growth was by poplar (av. ht. 15.2 m, dbh 18.3 cm). Least gains were in height by *B. malabaricum* (but dbh growth was good) and in dbh by *E. citriodora* (but ht. growth was good).

312
Sheikh, M. I. and Raza-ul-haq

Effect of spacing on the growth of *Dalbergia sissoo* (shisham).

Pakistan Journal of Forestry 1982. 32 (2): 73-74

English

Root and shoot cuttings (268) were planted at 2x2, 3x3 and 4x4 m spacings at the Forest Institute in Jan. 1978. Plants were irrigated fortnightly except in the winter. Data are tabulated showing ht. and diam., length of clear bole, and numbers, thickness and av. length of branches at 4 yr old. Spacing made no significant difference to ht. and diam. growth, but closer spacings increased the length of clear bole, while reducing numbers, thickness and length of branches.

313
Shrestha. B.P.

Forest Plants of Nepal

Educational Enterprise Pvt. Ltd. Kathmandu. Nepal 1989

English

The development of forest administration and the evolution of the current Forestry Department is described. Nepal's geomorphology, general climate and ecology are outlined. The natural vegetation is detailed in latitudinal regions and its altitudinal distribution within these; forest types are covered in tropical, subtropical, temperate and alpine array. *Dalbergia sissoo* is associated with stream sites of the tropical and subtropical forests.

314
Shukla, K. S. and Gupta, S. B.

Finishing qualities of some Indian woods.

The Indian Forester Feb. 1983. No 2: 80-87

English

Finishing is a protection against wear, abrasion, swelling, warping and raising of grain and protection against decaying agencies. The paper investigates the finishing qualities of 49 Indian tree species after giving five different surface treatments. *Dalbergia sissoo* developed High Gloss of ASTM specification D 523-51 in all five treatments.

315
Shukla, N. K., Rajput, S. S. and Sharma, R. R.

Some studies on the effect of rate of loading on the strength of wood.

Van Vigyan 1982. 20 (1/2): 19-25

English

From authors' summary: The results of bending and compression tests with 5 species (sissoo [*Dalbergia sissoo*], sal, toon [*Toona ciliata*], mango and chir) under 5 different loading rates suggest loading rate has a significant effect on strength measured. For comparable results tests should, therefore, be done at a fixed standard rate. Suitable formulae are provided for standardizing results if tests have to be carried out at different loading rates.

316
Siddiqui, K. M.

Seedling seed orchard of Shisham.

Pakistan Journal of Forestry 1975. 25 (2): 97-99

English

Describes the seed orchard of *Dalbergia sissoo* established in Feb. 1975 by the Pakistan Forest Institute, Peshawar, established with two-year-old seedlings of 40 families derived from open-pollinated parents selected for straightness of stem and superior height growth.

317
Siddiqui, K. M. and Akhtar, P.

Microspore, megaspore and embryo-sac development in Shisham (*Dalbergia sissoo* Roxb.).

Pakistan Journal of Forestry 1974. 24 (1): 19-28

English

From the authors abstract: The paper deals with the development of microspore megaspore and embryo-sac in *D. sissoo*. The archesporial development is hypodermal in this papilionaceous plant. The megaspore mother cell undergoes meiotic divisions to form a tetrad of megaspores, which are arranged in tetrahederal fashion. Out of four magaspores, only one functions while the other three degenerate.

318
Siddiqui, K. M. and Iqbal Mahmood

A note on physical and mechanical properties of *Eucalyptus tereticornis, E. sidrophylia [E. siderophloia]* and *E. kitsoniana*.

Pakistan Journal of Forestry 1986. 36 (3): 133-139

English

Air-dry samples from trees grown in Peshawar were tested and their density, MOE, MOR, compression strength, tensile strength perpendicular to the grain, cleavage, hardness, impact bending and shear strength were compared with published data for *E. camaldulensis, Morus alba, Dalbergia sissoo*, and *Acacia arabica*, grown in India or Pakistan. It was concluded that overall Eucalyptus wood gave better results than the other hardwoods.

319
Singh, A. and Dayal, R.

Preliminary studies on the role of trenches in isolating root effect of forest trees bordering agricultural crops.

Annals of Arid Zone 1975. 15 (3): 241-244

English

Reports studies at Vasad, [Rajasthan?], India, in which trenches were dug between a 15-year-old plantation of *Dalbergia sissoo* and a cotton crop and between a 15-year-old plantation of *Acacia nilotica* and a tobacco crop, so as to sever the lateral roots of the trees and to reduce the adverse effect of the trees on the adjacent crops. The treatment reduced the rate of moisture extraction from the soil under the agricultural crop. Yields of the cotton and tobacco on the treated plots were increased by 21 and 68%, respectively.

320
Singh, A. K. and Misra, K. N.

Climatic water balance of a tropical deciduous forest of India.

Journal of the Japanese Forestry Society 1980. 62 (5): 195-199

English

A study in the Chandraprabha Sanctuary in the Vindhyan Hills, an area of grass, savanna, plantations of bamboo, teak and shisham (*Dalbergia sissoo*) and near natural mixed broadleaved species (*Acacia catechu, Anogeissus latifolia, Buchanania lanzan, Diospyros tomentosa, Lagerstroemia indica* and *Terminalia tomentosa*). Potential evapotranspiration increased with increases in temp. and vice versa, but actual evapotranspiration was governed by the amount of water available for plant growth, being higher during the rainy season.

321
Singh, B., Mathur, H. N. and Joshie, P.

Effect of tree shade on grassland production in the moist subtropical region of northern India.

Indian Journal of Forestry 1980. 3 (4): 345-348

English

A study of a 9-yr-old fuel/fodder plantation established on shallow soil planted with *Dalbergia sissoo* and *Acacia catechu* at 4 spacings (4.57x4.57, 9.15x9.15, 13.72x13.72 and 18.29x18.29 m) and with *Chrysopogon fulvus* grass at 60x60 cm spacing. Forage yield was significantly higher in the open than under the partial shade of tree crown edges or full shade of tree crowns: av. values for yield and clump diam. of grass, as a % of those in the open, were respectively 87% and 38% in partial shade, and 59% and 29% in full shade. Forage yield was n.s.d. between tree species at 4.57x4.57 m spacing, but at wider spacings av. values of yield and clump size were respectively 32% and 22% higher for *D. sissoo* than *A. catechu*. Use of *D. sissoo* at a spacing of not less than 9x9 m is recommended. The establishment of fuel/fodder plantations is a recommended practice for use on the 13% 'cultural wastelands' of India.

322
Singh, K., Yadav, S. P. K. and Sharma, S. K.

Performance of shisham (*Dalbergia sissoo*) in salt affected soils

Indian Forester 115 (2): 154-162 Feb. 1990

English

Authors summary: Performance of sisham (*Dalbergia sissoo*) was studied in salt affected soils of Vrijbhumi Forest Division (U.P.) to evaluate its tolerance limit to varying salinity and sodicity conditions. Sisham of site quality class III to IV was found to occur in normal loamy soils (Fluventic and Aquic Ustochepts), whereas poor growth of quality class V was found in moderately saline soils (Loamy Typic Camborthids and Aeric Halaquepts) having values of ECe below 18.5 dS m^{-1} and ph below 8.8 in the root zone and quality class VI in sodic soils (Loamy Natric Palerothids) having ECP above 30 and pH above 9.0. Higher concentrations of neutral salts in the upper 12 or 17 cm soil did not adversely affect the growth of plants.

323
Singh, P., Jamaluddin and Purohit, M.

Studies on growth and development of some forest tree species in red mud soil Balco Korba.

Indian Forester 1988. 114 (5): 285-288

English

Experiments are reported on the germination and seedling growth of 11 species in waste red mud soil deposited by the Balco aluminium ore processing company at Korba, Madhya Pradesh. Data are reported on the chemical composition of the waste soil. Germination studies were carried out with 5 species (*Butea monosperma, Albizia lebbeck [A. lebbek], Pithecellobium dulce, Dendrocalamus strictus* and *Acacia catechu*) in buckets of Balco soil alone, Balco soil + soil mix or garden soil, and soil mix alone. Germination percentage was reduced in all species on Balco soil alone (compared with soil mix alone) and was zero in *D. strictus, Acacia catechu* and *Albizia lebbek*; it was reduced in most cases on the Balco soil mixed media. Seedlings of 3 other species (*Acacia auriculiformis, Pongamia pinnata* and a *Eucalyptus* sp.) were transplanted from media of pH 6-7 to polybags containing Balco soil (pH 13), and Balco soil + soil mix (pH 7.6) or 10% H2SO4 (pH 7.3) or both (pH 6.9), and soil mix alone. After 4 months there was 100% mortality in the Balco soil treatment but 100% survival in all the other treatments except for *A. auriculiformis* in the acid treatments, where survival was only 20-40%. Best growth and survival (compared with the soil mix treatment) was in Balco soil with soil mix. Seedlings of 7 species (*Albizia lebbek, Dalbergia sissoo, P. pinnata, Cassia siamea, Acacia auriculiformis, A. catechu* and *A. nilotica*) were transplanted to 2x2 ft pits in the mine waste area; the soil in the pits was replaced and cow dung added. After 4 months, survival was quite satisfactor 65-100%) for all species except *Acacia catechu* (42%); ht. data are also given.

