

Chir Pine (*Pinus roxburghii*)

Knowing the Species

(a) Natural Habitat and Classification:

Chir pine scientifically known as *Pinus roxburghii* (family Coniferae) is one of the six pines of India and the most widely occurring. It is also known as Himalayan long needle pine, long leaved Indian pine, Indian chir pine, chir or chil. The vernacular names of the species are: Kulhdin, sarol, sirli (Garhwal and Jaunsar); Chir (Hindi and Punjabi); Nyit (Lepcha) and Dhup (Nepali).

Chir pine is a native of the inter-ranges and principal valleys of the Himalaya, beginning from Afganistan in the west and ending in Bhutan in the east it extends through Pakistan, India and Nepal. In India its forests are found in Jammu and Kashmir, Haryana, Himachal Pradesh, Uttar Pradesh, parts of Sikkim, West Bengal and Arunachal Pradesh. The total area under chir forests is estimated to be 8,90,000 hectares and occurs between 450 m to 2300 m altitude. Chir pine forms pure forests in its habitat but in its upper and lower limits occurs mixed with other conifers and broad leaved species though rarely: In its upper limits it is found in association with deodar, kail, ban oak, burans (Rhododendron) etc. and in the lower limits with sal, sain, khair, harad, bahera, amla, jamun etc. The occurrence of the species in different states is given below:

- ◆ **Jammu and Kashmir:** There are a few areas of chir pine forests in the lower parts of Jammu region. In this region its forests occur in abundance in the outer hills from 600 m to 1800 m altitude. Trees below 900 m altitude are generally stunted and crooked.
- ◆ **Himachal Pradesh:** In Kangra, Hamirpur, Bilaspur and Una districts chir forests occur scattered between 450 m – 1050 m over the outer Siwalik hills and lower Himalayas. In Chamba pure chir pine forests occur in the outer hills between 900 m – 1350 m altitude and in the Dalhousie range it chiefly occurs between 1200 m – 1500 m altitude. In Kullu chir forests are found in the outer Saraj, outer Sainj and Tirthan Valley, on both banks of Parbatti river up to Manikaran and to a limited extent in Hurla and lower Beas Valleys. In Bushahar it occurs between 1200 m – 1950 m in Nogli, Taranda, Pandrabis and Pabar ranges. Sometimes the scattered trees may be seen up to 1650 m on the northern and upto 1800 m on southern aspects. In Shimla chir pine occurs in many localities in the form of almost pure forests. In Jubal it forms very open forests up to 1680 m. In Mandi also there is fair extent of chir pine forests up to 1800 m. Sirmur and Solan districts too have extensive Chir pine forests.
- ◆ **Uttaranchal:** In both Garhwal and Kumaun, chir pine is abundant. Chir forests in Chakrata and Jaunsar-Bawar areas occur in the valleys of the river Tons and its tributaries. The upper limit of gregarious chir forests is about 1950 m, though the species is found scattered on warm aspects up to 2300 m. It also occurs over Dehra Dun, Saharanpur Siwaliks between 600-900 m, Laduakot and Malkot hills between 1200-1800 m, other valleys of Jaunsar-Bawar and Tehri Garhwal between 900-1950 m.
- ◆ **Other states:** Chir forests are found in the Morni hills of Haryana. In Sikkim pure chir pine forests do not occur but at some places it occurs mixed with sal and other trees. To some observers it appears to being driven out slowly. Chir pine is found in Darjeeling in North Bengal and in Kamen District in Arunachal Pradesh.

(b) Growth Characteristics:

Chir pine is a large evergreen tree. The tree crown is elongated and more or less pyramidal upto middle age but later becomes spreading, rounded or umbrella-shaped with a massive branch system. Under favourable conditions, it attains large dimensions and forms a straight cylindrical bole. Trees

up to 55 m in height and 3.5 m in girth have been recorded in favourable localities. The oldest chir tree of 406 years exists in Kulu Forest Division (Himachal Pradesh). Age of another old tree located in Chakrata Forest Division (Uttar Pradesh) has been estimated to be 335 years.