324
Singh R.V.

Fodder Trees of India

Oxford & IBH Publishing Co., New Delhi 1982

English

The range, habitat, life history and tree dimensions of *Dalbergia sissoo* are discussed together with it's silvicultural characteristics. The species is noted as a good coppicer but susceptible to severe droughts and frosts. The natural regeneration potentials are stated and management requirements; artificial propagation of stands by direct sowing or plants/ stumps/root suckers is covered in detail. Seed collection and storage data are given. Vegetative propagation by air layers and cuttings is included and the use of rooting hormones is favored. The nursery and plantation establishment techniques are described in practical detail; poor genotype plants are discarded. A large number of pathogens are recorded; termites are a problem in dry areas; numerous leaf defoliators, miners, rollers and sap suckers and wood borers are cited; fungi (as wilt *Fusarium solani*, root rot *Ganoderma lucidum*, *Polyporus gilvus* and rusts, leaf spots and powdery mildew) and other hostile plant parasites as *Loranthus* and *Cuscuta* are noted.

D. sissoo leaf is regarded as highly nutritious and overall is classed as medium to good fodder. The leaves become less palatable and the % of crude protein and Phosphorus decreases with maturity while crude fibre and Calcium % increases. The chemical composition and average figures of contents are given though it is noted that there are wide variation eg of crude protein, 2.7-24.1%. It is recommended that leaves be used from the April-May period; green leaf feed may cause digestive disorder; silage treatment removes this problem; silage after acculturation is relished by cattle; dry weight and cell wall digestibility of 51 and 44 % are reported. The chemical composition of pods is given and these are referred to as used as emergency feed in times of fodder scarcity months. The pods contain about 2% tannins.

325
Singh, S. M.

The painting of wood.

Paintindia 1973. 23 (Feb.): 16-21

English

A detailed version of work on durability trials on painted woods in India, covering a total of 16 native species of contrasting textures. The only species judged to have good paint-holding properties were *Dalbergia sissoo* and *Tectona grandis*. Aluminium primer was generally less satisfactory than other primers except on *Pinus* spp.

326
Singh, Sadar

Some Important Honey Plants of The Punjab (India)

Report of the State Apiarist for 1948. Iowa pp 34-43

English

The author notes a thorough knowledge of honeyplants and their time of flowering is a pre-requisite to successful bee culture; often the significance of major sources is not well brought out. Shisham (*Dalbergia sissoo*) is a major source; it flowers in the last week of March in the plains and early in April in the hills and continues to the end of April. Bees are active in large numbers as attested by their loud hum. The blossoms are lightly attached to the branch and blossoms fall even in mild wind blows and bees are not able to take advantage of even a fraction of the bounteous number produced by trees. *D. sissoo* produces dark amber honey which is strong in flavor.

327
Singh, S. P.

Fuelwood as energy source.

Indian Forester 1981. 107 (12): 785-794

English

Increased use of smallwood for pulp and board manufacture has caused a major fall in the volume of fuelwood available from commercial plantations in India, and made the need to establish fast-growing fuelwood plantations all the more urgent. Max. yields obtainable from 26 species under various growth conditions are given. A rating index based on wood density, calorific value, and diam. and age at harvest (taken as the rotation for max. vol. production) is developed for assessing the most promising fuelwood species, and values are tabulated for 22 species. The species with highest rating were *Eucalyptus* spp., *Dalbergia sissoo, Acacia nilotica* and sal, all of which are widely used for this purpose.

328
Singh, S. P. and Gupta, B. K.

Suitability of four hardwoods for particle boards.

Journal of the Timber Development Association of India 1982. 28 (1): 31-37

English

Physical and mechanical properties were measured of boards made from *Dalbergia sissoo, Artocarpus chaplasha, Chloroxylon swietenia* and *Eucalyptus ['Mysore']* hybrid bonded with 8 and 12% UF (60% solid content) or PF (45% solid content) resins. Boards made with PF resins were superior, and strength properties increased and water absorption and swelling decreased with increase in resin %. All species except E. 'Mysore hybrid' produced PF-bonded boards that meet the requirements of Indian Standard IS:3087-1965 for medium density particleboards; *A. chaplasha* boards had the best overall quality.

329
Sitaramaiah, K. and Singh, R. S.

Effect of organic amendment on phenolic content of soil and plant and response of *Meloidogyne javanica* and its host to related compounds.

Plant and Soil 1978. 50 (3): 671-679

English

Amendment of soil with margosa oilcake (*Azadirachta indica*) and mixed wood sawdust (*Shorea robusta* and *Dalbergia sissoo*) increased phenolic contents of the soil and consequently increased resistance of tomato plants to attack by nematodes and reduced egg-laying capacity and larval motility in *M. javanica*.

330
Soni, P. L.

The chemistry of extractives of *Dalbergia sissoo*. Part I. The occurrence of 3,5-dihydroxy-trans-stilbene in the heartwood. Part II. The occurrence of 5:7-dihydroxy-4'-methoxy isoflavone.

Journal of the Indian Academy of Wood Science 1975. 6 (2): 57-58; 59-60

English

Abstract: Not available

331
Soni, P. and Vasistha, H. B.

Reclamation of mine spoils for environmental amelioration.

Indian Forester 1986. 112 (7): 621-632

English

A report of trials in 1982-86 of *Dalbergia sissoo, Acacia catechu* and other indigenous species of economic importance to the local people, as well as a selection of ornamental trees and shrubs, on an area affected by open-cast mining in Uttar Pradesh. A list of species suitable for reclamation is tabulated according to their uses. An economic analysis showed that costs were Rs 1.60/m^2 of overburden reclaimed (Rs 66000/ha), equivalent to Rs 1.66/t of rock phosphate ore produced (worth Rs 600/t). Recommendations are given for methods of depositing overburden.

332
Srivastava, P. J. and Misra, C. M.

Behavioural study on water uptake by different forest species.

Indian Journal of Forestry 1987. 10 (2): 107-110

English

Locally made 'evapotranspirometers' (lysimeters) made from 44-gal drums were set up at Kanpur, Uttar Pradesh, and planted with 4 seedlings each of 6 species. Two lysimeters were set up for each species, and for a control with no vegetation. Monthly records were made of plant vol. (calculated from diam. and ht.), and daily records of water uptake (calculated from rainfall and manual addition). The study ran from March 1982 to Feb. 1983. Plant dry wt. was recorded at the end of the experiment. The trend was for fast-growing species such as Eucalyptus hybrid [*E. tereticornis*] to consume the most water, while slow-growing species (*Pongamia pinnata*) consumed the least. In practice, orders based on dry wt. were not quite the same as those based on water consumption which decreased in the order: *E. tereticornis; Dalbergia sissoo; Acacia auriculiformis; Syzigium [Syzygium] cumini; A. lebbeck [A. lebbek]; P. pinnata.*

333
Srivastava, S. C., Ali, S. M. and Pandey, P. N.

Survival of lepidopterans against methanol and acetone extracts of the *Dalbergia*-root.

Zeitschrift fur Angewandte Zoologie 1979. 66 (1): 5-8

English

The roots of *Dalbergia sissoo* have long been known to possess insecticidal properties. Further tests are described, the results of which showed that the fraction soluble in methanol is an efficient insecticide against larvae of *Diacrisia obliqua (Wlk.), Spodoptera litura (F.) (Prodenia litura)* and *Argina cribraria* (Cl.). The fraction soluble in acetone previously reported to be toxic to these insects appeared to be harmless to them.

334
Stainton, J. D. A.

Forests of Nepal

The Camelot Press Ltd. Southampton, 1972

English

In the treatment Stainton describes a "Tropical Deciduous Riverrain Forest" found throughout the Gangetic Plain, mostly in the sub-Himalayan tracts of the United Provinces and Bihar; in Nepal it is found frequently along streams of the bhabar and dun valleys, in which khair and sissoo (*Acacia catechu-Dalbergia sissoo*) forests are a distinct band at the water's edge and on gravel islands in the middle of the watercourses. After five almost rainless months, these riverain forests rather surprisingly burst into flower at the beginning of the hot weather.

335
Stebbing, E. P.

Indian Forest Insects of Importance

Eyre, Spottiswood Ltd. London 1914

English

The author presents a study of the insect fauna of Indian forests from the economic standpoint and is based on injurious, and, as well, beneficial predaceous and parasitic species. Insects related to the life of *Dalbergia sissoo* include:

Flower feeding	Chrysomelidae	*Gyandrophthalma sp.?*
Leaf defoliator	Chrysomelidae	*Chrysomela sp?*
	Curculionidae	*Apoderus sissus Marshall*
		Myllocerus pustulatus Faust
	Malacodermidae	*Anthocomus sp?*; leaf defoliator or predator?
	Scarabaeidae	*Adoretus caliginosus Burm.*
Cambium feeding	Buprestideae	*Acmaeodera kerremansi Steb.*
Bast feeding		
birmanicum Kerremans		*Agrilus*

		Anthaxia marshalli Steb.
	Curculionidae	*Cryptorhynchus sp.?*
Wood tunneling	Bostrichidae	*Sinoxylon crassum S. anale*
Root feeding	Elateridae	*Larva feeding*
Dead/decaying wood feeding	Tenebrionidae	*Gonocephalum depressum Fabr.*
Predator	Colydiidae	*Bothrideres andrewsii Grouv.*
	Malacodermidae	*Anthocomus sp.? predator*

336
Storrs, A. and Storrs, J.

Discovering Trees

Sahayogi Press, Kathmandu, Nepal. 1984

English

The book describes common trees in the landscape of Nepal and this includes *Dalbergia sissoo*. The tree has a distribution across the sub-Himalayan valleys from the Terai to about 1500m. It is a fairly large, deciduous tree with a light crown and it often has a crooked trunk. In good conditions it may reach 30m. It flowers March-May and pods ripen December-January. Parrots often destroy the unripe pods. *D. sissoo* is one of the most important timber trees in Asia and a range of end uses is given. The authors note "unfortunately the wood makes a good fuel". The leaves and twigs are lopped for fodder, and they, as well as the roots, are used in the preparation of various medicines. *D. sissoo* is planted in tea plantations to provide shade for the young tea bushes.

337
Streets, R.J.

Exotic Forest Trees in the British Commonwealth

Clarendon Press Oxford 1962

English

Dalbergia sissoo is recorded as a species of the Himalayan tract and of the Himalayan valleys to about 3000', typically of riverbeds and alluvial flats and colonising landslips etc where soil is exposed. Ambient temperature ranges from an absolute maximum of 120-125 deg F to an absolute minimum of 25-42 deg F; rainfall varies from 30-120", mostly falling from June to September.

It is a medium to large tree, light crowned, reaching under optimum conditions 100' in height and 8' in girth, usually much smaller. The species is adaptable, a strong light demander, reproduces freely (viable seed set about the fourth year) from seed and suckers and in North India is considered frost hardy. The timber seasons well, is hard, strong and durable; figured heartwood is used for furniture, building carving and wheel work; it is an excellent fuel.

It was widely tested as an exotic in trial plantations in Africa (Ghana, Kenya, Northern Rhodesia, Nyasaland) and in the South Africa, but with limited success. Trials are reported in Palestine and Ceylon.

338
Subramaniam, K.

The Role of Forest Department in Developing Beekeeping in Western Ghat Areas of Maharashata

The Indian Bee Journal, Vol.41 (3 & 4) 1979 pp 91-93

English

Forests have been intimately associated with honey bees; honey is one of the minor forest products; preservation of forests and propagation of nectar and pollen yielding species is a normal activity of Forest Departments in consonance with silvicultural and ecological requirements of the area. The author describes the Forest Types of the Western Ghat and notes a program of establishing large scale plantations of bee plants such as *Dalbergia sissoo*.

339
Suryawanshi, M. V.

***Paraxonchium shamimi* sp.n. (Nematoda, Dorylaimoidea) from Maratliwada, India.**

Acta Parasitologica Polonica 1972. 20 (12/25): 195-198

English

Females of *Paraxonchium shamimi* n.sp. collected around roots of *Arachis hypogaea* and *Dalbergia sissoo* in Maharashtra, India, are described and illustrated. They have a beak-like spear with small aperture as reported for *P. rhamphionum*, but differ from this species in having a shorter body (0.66 to 0.74 mm), a narrower head which is not offset by a constriction and in the absence of cuticularized pieces in the vaginal wall.

340
Suwal, B., Karki, A. and Rajbhandary, S. B.

The in vitro proliferation of forest trees. 1. *Dalbergia sissoo* Roxb. ex Dc.

Silvae Genetica 1988. 37 (1): 26-28

English

Multiple shoots were induced on cotyledonary node cultures of *D. sissoo* in the presence of 1 mg/liter benzylaminopurine and 0.1 mg/litre NAA. On a medium containing 0.25 mg/litre benzylami-nopurine, these shoots multiplied at a rate of 10-15 shoots per explant after 4 wk culture. The shoots were subcultured for 2 yr at intervals of 8 wk with no loss of multiplication potential. On transfer to non-sterile sand beds 85% developed into rooted plantlets within 10 days, and were subsequently successfully established in the field.

341
Swaminath, M. H.

Studies on the response of fast growing forestry species for biomass production under irrigation.

Myforest 1988. 24 (2): 117-123 + 2 pl.

English

A study was made of 13 species (*Albizzia falcatoria [Albizia falcataria], Cassia siamea, Prosopis juliflora, Dalbergia sissoo, Acacia auriculiformis, Eucalyptus hybrid [E. tereticornis], Leucaena leucocephala, Casuarina equisetifolia, Albizia richardiana, Acacia nilotica, E. camaldulensis, Acacia mangium* and *Calliandra calothrysis [C. calothyrsus]*) chosen for high biomass production and value for industrial wood and fuelwood. One-yr-old seedlings raised in polybags were planted in a ploughed and harrowed area at the Mudigere Research Station, near Bangalore, Karnataka, an area of sandy loam soil (pH 7.5-7.7) with an annual rainfall of 800-1000 mm. Before planting FYM was applied to each plot. Seedlings of uniform ht. were planted in 0.6X0.6 X0.6-m pits at 2X2 m spacing in the last week of Oct. (near the end of the monsoon). Control and irrigated plots were watered for 3 months and thereafter only irrigated plots were watered. Biomass estimates (dry wt./plant) were made 15 months (in Jan. 1987) after planting and after 21 and 31 months; av. biomass was obtained by excluding border plants from the calculations. Biomass production was increased by irrigation for all species. Max. production under irrigated conditions was by *Cassia siamea* (55.55 t/ha p.a.) followed by *E. camaldulensis* (40.13) and *E. tereticornis* (33.84); *Albizia falcataria, Casuarina equisetifolia, Leucaena leucocephala, Acacia auriculiformis* and *Calliandra calothrysus* produced 20-30 t/ha p.a. The other species tested produced 5-20 t/ha p.a. In the unirrigated plots max. biomass production was by *Acacia auriculiformis* (21.48 t/ha p.a.) followed by *Cassia siamea* (18.72) and *Casuarina equisetifolia* (17.95). Max. response to irrigation was by *Albizia falcataria* (600%) and least by *Acacia auriculiformis* (around 20%).

342
Swaminath, M. H. and Vadiraj, B. A.

Nursery studies on the influence of *Azospirillum* bio-fertilizer on the growth and dry matter of forestry species.

Myforest 1988. 24 (4): 289-294

English

Seeds of 8 species (*Leucaena leucocephala, Dalbergia sissoo, Acacia nilotica, Calliandra calothyrsus, Casuarina equisetifolia, Pongamia pinnata, Albizzia lebbeck [Albizia lebbek]* and *Eucalyptus hybrid [E. tereticornis])* were treated with a culture of *Azospirillum* (a nitrogen-fixing bacterium) before sowing in polybags; untreated seeds were also sown. Bags were watered daily and shoot and root length and seedlings compared with the controls, but amounts varied. The percentage increase in root length ranged from 34.2 to 2.4, and was highest for *Dalbergia sissoo* and lowest for *Acacia nilotica*; among the other species *Albizia lebbek, Casuarina equisetifolia* and *Leucaena leucocephala* showed more than 25% growth increase over the control; other species showed an increase of 10%. Similarly the % increase in shoot growth ranged from 62.93 to 0.77, and was greatest in *Dalbergia sissoo* and least in *Pongamia pinnata*; among the other species only *Albizia lebbek* showed an increase of 15%. The % increase in root dry weight ranged from 143.59 to 5.37, and was highest for *Dalbergia sissoo* and lowest for *Acacia nilotica*; among the other species *Casuarina equisetifolia* gave an increase of 100%, *Calliandra calothyrsus, Leucaena leucocephala* and *Eucalyptus* hybrid 30% and *Albizia lebbek, Pongamia pinnata,* and *Acacia nilotica* 12%. The % increase in shoot growth ranged from 288.46 to 3.52 and was highest for *Dalbergia sissoo* and lowest for *Calliandra calothyrsus*; except for *Acacia nilotica* and *Calliandra calothyrsus* all the other species showed 25% increased dry weight over the control.

343
Tahir, M. A. and Ali, M. A.

Effect of 100 years' cultivation and tree plantation on a model soil of the Punjab doabs.

Pakistan Journal of Forestry 1974. 24 (3): 200-208

English

Describes the profiles and tabulates data from physical and chemical analyses of soil samples from three sites of the Bhalwal soil series under, respectively, natural vegetation, irrigated agricultural crops, and an irrigated plantation of *Dalbergia sissoo* and *Morus alba*. The data indicated that the tree plantation and agricultural cultivation have caused significant changes in some of the soil characteristics.

344
Thapa, F.

Dieback threatens *Dalbergia sissoo*

Farm Forestry News, Vol. 3 No. 4 1990

English

The author notes *Dalbergia sissoo* is a fast growing multipurpose tree species common in Terai community forestry programs in Nepal. Die back is a serious problem of the past four years; trees die from the tip downwards and the infection continues to death about a year later; 20% of the population (20,000 trees) has died, 50% is seriously affected.

345
Thind, K. S. and Rattan, S. S.

The Thelephoraceae of India - X.