Bark of poles and immature trees is dark-grey and deeply fissured, whereas that of older trees is red, turning light grey on surface with exposure, thickness ranges from 1 cm in young saplings to an average of about 5 cm in mature trees. Needles are in fascicles of 3 and are 20-30 cm long. They persist for 1-3 years but normally for about one and a half years. The flowers are yellowish green before ripening, turning light reddish brown after the pollens are shed. Fruit is a woody cone. Cones are solitary or 2-5 together, 10.5-20 x 7.5-13 cm ovoid, wide at the base, on short stout stalks. Young cones are erect, scales arranged spirally and are hard, thick and woody. Seeds are 0.7-1 cm long with 2.5 cm long thin membranous wing.

New needles appear in February-March and old needles fall in May-June. Flowering takes place during February-April. Cones take 25 months to mature. They begin to open in April or May, sometimes as early as March or as late as June, depending on weather conditions. The seeds are winged and lie in pairs at the base of each cone scale. 10-12 seeds weigh one gram and each cone bears on an average 58 to 42 seeds. Good seed years occur once every three to four years depending on the locality. Winged seeds are released from the cones which are carried to far off places by wind. The fallen seeds germinate with the onset of the monsoon.

(c) As a Plantation Tree:

Chir pine is the fastest growing among the conifers found in the Himalayas. The species is hardy, frugal in its soil requirements and adapted to degraded sites which are deficient in nutrients. It grows with ease both on deep soils which should be well drained as well as on skeletal soils. Being a light demanding species, it easily rehabilitates exposed sites where most of broad leaved species rarely succeed. Chir pine being highly resistant to fire, is better suited for tracts where complete fire protection is difficult to ensure. In plantations Chir trees grow faster resulting in higher volume production compared to natural forests. It is thus the only suitable species for afforestation of degraded barren slopes of Siwaliks and lower Himalayas.

Utilization of the Species

Chir wood finds varied uses, including fabrication of panel products and for constructional. Chir pine trees also yield a commercially important oleo-resin which forms the raw material for rosin and turpentine oil industry. Chir needles are suitable for producing needle board and yield an essential oil. Its seeds are rich in fatty oil and tannin obtained from its bark is suitable for curing leather.

Uses of Chir Pine:

Chir pine provides a variety of wide ranged goods and services to the people. In fact, all parts of the tree are valuable and are used in one form or the other. It is a popular timber of North India, especially in hills and is used for various purposes including house building, as rafters, poles and posts, doors and windows, shingles, flooring blocks, packing boxes, boards, railway sleepers and in the manufacture of pulp and paper. It is suitable for boat building, tea chests, sports articles, bodies of violins, matchsticks, oars etc. Various uses of the species are given hereunder:

◆ Construction

Chir has been classified under ordinary group for structural use and has been included in IS: 883-1970: Code of practice for design of structural timber in building. It is suitable for nailed and bolted timber constructions.

◆ Railway sleepers

Chir is recommended for railway sleepers and included in IS: 10394-1982 specification of wooden sleepers for railway tracks. Treated sleepers have a life of about 17 years.

◆ **Wooden poles**

Chir is classified as Group C species for use as single solid and jointed wood poles for overhead power and telecommunication lines. It has been included in IS: 876-1970 specification for use as jointed wooden poles in overhead power and telecommunication lines.

◆ **Door, windows and ventilators**

Chir is classified as Group II species for the manufacture of door/window/ventilator frames and shutters and included in IS:12896-1990. Indian Timber for door and window shutters and frames classification.

◆ **Furniture and cabinet making**

Chir has been classified as Group III species with strength coefficient more than 50 with respect to teak as 100.

◆ **Packing cases and crates**

Among coniferous species Chir is preferred for manufacture of packing cases and crates because of its moderate weight, light colour and nail/screw holding power (included in IS:6662-1980 Specification for timber species suitable for wooden packaging). Boxes of chir wood are as good as that of other conventional woods used for packing apples and other horticultural produce. Chir pine is also suitable for manufacture of plywood tea-chest battens (IS:10(Pt.3), 1974).