Mycologia 1973. 65 (6): 1250-1258

English

Three new species from the NW Himalayas are described and illustrated: *Peniophora indica* from wood of *Dalbergia sissoo, P. fibuligera* from the wood of *Cedrus deodara* and *Aleurodiscus taxicola* from the cortex of *Taxus baccata.*

346
Trivedi, S. N.

Financial appraisal for some afforestation species in Bihar (India) under the risk of illicit felling.

Forest Ecology and Management 1986. 17 (4): 261-277

English

Major afforestation schemes in the state of Bihar consist of coppicing of degenerated natural forests

(mainly *Shorea robusta*) and/or raising plantations of various species (mainly *Eucalyptus* hybrid [*E. tereticornis*] and *Dalbergia sissoo*) at a spacing of 2X2 m. A detailed financial cost-benefit analysis was made for the 3 species separately and some management options are discussed regarding the choice of rotation for each species under the risk of illicit felling. Three quality classes (I, II and III) were considered separately for all the species. Yield of the plantations was estimated using a regression model for variable stocking density. Net present value per ha was selected as the criterion for appraisal and its value for the three species for the management options considered was calculated for one rotation as well as for an infinite series of rotations. The risk of illicit felling was accounted for by adding a premium to the pure temporal discount rate. For a given species, the best management option would be different for different quality classes. In general, plantations in quality class I are viable, but for quality classes II and III plantations are worth undertaking only if illicit felling is sufficiently under control to justify low discount rates.

347
Trotter, H.

The Common Commercial Timbers of India and their Use

Government of India Press, Delhi 4th reprint 1959

English

The author states that Rosewood and *D. sissoo* rank amongst the finest of India's cabinet and furniture woods, and this is their proper metier. The work provides generalised information of *Dalbergia sissoo* such as: wood description; seasoning; strength; durability; working qualities and uses including: handles for carpentry tools; unsuited as bearings; boat building - knees and frames; brush bases; carts -framework; construction and general joinery, furniture and utility wood, it is strong, elastic, reasonably durable; parquet flooring; furniture and cabinet making and pannelling, excellent for carving; military camp furniture; mathematical instruments; musical instruments, sitars, used as keys; textile shuttles; gun stocks; tobacco pipes; walking sticks and umbrella handles.

348
Troup, R. S.

Indian Forest Utilisation

Superintendent of Government Printing, Calcutta, 2nd Edition 1913

English

A comprehensive review of the knowledge of forest utilisation arranged in sections: the technical properties of wood; industrial uses; felling and conversion of timber; wood depots.

Data related to *Dalbergia sissoo* are: moisture content (70.2 lbs/c.ft. green, 53.5 air dry); classification according to weight (Class 11 very heavy, 50 lbs. and over, less than 60); classification according to hardness (Class 11 very hard); elasticity (Class 11 elastic); Fissibility (class 1V difficult to split); resistance to transverse strain (Class 111 P = 800-900); seasoning (Class 1 woods that season well); durability (Class 11 very durable); heating power (calorific value for completely dry timber 8366 BTU); fungal disease (*Polystrictus egregarius* known to attack *D. sissoo*).

Noted uses are: superstructures, beams, rafters, scantling, door and window frames; house and fence posts (sapwood free). Machinery uses: oil presses, sugar mills, rice pounders; boat and ship building: hulls, oars and helms; joinery and cabinet making - taking a very fine polish; cart and carriage making: wheels, axels, arches, shaft, naves, spokes, felloes; gun carriages. Coopers items: beer barrels, tubs, buckets, casks; carving and turning - *D. sissoo* very much used; tobacco pipes and hookahs; basket and matting - stems and twigs. Regarded as one of the best woods for fuelwood and charcoal.

349
Troup R.S.

The Silviculture of Indian Trees

Clarendon Press Oxford Vol I II III 1921 Revised and reprinted: Vol. IV Leguminoseae Government of India Press 1983

English

This compendium of information states that 47.200 ha of *Dalbergia sissoo* plantations had been established in India up to the period 1968-69. *D. sissoo* has an indigenous distribution from Afghanistan to Assam in Sub-Himalayan valleys and bhabar tracts and is introduced elsewhere by man. Growth habit, morphology, site factors, topography, geology and soil and races are discussed. It notes that trees of different origins (races) are known to differ considerably in growth and form and in timber qualities. Under forest types *D. sissoo* is placed as a classic example of a primary colonist in the Gangetic riverain succession. Its silvicultural characteristics include: coppicing and nitrogen-fixing ability, drought hardiness in natural conditions, frost hardiness, ordinarily wind tolerant, early flowering and fruiting and intolerance of shade, subject to fire damage and to bad soil drainage.

Regeneration of stands under natural and artificial techniques are treated. A silvicultural system of coppice with standards (rotation 22 yrs for coppice and 60-70 for standards) is common. *D. sissoo* seeds abundantly annually and seed collection, nursery practices, plantation establishment and maintenance are dealt with. Plantations may be made by direct sowing or with plants or stumps, with plants raised from weed or vegetatively reproduced from cuttings, root suckers or air layers - though this is not considered satisfactory; careful weeding is stressed. Plantation site amelioration through irrigation is a common practice. Time of planting, spacing and later thinnings are covered. A number of pathogenic injuries from, mistletoe, fungi and insects are noted; *Fusarium* wilt, *Ganoderma* root rot and *Polyporus* die back are prime pathogens; the defoliator *Plecoptera reflexa* is a serious insect problem.

D. sissoo has a rapid growth rate under favourable conditions; attention is drawn to published yield tables and further data are included viz Ht. Dia. comparisons from three sources age to 60 yrs; plantation data, S.Q. I II III dia. ht. and basal area; canal bank plantation data (MAI rising to 9.5 cu.m.ha/yr at age 40), regional plantation growth and irrigated plantation growth.

The wood physical and mechanical properties are stated; weight at 12 % M.C. is 785 kg/cu m ranging from 625 to 930. *D. sissoo* converts readily to timber, turns well, peels exceptionally well, seasons (air or kiln) readily, is good for steam bending, the heartwood is very durable and is refactory to treatment, the sapwood is highly susceptible to borers but is easily treated. It is considered as one of the finest timbers of India and has a wide range of uses viz in carving and engraving; furniture and cabinet making; marine and aircraft grade ply wood; decorative veneers; construction; door and window panelling; carriage and wagon building; tool handles; cart spokes, poles; boat bottoms and hulls; poles (with treatment) for telecommunication and power transmission. It is an excellent firewood, has a low ash 2.4-4.7 residue and the calorific value is 4908 to 5121 calories. The heartwood oil extract is suitable for lubrication; the leaves are used as fodder and are said to contain medicinal properties.

350
Vakshasya, R. K. and Rawat, M. S.

Mutation for precocious flowering in *Dalbergia sissoo* Roxb.

Silvae Genetica 1986. 35 (5/6): 247-248

English

An off type from open pollinated single tree progenies belonging to seven different sources of *Dalbergia sissoo* is reported for its precocious flowering at only 9 months age. Early flowering records and their probable causes are reviewed for tree species; the article describes here is the effect of mutation for this characteristic.

The authors also state "the floral morphology and the phenology of *D. sissoo* indicate it to be a self pollinated crop like most leguminous species."

351
Vats, L. K., Handa, S. and Goel, S. C.

Soil litter arthropods in a tropical deciduous forest stand.

Muzaffarnagar, India; Sanatan Dharm College 1983. 181-186

English

The quantitative and taxonomic composition and seasonal density of soil-litter arthropods collected

in 1981-82 in a forest in Haryana, India, dominated by *Dalbergia sissoo* are described. *Collembola* were the most dominant group in all seasons, constituting 73.5% of the total arthropod population. These were followed in numbers by *Acari*; the remaining orders contributed very little. *Diplopoda* and *Diplura* were not recorded in winter or summer, and *Pseudoscorpiones* (Chelonethida), *Dermaptera* and *Neuroptera* were absent only in the summer. Arthropod populations were highest in the summer and lowest in the rainy season.

352
Vats, L. K., Mittal, K. and Goel, S. C.

Caloric values of insects of different trophic levels in a tropical deciduous forest stand.

Muzaffarnagar, India; Sanatan Dharm College 1983. 232-235

English

About 150 insect species collected in a *Dalbergia sissoo*-dominated forest stand in Haryana, India, were categorized as: herbivores (3 kinds), omnivores, predators, omnivores-cum-scavengers, scavengers, or parasites. For the respective categories, the caloric values (in Cal/g dry weight) were found to average 6248-8543, 6214, 4944, 4564, 2548 and 1526. For 5 species in different categories, the caloric values are given and compared with published values for similar species in the same categories.

353
Vats, L. K. and Handa, S

Soil litter arthropods in a deciduous forest stand at Kuruksetra.

Indian Journal of Forestry 1988. 11 (1): 13-19

English

Taxonomic composition and the effects on population density of temp., soil m.c. and litter quantity were studied in a stand dominated by *Dalbergia sissoo* in Haryana from Aug. 1981 to Aug. 1983. Some 70 395 individuals belonging to 24 orders were collected in 260 samples. *Collembola* constituted 71.7% of the total individuals. The max. number of species were recorded from the *Coleoptera*. Population density varied from 257.8 to 51 484.1/m^2 and was influenced by temp. and soil m.c. but not litter quantity.

354
Vedant, C. S.

Aerial seeding technique for afforestation of degraded lands - an assessment.

Myforest 1984. 20 (2): 81-83

English

Seeds of *Prosopis juliflora, Acacia nilotica, Dalbergia sissoo* and *Helloptelea [Holoptelea] integrifolia* were dispersed from a fixed-wing aircraft over 863.5 ha of heavily ravined and eroded land in the area of the Chambal R., Agra District, Uttar Pradesh, in June 1982. The area was divided into 6 blocks of 54-223 ha. The results were assessed in May 1984 by counting and measuring seedlings established in 36 sample plots (50x2 m) over the area. The mean number of seedlings/ha was 1038, with a range of 214-1780 over the 6 blocks. Reasons for the wide variation are discussed, and the data are analysed in terms of differential germination: 25% of the sown area was blank and 16.7% adequately germinated (2000 seedlings/ha); ravine tops were usually without seedlings and ravine slopes more highly populated. Some 96% of the seedlings were *P. juliflora* and the remaining 4% *A. nilotica*. The cost of the sowing operation was Rs122.30/ha, and it is concluded that it is an appropriate method for afforesting extensive tracts of denuded land.

355
Venugopal, N. and Krishnamurthy, K. V.

Seasonal production of secondary phloem in the twigs of certain tropical timber trees.

Annals of Botany 1987. 60 (1): 61-67

English

A study based on samples from 4 deciduous (Albizia lebbek, *Dalbergia sissoo, Tectona grandis, Terminalia crenulata)* and 3 evergreen (*Calophyllum inophyllum, Mangifera indica, Morinda tinctoria*) trees in Tamil Nadu, India. In *Tectona grandis* and the evergreen species there was one flush of phloem production corresponding to cambial activity; in the other deciduous species there were two flushes.

356
Venugopal, N. and Krishnamurthy, K. V.

Seasonal production of secondary xylem in the twigs of certain tropical trees.

IAWA Bulletin 1987. 8 (1): 31-40

English

Twigs were collected fortnightly for 2 years from 4 deciduous species (*Albizia lebbek, Dalbergia sissoo, Tectona grandis* and *Terminalia crenulata*) and 3 evergreen species (*Calophyllum inophyllum, Mangifera indica* and *Morinda tinctoria*) on the banks of the rivers Cauvery and Coleroon, Tiruchirapalli, Tamil Nadu. The phenology and secondary xylem production of each species are briefly described. In the evergreen species and *Tectona grandis*, there was only one annual period of xylem production. In the other deciduous species, two periods of xylem production corresponded with 2 flushes of cambial activity and vegetative bud production each year.

357
Venugopal, N. and Krishnamurthy, K. V.

Organisation of vascular cambium during different seasons in some tropical timber trees.

Nordic Journal of Botany 1989. 8 (6): 631-638

English

The vascular cambium of *Albizzia lebbeck [Albizia lebbek], Tectona grandis, Terminalia crenulata, Calophyllum inophyllum, Mangifera indica* and *Morinda tinctoria* was non-storied while that of *Dalbergia sissoo* was semi-storied. Ray initials were uniseriate in *T. crenulata* and *C. inophyllum*, both uniseriate and biseriate in *A. lebbek, D. sissoo, M. indica* and *M. tinctoria*, and multiseriate in *T. grandis*. They were homogeneous in *A. lebbek* and heterogeneous in the other species. The radial walls of cambial cells were always beaded, although beads were more prominent and closer to one another during periods of cambial dormancy than during activity. The fusiform initials were comparatively less vacuolated during dormancy. When active, the fusiform and ray initials of all species, except *C. inophyllum*, also showed a multinucleate condition (2-10 depending on species). The proportion of ray initials to fusiform initials was almost constant throughout the year in all species.

358
Verma, A. N. and Khurana, A. D.

Further new host records of *Indarbela* sp. (Lepidoptera: Metarbelidae).

Haryana Agricultural University Journal of Research 1974. 4 (3): 253-254

English

In surveys in Haryana, India, since 1971, bark-boring larvae of Indarbela sp. were found for the first time on plum, pear, *Ficus glomerata, Madhuca longifolia, Moringa oleifera, Eleanthus excellsa, Cassia fistula, Dalbergia sissoo, Acacia arabica (nilotica), Pithecolobium dulce* and *Prosopis juliflora*.

359
Verma, S. C., Jain, R. K., Rao, M. V., Misra, P. N. and Murty, A. S.

Influence of canopy on soil composition of man-made forest in alkali soil of Banthra (Lucknow).

Indian Forester 1982. 108 (6): 431-437

English

Soil chemical properties are reported for samples taken from 11 sites in a mixed plantation under different types of canopy (1 open, 7 single-species and 3 mixed). Ground flora at the sites was sampled using 30x30 cm quadrats. In an open-canopy site pH of the top 30 cm of soil was

10.2. Under a single-species canopy the max. reduction in pH was brought about by *Albizia procera* (7.9) followed by *Acacia nilotica* indica and *Syzygium cumini* (both 8.3), but a mixed canopy (of *A. nilotica, S. cumini, Ficus bengalensis, Phyllanthus emblica* and *Dalbergia sissoo*) was the most effective, reducing pH to 7.2. Exchangeable sodium (in the top 90 cm of soil) was most reduced by canopies of *S. cumini* and *Terminalia arjuna/S. cumini*. The maximum number of species in the ground flora was observed under a canopy of *Albizia procera*.

360
Vidakovic, M.

Propagation of Shisham (*Dalbergia sissoo Roxb.*) by cuttings

UNDP-FAO Pak. For. Res. and Training Program. Rep. No 3. 1968

English

Author's summary: The importance of vegetative reproduction of shisham (*Dalbergia sissoo* Roxb.) by cuttings is stressed. The experiments have taken into consideration the following factors which may influence the rooting ability. They are: hardwood, semi hardwood and softwood cutting, age of the tree, part of the crown, time of planting and the individual tree from which the cuttings were taken. The experiments were established at different intervals starting from 20th January 1967, and continuing upto 30th August 1967. Hardwood cuttings taken from one year old plants gave the best results. The rootability was from 34 to 73%. Cuttings from 4 and 15 year old trees gave a much lower rootability percentage. Semi hardwood cuttings gave completely negative results. Softwood cuttings planted in May and June failed completely, while those planted in August rooted from 8.3 to 20%. Root cuttings from 1 year old plants rooted from 46 to 62% while those taken from 4 year old plants rooted from 18 to 38%.

The results obtained show that beside the type of cuttings the age of the tree from which the cuttings were taken and the time of planting are also important factors for rootability. The possibility of using those methods in breeding of *D. sissoo* and in practical silviculture are discussed.

361
Vidakovic, M. and Ahsan, J.

The improvement of stem form in Shisham (*Dalbergia sissoo*)

Pakistan Journal of Forestry January 1970. Vol 20: 115-119

English

From the authors abstract: Shisham (*Dalbergia sissoo*) is a commonly grown forest tree in plantations, road and canal side plantings. A great amount of variation can be observed in the growth and stem form of *D. sissoo* the biggest drawback is its extremely poor form with generally a crooked and forked bole. Since the straightness of the stem and forking are much less influenced by [the Pakistan plantation management] environment, it is safer to select a quality plus tree considering the stem form. Preliminary investigations showed the estimated heritability for crookednes of stem was 42 to 65%, these results indicate crookedness is under strong genetic control; heritability for height growth varied from 6.8 to 11.1%, diameter varied from 0.3 to 1.2%. The reason for these latter low degrees of heritability is the environmental effect of the quantity of water and the management practices.

Propagation and breeding. By combining breeding of *D. sissoo* with vegetative propagation, high improvement of stem form and a moderate improvement of growth can be made. Hardwood stem cuttings taken from one year old plants rooted the best (34 to 73%); percentage from older trees was rather low (17%); root cuttings from one year old plants gave 46 to 62% rootability; root cuttings from four old trees gave 18 to 38%. As it is not known if *D. sissoo* is insect or wind pollinated, or whether both agencies play their role in nature, or whether it is self-pollinating or outcrossing or both; when pollination and fertilization occur, solving these problems is a priority.

The authors recommend: selection of a sufficient number of quality plus trees with great selection differential; establishment of one parent progeny trials; improvement of stem and root propagation; development of controlled pollination to carry out intraspecific hybridization.

362
Vidakovic, M. and Siddiqui, K. M.

Heritability of height and diameter growth using one parent-progeny test

Pakistan Journal of Forestry 18 (1): 75-94

English

The heritability of height and diameter growth in shisham (*Dalbergia sissoo* Roxb.) has been calculated by using one parent progeny regression. The mother trees were selected in three irrigated plantations: 13 trees from Daphar, 7 from Pirawala and 4 from Chichawatni plantations. The progenies were one year old. The heritability of height growth varied from 6.8 to 11.1% and diameter growth from 0.3 to 1.2%.

The reasons for such a low degree of heritability are discussed. These are: inadequacy of one parent progeny test, effect of irrigation on the growth of mother trees, management practices in the irrigated plantations, low age of the progenies and the absence of properly designed experiment for the progenies. Under such conditions we cannot expect a safe and high genetic gain by selecting dominant phenotypes. It will be necessary to raise a large number of parent trees under the same environmental conditions and subsequently carry out intensive selection within and between progenies.