Chir wood is aromatic, antiseptic, deodorant, stimulant and diaphoretic. Its wood paste is soothing and is used for treating body ulcers (Duster). Roots and knotty stem and branch wood is used as torch wood by local people.

◆ **Miscellaneous uses**

The species is also suitable for manufacture of dunnage pallets, wooden piles (Group II species), ballies (IS:3337-1978), fence posts (IS:3386-1989), cross-arms (IS:2203-1976), cooling towers (IS:2372-1963) and cable drums (IS:1178-1980).

◆ **Pulp and paper making**

Chir pine has long fibres with an average length of 3.6 mm and 0.052 mm diameter. It gives 40-43.5 per cent yield of bleached grade pulp with satisfactory strength properties – having the highest tear and burst factor amongst the species used for paper manufacture. The printing paper made from 100 per cent chir pine pulp has good formation and satisfactory strength properties. The species is also suitable for making electrical insulation paper. In the present context of supply and demand the residual wood after conversion from saw mills and factories is well suited for manufacture of white writing and printing paper. As chir is long fibred, its pulp is admixed with short fibre pulp in paper manufacture. Twisted chir, which hardly finds any other use, provides a yield of about 53 per cent unbleached pulp which is used for manufacture of wrapping paper with satisfactory strength.

◆ **Resin**

Chir pine yields a good quality oleo resin, which on stem distillation generates two industrially important products viz., turpentine oil (about 70%) and rosin (about 17%). Rosin is extensively used in many industries viz., soap, paper, paints and varnishes, Pinoleum, sealing waxes, oil cloth, inks and disinfectants. Turpentine is chiefly used in preparation of paints and varnishes, polishes, chemicals and pharmaceuticals. It is also used for dissolving fats, resin and for domestic purposes.

The oleo resin also has medicinal value. It is a stimulant, and is considered to be efficacious in gleet, gonorrhoea and disorders of the genitourinary organs. Externally resin is used in dressing for fowl ulcers, buboes and abscesses to promote suppuration. It is also a common ingredient of plasters, ointments and pastilles for fumigation.

- ◆ **Needles**

Chir pine needles are used as packing wool in vegetable and fruit boxes and as bedding material in cowsheds. In Himachal Pradesh a plant has been established to manufacture needle boards. In India more than one million ton chir pine needles are available annually as litter in chir forests.

- ◆ **Fuelwood**

Lops and tops of trees, parts of stem and branches of the species are used as fuelwood. Calorific value of its sapwood is 4967 cal. and that of heartwood 5063 cal. Charcoal made from chir pine wood is used particularly by blacksmiths for heating iron and goldsmiths for heating precious metals for making ornaments.

- ◆ **Seed**

Kernels of the species are rich in fats and proteins and are eaten as food.

- ◆ **Bark**

Bark contains tannin upto 14 per cent and is used in leather industry. Raw bark is also used as shel wood in making terra-cotta articles.

Natural Regeneration of the Species Including Calendar

Chir pine seeds are dispersed from April to July and germinate as soon as sufficient rain is received. Seeds germinate under a moderately dense canopy and mortality of young seedlings is high in canopy open too. Factors affecting natural regeneration of the species are: (1) nature of seed bearers, (2) light, (3) drought, (4) aspect, (5) topography, (6) soil covering and undergrowth (7) fire, (8) grazing and grass cutting.

Silvicultural System

Earlier chir pine forests were worked under selection system. With added information on the silviculture requirements of pine, the system was modified to uniform/shelter wood system with slight modification to suit local conditions. Owing to the simplicity of management and ease of regeneration under the uniform system it is now considered the best system of management for this species and is the standard method adopted throughout the country for chir forests.

One of the modifications of shelter wood system, is "Punjab shelter wood system" under which chir pine forests of northern India are worked. This system allows selective fellings along steep slopes and the retention of advance growth up to 35/40 cm dbh if occurring in compact patches of 0.2 ha or more as part of the future crop, specially along stream banks and steep slopes as a safeguard against soil erosion. Malformed trees or suppressed trees even below 20 cm dbh are not retained.