363
Vijayan, A. K. and Rehill, P. S.

Triplet seedlings in shisham (*Dalbergia sissoo* Roxb.).

Indian Forester 1988. 114 (4): 239

English

A first report of triplet seedlings in this species, observed during germination studies with 600 seeds. One seed produced the triplet seedling, which did not survive transplanting to germination pots with a garden soil medium.

364
Watt, G.

Dictionary of the Economic plants of India

Periodical Expert, Delhi, India 2nd reprint 1972 (1st edition 1908)

English

The author notes that the indigenous habitat of *Dalbergia sissoo* is much narrower than thought and allows its range: Baluchistan, Afganistan to the eastern Duars (only) of the Goalpura District of Assam, excluding Burma. He quotes Brandis as saying, "I have never seen it really wild outside the sub-Himalayan tract." It is widely planted throughout India, in tracts and as avenue trees. The wood is highly esteemed for all purposes where strength and elasticity are required; it had a high reputation in wheel use, ship buildings, sleepers, fuel, and charcoal. Traditional uses as medicine are mentioned and that the leaves of young trees are browsed by cattle. The tree is planted by the Hindus, being viewed by them as sacred.

365
Watt, G.

The Commercial Products of India (An abrigement of The dictionary of the Economic Plants of India, G. Watt.)

Today & Tomorrow's Printers and Publishers, New Delhi 2nd edition 1966

English

Shisham (*Dalbergis sissoo*) is a deciduous tree of the sub-Himalayan tracts, Indrus-Assam ascending to 3,000 feet, but probably nowhere in India strictly speaking indigenous. Natural occurrence is gregarious on the banks of sandy, stony, torrential rivers. Watt quotes Sir D. Brandis "The tree is chiefly found along the streams that emerge from the Himalaya. Large trees became scarce about 60 years ago but the tree is now regularly and extensively planted. An exhaustive report was prepared in 1826 by an eminent botanist Dr. Wallich, respecting the localities producing the *Sissu*, which showed that the supply of large timber at that time was nearly exhausted." Cultivated and often self-sown on the plains of India. Direct sowing is favoured in propagation and its quick growth (associated poor quality timber) and susceptibility to fungi damage in

irrigated plantations is noted. The wood is very durable, seasons well and does not warp or split and is highly esteemed where strength and elasticity are required. At one time extensively employed in making gun carriages; is one of the good fuelwood and charcoal source and successfully tested as sleepers but now too expensive to be utilised for such purposes. Medicinal uses are quoted and its use as a shade tree in tea gardens at Dehra Dun is reported.

366
Webb, D. B., Wood, P. J., Smith, J. P. and Henman, G. S.

A Guide to Species Selection for Tropical and Sub-Tropical Plantations.

Tropical Forestry Papers. No. 15, 2nd. edition, revised. Unit of Tropical Silviculture, Commonwealth Forestry Institute, Oxford. 1984

English

The authors provide a card sorting key as a means of species/site selection aid by the application of a series of site factors and/or species characteristics. The objectives include the condensing information into a small and convenient space and to give guidelines to more detailed sources of information on species of interest. The card indicates that consideration be given to *Dalbergia sissoo* in these conditions:

Mean annual rainfall mm	Mean annual temperature C	Altitude m
250-400	18-20	1400-1800
	20-22	1000-1400
	22-24	600-1000
400-650	18-20	1400-1800
	20-22	1000-1400
	22-24	600-1000
650-1000	18-20	1400-1800
	20-22	1000-1400
	22-24	600-1000
1000-1600	18-20	1400-1800
	20-22	1000-1400
	22-24	600-1000

367
Westwood, S.

The optimum growing period in the nursery for six important tree species in lowland Nepal.

Banko Janakari 1987. 1 (1): 5-12

English

The author discusses container plant stock qualities and timely production for monsoon planting of six tree species at a sub-tropic (474m.) nursery locality in Nepal - *Acacia auriculaeformis, A. catechu, Cassia siamea, Dalbergia sissoo, Eucalyptus camaldulensis* and *Leucaena leucocephala*. Plant qualifications included suitable: planting height; root collar diameter; ratio of root collar diameter to height, and a well-formed root system. The time to produce container (7x3" polypots) seedlings of sissoo (*Dalbergia sissoo*) to satisfy most of the plant quality criteria was fourteen weeks.

368
White, K.J.

Intercrop strategy and practices in the Bhabar Terai of central Nepal. Manual No. 1 1988 Sec. Edn.

Sagarnath Forest Development Project. Ministry of Forests, Nepal

English

The Manual describes detailed intercrop practices in a large-scale, fast-growing tree plantation program in the Bhabar Terai of Nepal. The plantation program is of 1000 ha/yr; 5100 ha was established 1979-87, 2733 ha of *Eucalyptus camaldulensis*, 1793 of *Dalbergia sissoo* in the Bhabar Terai environment.

The plantation wood production strategy adopted for fast-growing, short rotation tree crops draws on proven agricultural crop field management practices of clean weeding and fire exclusion. Agricultural intercrop management is developed for the major tree species. The manual discusses crops and cropping systems, tree and crop spacing and their interaction, crop and tree yields (cash and biomass) and a preferred model for years 1-3 for summer and winter crops for Sagarnath is

given. While the model relates to tree crop interests, it is considered to approximate farmer interest as well.

Environment changes, largely the influence of canopy development, require a shift in crops to those tolerant of lower light intensity as the tree crop ages. High value horticultural and medicinal shrub and root crops are reported and these may be replaced in a plant succession with forage/fodder crops to cover the full tree crop rotation.

369
White, K.J.

Tree farming practices in the Bhabar Terai of Nepal Manual No. 2, 1988 Sec. Edn.

Sagarnath Forest Development Project, Ministry of Forestry, Kathmandu, Nepal

English

The Manual provides detailed prescriptions for the successful development of a 1000 ha/year plantation of fast-growing tree crops in the difficult Bhabar Terai environment. Tree crops of 5100 ha were established in 1979-1987. 2733 of *Eucalyptus camaldulensis* and 1973 of *Dalbergia sissoo*. The manual discusses the environmental impact to monospecific plantations in relation to: forest ecology, natural forest yield, changes in the water table, desertification, traditional forest use, wild life and soil fertility and goes on to explain the rationale behind the change from high Sal forest management to uniform crops of *Eucalyptus* and *D. sissoo* plantations. Failure of *D. sissoo* plantations due to Bhabar site drought effect and/or cellular cavitation in water transport is discussed.

The short planting period imposed by nature required a mechanized approach to: clear felling, harvesting of products, wind rowing, land and ploughing/discing. A time/activity calendar controls the operation.

Plantation Site Qualities are given with species selections and management procedures for each; management strategy calls for fast growth trees, multipurpose species (including opportunities in non traditional uses as leaf oil, tannins, honey, etc.) and coppicing ability. Major species included: *Eucalyptus camaldulensis* Petford provenance, *Dalbergia sissoo* and *Tectona grandis*. Trials included: *Acacia auriculaeformis. Acrocarpus fraxinifolius, Albizia lebbeck, A. procera, Cassia siamea, Dalbergia latifolia, Dendrocalamus strictus, Eucalyptus* spp. and provenances, *Gmelina arborea, Leucaena leucocephala, Melia azedarach, Populus deltoides, Prosopsis juliflora*. Plantation establishment focuses on: time and season of planting with emphasis on "dry" and pre monsoon season planting, planting tools and methods, field organization, daily targets, and the use of wide spacing (5x2 m 10 sq.m/tree).

Post planting care includes: a local importance in the use of intercrops for technical and social participation in forestry and for cost control and transfer, to the agricultural sector; tending (weeding) strategy, schedules and practice; treatment of failed plantations; requirement of fertilizer and trace elements; fencing.

Protection: Fire The exclusion of fire from all plantation areas is a requirement. Predisposing factors, prevention emphasis and control measures are given. Fungi - with *D. sissoo*, wilt *Fusarium solani* noted as a problem in waterlogged areas; *D. sissoo* is also affected by *Phylloachorea dalberginae, Uredo sissoo, Maravalia achroa* and *butt rot Polyporus gilvus*. Insect attack by *Plecoptera, Dasychira, Euproctis, Dicomeris, Litocollectidae* and stem borer *Peressus* is noted. Eucalyptus has fewer problems, mostly associated with damping off in the nursery and a root/butt incident of *P. gilvus* was controlled by trenching; insect - an unknown tip cutter caused some concern in the plantation. Frost chilling was a slight problem with *Eucalyptus*. Tree damage in site preparation with animal plowing is not a serious problem. Cattle graze *D. sissoo* particularly in drought times, the Langur monkey (*Presbytis*) feed on its young leaves/shoots; jungle rats can be a problem in nursery and plantation, moreso in drought conditions.

Wood and biomass production, related to Site Qualities and actual plantation productivity as regulated by applied treatments are given, and comparison made to natural forest yield. Spacing and its effect on yield, and thinning schedules related to plantation multiple objectives are tabulated. Yield of posts, poles, timber and fuelwood are quantified. Other matters include: plantation tools, a relevant research program species for use in regional windbreaks; climate,

soil, water, and natural forest composition.

370
White, K.J.

Forest nursery strategies and practices in the Bhabar Terai of central Nepal Manual No. 3 1988 Sec. Edn.