- ◆ **Method of obtaining regeneration**

The regeneration operations comprises of reduction in the canopy density of a part of mature stands fillings namely, seeding, secondary and final fellings. These fellings are advanced as the regeneration establishes and completed over a prescribed period known as regeneration period. The area set aside for regeneration during the regeneration period is termed as Periodic block.

- ◆ **Regeneration period**

Chir pine regeneration is considered established when plants attain a height of about 4 metre and the area is at least twice control burnt. The crop at this stage is reasonably safe against grazing and fire. This stage is achieved in about 20 years time. However keeping in view the accidental fires and biotic damages, regeneration period sometimes extends to about 30 years.

◆ **Rotation**

Rotation adopted in chir pine forests is 90 to 120 years at which a diameter of 50-55 cm dbh is obtained.

Nursery Practices

Nursery Site

The present practice of raising chir pine plantations concentrates on use of polythene bag raised seedlings. The transportation of seedlings in polythene bags from nursery to the plantation site is an important factor in deciding the site of the nursery. To reduce the transportation cost, chir pine seedlings are mostly raised in temporary nurseries located near the plantation sites. Other factors to be considered in deciding the nursery site are:

- ◆ Availability of sufficient water for seedling irrigation particularly during dry months of May and June
- ◆ Site should be open and sunny.
- ◆ Preferably be located in the natural chir zone.

Nurseries for 25000-35000 seedlings requiring an area of about 0.05 ha are more economical than smaller ones. To produce 1000 seedlings an effective nursery area of ten square metres is needed.

Seed Collection

Mature cones are collected from healthy, well grown, twist free and self pruned trees during February/March. Smaller ripe cones may even be collected as early as December provided not less than 10 cm in length as smaller cones usually contain immature seeds if collected in this month. Each cone of 10 cm and above length contains approximately 45 seeds. One kg seed may be collected from about 150-200 cones (50 kg by weight) or roughly 5 trees. Seeds should be collected during good seed years. Seeds collected during bumper seed years excel in most cone/seed characteristics especially in number of seeds and germination per cent, in contrast to seed from lean and medium seed years. Cone and seed production is not affected by tapping for resin and cones may be collected from such trees. The cones are spread in a single layer either on tarpaulins or on cemented floor and are allowed to open. Cones are sometimes covered by a polythene sheet to permit fast drying and prevent them from absorbing moisture. The polythene sheet is removed once during the day to permit evaporation of the trapped condensed moisture. By this method during the month of March the cones take about 3-4 weeks to open. The seeds are separated and cleaned and to a kilogram about 8800 to 12300 seeds are found. The seed size influences germination and subsequent growth. It is, therefore, recommended that seeds be sown grade-wise to obtain a uniform planting stock. Germination of freshly collected seeds on an average is 80-90 per cent and decreases with storage.

Filling of Polythene Bags

Perforated polythene bags of 23 cm x 13 cm size and of 150 gauge (about 300 to 350 bags per kg) are used for raising seedlings. The soil is dug and sieved to remove stones, clods etc. The sieved soil is mixed with well decomposed farm yard manure (2:1 ratio). About one quintal of compost is required for filling 300 bags. In case the soil is clayey, sand is added to improve texture. One kg CAN (Calcium Ammonium Nitrate), 1.50 kg single superphosphate and 0.850 kg muriate of potash are

added to one cubic meter of prepared soil and the mixture is sufficient to fill 1000 polythene bags. The soil is compacted regularly while filling the bags.

Pre-Sowing Treatment and Sowing of Seeds

The cleaned seeds are placed in a container with water. Unsound seeds (about 10%) which float to the surface are rejected whereas the remaining seeds that settle down the container bottom are allowed to remain in water for 24 hours. Thereafter the seeds are mixed with fresh dung and wrapped in gunny bags to keep them moist. Seeds start sprouting after 8-10 days when they are sown in prepared polythene bags. The seeds, which do not sprout within a week from the start of germination are rejected. This practice advances the growth period by about two weeks.

Seeds are normally sown before March as seedlings obtained from late sowing are not fit for planting in July. In some areas sowing is also done in September/October to obtain plantable size seedlings for planting during the following monsoon. In areas where winter planting of the species is preferred, seeds are sown during March/April. Two seeds per bag are sown at a depth of about 15 mm.

After Care

Polythene bags are covered with a thin layer of grasses/shrubs or with hail covers erected on bamboo/wooden posts to protect seedlings from direct insolation, birds and hail storms. Light watering is done with a rose can twice a day except on rainy days. Plants in polythene bags are shifted twice within the nursery to prevent their roots from striking the earth. The first shifting is done in May and second combined with grading is just before planting i.e. in the last week of June or beginning of July. Similarly, for plants raised for winter planting, shifting is done in August/September and later on shifting is combined with grading in December/January.

Mycorrhizal Inoculation

Mycorrhiza is a compound structure consisting of fungus and the plant roots. It increases the absorptive surface of the root and thereby enhances plant growth by making available more N, P, K, Ca, and Mg to the seedlings, particularly P which is important for their health and growth. Besides, it increases the plant's resistance to stress conditions such as drought, frost, extremes of soil acidity and heavy metal toxicity. It also reduces transplantation shock to permit establishment and subsequent growth of out-planted seedlings.

Mycorrhizal introduction is best done in nurseries as here a large number of seedlings may be conveniently inoculated at one place. Soil from the top 15 cm layer in chir forest excluding litter is rich in mycorrhiza and is used as inoculum. The inoculum is affected, if the soil is too dry, too wet or stored under high temperatures. The soil inoculum should be collected during and after rains when the percentage of viable mycorrhizae is high. The soil inoculum is thoroughly mixed with the potting mixtures before filling polythene bags.

Vegetative Propagation

Plantations of chir pine are traditionally raised using seed grown nursery stock. Vegetatively propagated clonal material assumes importance for improving plantation yields and for establishing clonal seed orchards. Compared to grafting air layering is more successful in the vegetative propagation of chir pine.

Particulars	Month	
	Monsoon planting	Winter planting
Cone collection	Jan-April	-
Seed extraction	Feb-May	
Polythene bag filling	Jan/Feb	March/April
Seed sowing	Feb/March	May/June
Shifting and grading of seedlings	(i) May	Sept/Oct.
	(ii) June/July	Dec/Jan.

Planting Practices for the Species Including Calendar

Chir pine plantations are generally raised either on blank mountain slopes or in areas with scrup growth or scattered trees of miscellaneous species. The amount of work involved in site clearance depends upon type of area to be planted. Site preparation involves shrub clearance and burning of cut material. This work is normally done during winters to reduce fire hazard and ensure timely digging of pits in March. Planting spacing of 3 m x 3 m or 2.5 m x 2.5 m is adopted in chir plantations. Pits are aligned along contours and spaced at 2.5 m or 3 m from each other. Pits of 30 cm x 30 cm x 30 cm size are dug from March to May. The seedlings are transported and delivered at each pit in the plantation area. The polythene bag is slit by giving a vertical cut with a sharp blade and the soil ball with the seedling placed in the pit. The pit is gradually and carefully filled with soil and rammed properly. The filling is kept slightly higher at the centre than the surrounding level so that the soil in the pit after settling down is not lower than ground level as otherwise rain water may stagnate around the seedlings.

Under favourable conditions the plants grow rapidly and by the time they are 10 years old, the spreading lateral branches are sufficiently wide and developed at time posing a fire hazard. It is, therefore, advisable at this stage to prune the branches from the lower one third part of the stem.

Cultural Operations and Its Calendar

Tending Operations

The following tending operations are required by chir forests/plantations.

Weeding

Weeding in chir plantations is usually done when the crop is very young. Of recent, chir areas have been invaded by *Lantana camara*, which if not removed, suppresses chir seedlings and also creates severe root competition for nutrients and moisture. Chir plantations must be regularly weeded till the crop is 3-4 years of age and at intervals thereafter till seedlings are fully established. In natural regeneration areas weeding is rarely done.