Sagarnath Forest Development Project. Ministry of Forestry, Nepal

English

The Manual prescribes detailed techniques and operational schedules for the annual production of 2,000,000 high quality plant seedlings of *Eucalyptus camaldulensis* and *Dalbergia sissoo* for a 1000 ha fast-growing tree plantation program. The all-weather road and site access commends a central nursery distribution system; this intimate site access and the favorable advantages of container stock nominate the use of poly bag stock. Nursery plant production is very closely linked to a 50 ha a day planting goal in the short moonsoon planting season; this requires daily seed sowing for 5-week-old *Eucalyptus* and 12-week *D. sissoo* plants.

Specific Australian seed sources for *Eucalyptus* provenances are given, with *D. sissoo* local Nepal sources strongly recommended. *D. sissoo* seeds November - March. *Container stock*: heat sterilized soil is regarded as essential for seed boxes and *Eucalyptus* poly bags. Strict sowing dates and growth periods, cover, recovery shade after transplanting to poly bag, watering and weeding are given. *Open Bed*: *D. sissoo* production includes mechanized fine soil tilthing, seed pre germination treatment, time of sowing, bed stocking, weeding, shoot cutting and lifting techniques; methods of raising stem cuttings are described.

Protection operations cover environment damage and lists insect, fungi and mammal problems encountered and measures for their control. Rhizobium inoculation may be required after heat soil treatment.

Quality control is seen as a necessity in both container and open bed stock and optimum plant size is stipulated. Nursery costs are itemized and condensed notes are included for production of 13 other species.

371
White, K.J.

Forest fire control, strategies and practices in the Bhabar Terai of central Nepal. Manual No. 4 1988 Sec. Edn.

Sagarnath forest development project. Ministry of Forestry, Kathmandu, Nepal

English

The manual shows that large areas of plantations established from 1979-1987, 2733 ha of *Eucalyptus* and 1973 of *Dalbergia sissoo* will be destroyed unless adequate fire control measures are taken; *D. sissoo* is shown as particularly vulnerable. Predisposing factors include: human causes, weather, fuel, and season variations.

The Manual defines fire control objectives as: complete fire exclusion from plantations less than 5 years age and containing other fires to an area of less than 0.5 ha each. The Bhabar Terai fire environment is characterized by long summer dry periods of high temperatures and strong winds. The statistics show that 97% of the fires from 1979-87 were deliberately lit by man - a social confrontation of Project and villagers over forest land management.

Prevention is considered the best form of protection, it is advanced through: a heavy concentration on intercrop practices to prevent fire fuel build up; prevention of fire entry by control burning of adjacent areas, use of roads, trails and access lines and education of project values to the community. Suppression relies on early detection with a fire tower network using radio communication to rapidly mobilize and concentrate manpower and equipment resources at fire points. Other measures, such as control burns, back burns, fire assessments and reports are discussed.

372
White, K.J.

Practical tree breeding strategies and practices and programmes in the Bhabar Terai of central

Nepal. Manual No. 5, 1988 Sec. Edn.

Sagarnath forest development project. Ministry of Forestry, Kathmandu, Nepal

English

Nepal faces large-scale investment in tree planting; the scale of this demands the complementary support of genetically superior plant stock to provide dramatic increases in wood growth and in other tree qualities. A tree breeding program and the practical techniques to achieve rapid advances with *Eucalyptus camaldulensis* and *Dalbergia sissoo* are described in detail for the Sagarnath project. Both *E. camaldulensis* and *D. sissoo* show variable characteristics in provenances and within progenies to enable directional selection.

For *D. sissoo* the objectives are given as: doubling of wood production on S.Q.1 to 25 cu.m. ha/yr plus; form improvement to reach pole standard qualification; improved water use metabolism; narrow crowns, early winter defoliation for intercrop compatibility; early crown development for windbreaks; resistance to pathogens *Fusarium solani* and *Polyporus gilvus*: fodder palatability; ornamental value.

D. sissoo gene resources are established plant options of known natural origin; a variable parent stand is named. *Dalbergia sissoo* is shown as reliably propagated from young stem cuttings; a tissue culture stage is recommended to provide rapid multiplication for tests and clone bank establishment. *D. sissoo* is shown as readily grafted by standard techniques and this allows the centralization of a large number of candidate clones for tissue culture multiplication for field tests.

Clone bank establishment and management for *Eucalyptus* is described.

373
White, K. J.

Practical applications in propagation reproduction for genetic gains of forest tree species in the region.

UNDP/FAO Asia Pacific regional workshop on tree breeding and propagation. FAO Regional Office, Bangkok, 10-14 July 1990

English

Dramatic expectations of improvement of tree form and vigour in the decade 1990-2000 through selection and breeding will depend on existing tree populations and through vegetative reproduction of superior genotypes and/or recombinant F1 generations; lesser levels will be achieved from existing or maturing seed orchards. Broad silvicultural and utilization objectives will only be realised if they are supported by large diversified genetic resources. Due note must be taken of the time period required to arrive at satisfactory scientific levels of genetic superiority to: screen provenance; undertake progeny trials; select, multiply and test candidates.

It is possible to supply vegetatively reproduced plantlets of the region's major lowland species: *Acacia spp. Casuarina junghuhniana, Dalbergia sissoo and Eucalyptus spp.* through stem cuttings and tissue culture. Tissue culture offers a technique to rapidly multiply rare, quality genotypes and to move superior genotypes in the region; routine plant supply would generally be from robust stem cutting nursery techniques supported by clone banks of genotypes.

The paper describes *Dalbergia sissoo* tree breeding objectives [for Nepal] through a program of tree selections from provenances and progenies and asexual reproduction as stem cuttings as: doubling of MAI volume production to 25 m^3 ha/yr for site quality one; stem form improvement; improved fodder palatability; resistance to fungal/insect pathogens; efficient water use/wood production; spread of flowering time (honey production); and manipulation of leaf fall for wind protection and for integration with intercrop activities.

Natural forest provenances, tree selection, elimination and growth trials, vegetative reproduction by grafting, stem cutting and tissue culture, and clone bank management and period of improvement timetable are discussed.

374
White, K. J.

An improvement plan for *Dalbergia sissoo* Roxb. in Nepal

Banko Janaki, Vol 2 No. 4 Aug./Sept. 1990

English

D. sissoo is an important tree species in formal and extension plantings in Nepal; further large scale investment in such plantings is in train, unfortunately of unselected seed. Significant differences in form and vigor of natural *D. sissoo* stands has been demonstrated and even greater differences within these provenances. An action plan is developed to provide that plants used after 1995 will be of genetically superior quality of straight stems, be vegetatively reproduced and have the potential of producing at least 100% more volume than current plantings.

375
White, K. J.

Horticultural varieties and amenity uses of *Dalbergia sissoo* Roxb. in Nepal

Banko Janakari, Vol 2 No. 4, Aug./Sept. 1990

English

Dalbergia sissoo is widely cultivated in urban and roadside plantings on the Indian sub-continent and in other parts of the world. Foresters, with access to trees in the wild and to large plantings, have an opportunity to select a wide range of trees with desirable horticultural values that can be preserved in vegetative reproduction and be made generally available. Some Nepal provenances of high volativity and special interest are indicated.

376
White, K. J., Gautam, I. and Dahl, M.

A study of six Nepal provenances of *Dalbergia sissoo* Roxb. at Sagarnath Fores Project, central Nepal.

Banko Janakari, Vol 2 No. 4, Aug./Sept. 1990

English

A study of 4.6 year old plantations of *Dalbergia sissoo* from six provenances from natural forest at Sagarnath Nepal, showed substantial differences between the form and vigor of these seed sources and led to the designating of five provenances, corresponding to major watersheds, and a number of tributary sub-provenances. Significant differences in volume production point to the Kailali provenance, Sethi river as an outstanding provenance which is recommended for widespread planting. Very significant differences exist within these provenances and a selection and vegetative reproduction program is advised to take advantage of the high potential genetic gains available. Scientific management should be applied to in and ex situ gene preservation.

377
White, K. J. and Thapa, S.

The vegetative reproduction of *Dalbergia sissoo* in Nepal

Banko Janakari, Vol 2 No. 4 Aug./Sept. 1990

English

The note collates current information on the vegetative reproduction of *Dalbergia sissoo* in Nepal, in tissue culture, stem cuttings and grafting. Robust techniques allow the stem cutting multiplication of 1-year-old *D. sissoo* plants to be carried out at the most simple nursery. Selected clonal quality parent trees can be grafted, to provide rejuvenated explants. for rapid multiplication in a successfully demonstrated tissue culture process. The tissue cultured plants can be mass produced at site nurseries for testing, general use etc. Notes on clone bank area to service 100-1000 ha annual plantations and on management of clone banks are included.

378
Whitesell, C. D. and Walters, G A.

Species adaptability trials for man-made forests in Hawaii.

USDA Forest Service Research Paper, Pacific Southwest Forest and Range Experiment Station 1976. (No. PSW-118): 30 pp.

English

Seedlings of 90 tree species from 140 provenances were planted at 30 to 1940 m alt. at 16 sites on Hawaii, Maui, Molokai, Oahu and Kauai. Av. annual rainfall at the sites ranged from 500 to 5000 mm. Tabulated data are presented for seedling survival, growth and vigor from 1 to 7 yrs after planting. Ten conifers and 32 broadleaved species (including 10 species of *Eucalyptus*) were considered potentially suitable for timber production, amenity plantings or protection forests.