Cleaning

Cleaning is done to free chir seedlings from competition by other vegetation of inferior species, climbers, etc. In naturally regenerated areas where chir comes up profusely, leading stems with good form are freed from competition of inferior stems/species. The operation is conducted in the sapling crop during December/ January once or twice. The material obtained from this operation is collected, dumped in the nallah and burnt during winters when fire hazard is minimum.

Pruning

In natural stands chir seedlings get self pruned due to intense competition for light due to close spacing. In plantations, the chir plants are widely spaced and develop a spreading crown at an early age. Such plants if not pruned, become susceptible to fire damage and develop knots in the timber. The young chir plants are therefore pruned when they are 2 to 4 m in height and the lower 1/3 of the crown is pruned during December/January.

Thinning

Thinnings are carried out both in naturally regenerated stands and plantations after the crop attains the young pole stage. Inferior and suppressed stems are removed to free the good stems from competition

and permit them better opportunity for growth. Table below indicates the ideal number of stems per ha for different average crop diameters in respect of quality III site.

Average diameter in cms	No. of stems/ha
5	4385
10	1958
15	1096
20	704
25	489
30	359
35	278
40	217
45	176
50	145

Resin Tapping

Chir pine is widely tapped for resin in India. Resin tapping begins at the age of 60 years in (in natural forests) when the average crop diameter is about 30 cms. Light continuous tapping is done from 60th year to 85th year. Heavy tapping is carried out for 5 years before felling. Two methods of resin tapping are employed in the country. In the old method known as cup and lip method, a blaze of 15x10 cm is cut near the base of tree and is freshened weekly through out the tapping season. The resin is collected in a cup fixed as the base of the blaze. This method is being replaced by a new method, known as Rill method (standardized at FRI Dehradun). Unrestricted blaze depth made under the former led to severe damages to tapped trees. Rill method ensures safety of trees as the depth of blaze is controlled and superficial. In this method blaze size is marked with the help of blaze frame and marking gauge. A central groove is cut with groove cutter. One inclined rill is made on either side of the central groove through which resin flows into a cup fixed at the base of the blaze.

Pests and Diseases

Insect Pests

Chir pine is prone to insect damage at all stages of its growth; seed/cones, seedlings, standing trees and timber. The important insects on chir pine trees and timber and their control methods are appended in the table below

Insect Pests of Chir Pine

Insect species	Particulars	Control	
		Insecticides	Application
Cone & Seed pests	Feed on cones and seeds of standing trees	Thimet 10G @ 100g/5cm DBH	Application to soil around trees after soil working

<i>Dioryctria abietella</i> , <i>Chlorophorus</i> <i>strobilicola</i>		or Dimethoate 30 EC @ 100 ml/ 5 cm DBH	-do-
Nursery Pests	Feed on seedling Roots and killed them	Thimet 10 G @ 200 g/m ³ of potting mixture	Mixing with potting mixture
<i>Anomala rufiventris</i> <i>Granida albosparsa</i> <i>Mimela mundissima</i> <i>Popillia cyanea</i>	-Do- -Do-	or Chlorpyriphos 20 EC @ 75 ml in 50 L water/bed	Through irrigation water
Pests of standing tree Defoliators	Feed on needles (Epidemic observed in Hamirpur and Bilaspur (H.P.), Chakrata (U.P.); and Rajouri (J& K)	Folithion 50 EC OR Carboryl 50 wp 0.2% or Dimlin 25 wp @ 300g/ha.	Spraying -do- -do-
<i>Cryptothelia crameri</i> (Chirpine bagworm)			
<i>Lebeda nobilis</i>	Voracious feeder of the needles (Epidemic defoliation recorded from lower Bhutan)		
Shoot Borers	Feed on twigs and shoots killing the main stem	0.03% Phosphomidon Or Monocrotophos in water	
<i>Dioryctria abietella</i>			
Stem Borers	Larvae feed on Cambium and sap- wood particularly of young trees	Billet heap traps placed on the floor. Traps on infestation	
<i>Cryptorrainchus</i> <i>rufescens</i> (Short beetle)			
<i>Hylobius angustus</i> (taller weevil) <i>Ips</i> <i>longifolia</i>	Attack plants at the collar region Larvae feed on the bark, cork cambium and sometimes on the outer sapwood		
<i>Pityogenes scitus</i>	Larva feed on the cambium and sapwood and make galleries		
<i>Polygraphus</i> <i>longifolia</i>	-do-	-do-	-do-
<i>Melanophila ignicola</i>	-do-	-do-	-do-
<i>Sphanopters aterrma</i> <i>Tlatypus biformis</i> (Pin hole borer)	-do-	-do-	-do-
Sap suckers	Feed on lateral and leading current year shoots and needles. Heavy infestation results in drying of attacked parts	Phosphomidon 0.02% OR Dimethoate 0.02%	Spray Spray
<i>Ripresia resinophila</i>			