379
Yunus, M.

Longevity of secondary phloem in *Dalbergia sissoo* Roxb. (Leguminosae).

Brenesia 1983. (No. 21): 403-408

English

In 40 trees studied from 1972-1974 at Aligarh (Uttar Pradesh), phloem was produced in two distinct flushes over the course of the year. The first flush began in May, immediately after cambium reactivation, and the second in mid-Oct. to Nov., about a month before cessation of cambial activity. Phloem produced in either flush remained functional for only approximately 7-8 months.

380
Yunus, M. and Ghouse, A. K. M.

Estimation of mass transfer tissue in the main trunks of some timber yielding species of *Dalbergia*.

Journal of the Indian Botanical Society 1980. 59 (3): 274-277

English

From authors'summary: A microscopic examination of bark samples from 5 species showed that sieve tube elements occupied about 15% of total cross- sectional area in the conducting region of the secondary phloem in *D. sissoo*, 16% in *D. latifolia*, 18% in *D. rimosa*, 24% in *D. lanceolaria*, and 27% in *D. melanoxylon*.

381
Zakulla, Mohammad Irfanul Haque and Khial Badshah

***Loranthus* parasitism: A challenge to the development of economic tree resource in the Rawalpindi East region**

Pakistan Journal of Forestry, April 1985. Vol. 34: 101-109

English

The authors note the rare occurrence of *Loranthus longiflorus* and *L. pulverulentus* on *Dalbergia sissoo* in the 500-1050 m altitude range. *L. pulverulentus* parasitizing in the upper part of the range and *L. longiflorus* in the lower. The study suggests that, when grown out of their optimal range, a large number of economic trees are subject to attack of *Loranthus* parasites in the area.

382
Zech, W. and Weinstabel, P. E.

Location, state of nutrition and feed value of tree species important in forestry in Upper Volta.

Plant Research and Development 1983. 17:42-60

English

The nutritional status of *Eucalyptus camaldulensis, Azadirachta indica, Dalbergia sissoo* and *Parkia biglobosa* in the Gonse area of Upper Volta and of *E. camaldulensis, Acacia holosericia* and *Prosopis* sp. in the Djibo area is discussed. Feeding value of leaves of these spp. ranged from 0.87 FU/kg DM in *A. holosericia* to 1.08 FU/kg in *E. camaldulensis* and *A. indica*. DCP contents ranged from 3.1 to 20.1% and were highest in *Prosopis juliflora*. Ca, K and Fe contents of the leaves were above the requirements of grazing animals, Mg, Cu, Mn and Zn were marginally adequate, P was usually too low and Na always so.

APPENDIX

Table 1. The Tribe Dalbergieae in Subfamily Papilioncideae, Family Leguminosae.

Genus	Total	Number of Species* That Fix N	Doubtful
Genera known to include arboreal species:			
Andira	20	7	1
Cascaronia	1		
Centrolobium	6	4	
Dalbergia	100	24	1
Dalbergiella	3	1	1
Etaballia	1	1	
Geoffroea	3	1	
Hymenolobium	15	3	
Machaerium	120	16	4
Platymiscium	20	4	1
Platypodium	1	1	
Poecilanthe	7	2	
Pterocarpus	20	17	3
Tipuana	1	1	
Vatairea	7	2	
Vataireopsis	3	1	
Genera whose arboreal status is uncertain:			
Grazielodendron	1		
Inocarpus	3		
Riedeliella	3		

*Remaining species are unstudied.

Source: A Regional Research Plan for *Dalbergia sissoo*. Anon. F/FRED 1989.

Appendix

Table 2. The Genus Dalbergia.

Species	Center of Origin	Form, if not tree
Section 1. ASIAN Endemics		
D. abbreviata Craib.	SE Asia	
D. acaciaefolia Dalz.	W. India (=tamarindifolia?)	
D. assamica Benth.	Assam (=D. lanceolaria?)	
D. bariensis Pierre	SE Asia	
D. burmanica Prain	Burma	
D. cana Grah.	Burma, Thai	
D. candenatensis Prain.	SE Asia	
D. cochinchinensis Pierre	SE Asia	
D. collettii Prain	Burma	large climber
D. confertiflora Benth.	India	climber
D. coromandeliana Prian	India	shrub
D. cultrata Grah. ex Benth.	Burma	
D. curtisii Prain	Indonesia	climbing shrub
D. discolor Bl.	SE Asia	
D. dongnaiensis Pierre	SE Asia	
D. duperreana Pierre	SE Asia	
D. errans Craib	SE Asia	
D. floribunda Roxb.	SE Asia	
D. foliacea Wall.	SE Asia	sprawling shrub
D. fusca Pierre	China, SE Asia	
D. glauca Wall.	Burma, India	
D. glomeriflora Kurz	Burma, Thai	
D. hainanensis Merr. et Chun	China	
D. hemsleyi Prain	Burma	
D. hullettii Prain.	Malay Arch.	shrub, small tree
D. hypeana	India	
D. kerrii Craib	SE Asia	
D. kingiana Prain	India	climber
D. kunstleri Prain	Malaya	liana
D. kurzii Prain	Burma	
D. lakhonensis Gagnep.	SE Asia	
D. lanceolaria L.	S Asia	
D. latifolia Roxb.	S Asia	
D. malabarica Prain	S. Asia	
D. maymyensis Craib	SE Asia	
D. memoeides Prain.	Malay Arch.	woody climber
D. mimosoides Franchet	China (=D. milletti Prain?)	
D. monosperma Dalz.	India, China, Australia (= D. torta, = D. candenatensis Prain)	climbing shrub
D. multiflora Heyne	India (=D. sympathetica Nimmo)	spiny tree
D. nigrescens Kurz	Burma	
D. odorifera	China	
D. oliveri Gamble	Burma (=D. paniculata Kurz)	
D. ovata Grah.	Burma (=D. obtusifolia)	

Table 2 cont'd.

Species	*Center of Origin*	*(Form, if not tree)*
D. paniculata Roxb.	India, Burma (white wood)	
D. parviflora Roxb.	Malay Arch.	liana
D. phyllanthoides Bl.	SE Asia	climbing shrub
D. prazeri Prain	Burma	
D. purpurea Wall.	Burma	
D. reniformis Roxb.	Assam, Burma	
D. rimosa Roxb.	SE Asia	shrub, climber
D. rostrata Grah.	S. and SE Asia	woody climber
D. rubiginosa Roxb.	India	climber and shrub
D. scortechinii Prain.	SE Asia	climbing shrub
D. sericea G. Don.	India	small tree
D. sissoides Grah.	S. India	
D. sissoo Roxb.	S Asia	
D. spinosa Roxb.	India, Burma	scrambling shrub
D. stercorracea Maing.	Indonesia	climbing shrub
D. stevensonii Standl.		
D. stipulacea Rosb.	S. Asia	climbing shrub
D. szemaoensis Prain	China	
D. tamarindifolia Roxb.	S. and SE Asia	shrub or tree
D. thomsoni Benth.	Assam	climber; see stipulacea
D. torta Grah.	SE Asia, Pacific	climbing shrub
D. velutina Benth.	Burma to SE Asia	climbing shrub
D. volubilis Roxb.	S, SE Asia	spreading, climbing shrub
D. wattii Clarke	Burma	

Section 2. African and American endemics, and unknowns.

D. baronai ?		
D. cearensis ?		
D. commiphoroides	Africa	bush
D. cubilquitensis ?		
D. greveana ?		
D. melanoxylon Guill.& Per.	Africa (=D.stocksii Benth)	
D. nigra Allem. ?		
D. retusa Hemsl. ?		
D. roxa	Brazil	
D. spruciana ?		

Source: A Regional Research Plan for *Dalbergia sissoo*. Anon. F/FRED 1989.

Table 3. Major tree species of the genus *Dalbergia* in Asia.

Species (Common Names)	Center of Origin	Distribution	Primary Uses; Comments
D. Cultrata Grah. (Burma blackwood)	Burma, Thailand		Handsome wood, ebony-colored or red-streaked
D. fusca Pierre	China		Superb blackwood, used to make clarinets, etc.
D. kerrii Craib	SE Asia		Valuable timber; a protected spp. in Thailand
D. latifolia Roxb. (blackwood, rosewood)	S. Asia, largely India	to 3000 ft.	Superb wood; endangered sp.; trees were up to 5 m dia. basically this is a "giant" *D. sissoo*
D. oliveri Gamble (Burma rosewood)	Burma, Thailand		Highly valued handsome wood; trees to 25 m; looks like *Pterocarpus macrocarpus*
D. sissoides Grah. (Malabar blackwood)	S. India		Valued rosewood; probably race of *D. latifolia*, smaller, with less compact foliage
D. sissoo Roxb. (sissoo, sisau, shisham)	N. India and Nepal from Assam to Pakistan	introduced to SE Asia, Africa, Near East	Valued timber for cabinetry and furniture; good fuelwood, useful off-season fodder

Source: A Regional Research Plan for *Dalbergia sissoo*. Anon. F/FRED 1989.

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