Diseases

Like insect pests, fungi also attack chir pine at all stages of growth. At the nursery stage the main diseases are damping off, wilt and needle blight, whereas rust and blight are common diseases of old trees. The main diseases of the species and their cures are described hereunder.

Damping Off

Damping off is highly destructive and takes a heavy toll of seedlings. It is caused by *Pythium*, *Fusarium* and *Rhizoctonia* which are soil inhabitants. The seedlings are prone to attack at different stages of growth and accordingly the disease is termed as pre-emergence and post emergence damping off and root rot. High temperature, high soil moisture, high soil pH, high nitrogen content and soil with poor drainage are conducive to disease development. The disease has been successfully managed through cultural practices and use of chemicals such as formalin and fungicides (blitox 19.3 g, thiram 22.5 g, brassicol 22.5 g, captan 22.5 g).

- ◆ **Fusarium wilt:** *Fusarium oxysporum* causes root rot and crown rot of seedlings after transplanting. The needles of the affected seedlings become pale and finally dry up. The drying process progresses downwards resulting in the death of seedlings. The disease can be effectively controlled by drenching soil with 0.2 per cent captan or thiram.
- ◆ ***Pseudocercospora* needle blight:** *Pseudocercospora pini-densiflorae* has emerged as a major disease in pine nurseries. The pathogen infects needles producing pale green lesions which later turn brown to grayish brown. The disease manifests in the lower needles and later progresses upwards. It appears during July, spreads rapidly from August to September and later declines. Sanitation and application of Dithane M 45 (1%) as foliar spray at triweekly intervals minimizes the incidence of disease. Strict internal quarantine is warranted to prevent entry of the pathogen into disease free areas.

In plantations and natural forests of chir pine – *Swertia* felt rust, *Trimmatostroma* needle blight and *Coleosporium* needle rust are potentially important.

Chir Pine – Swertia Felt Rust

Cronartium himalayense – the stem blister rust, is a highly destructive pathogen in young plantations in Garhwal and Kumaon hills. The rust is heteroecious and macrocyclic and completes its life cycle on chir pine and *Swertia* sp. On chir pine, the disease manifests with yellow spots on needles. On stems, the symptoms include exudation of resin and bark splitting followed by appearance of orange yellow aecial cups. The affected stem and branches are girdled resulting in death of the plants. Uredinia and telia spores of the fungus are developed on both leaves and stem of *Swertia* – the disease incidence can be minimized by eradicating the alternate host *Swertia*, by use of weedicides.

Trimmatostroma Needle Blight

The disease occurs widely in Uttar Pradesh. Trees of all ages are affected. The needles appear pale brown from tip downwards presenting a blighted appearance.

Coleosporium Needle Rust

Coleosporium campanulae commonly occurs on chir pine throughout the range of its distribution. It is a heteroecious and macrocyclic rust alternating between chir pine and *Companula colorota*, a weed. The aecia appear on chir needles in November and later during February-March. Whereas Uredinia and telia are developed on leaves and stem of *C. colorota* from March to September and in autumn, respectively.

Chir pine is relatively fast grown among the conifers of India. It attains a harvestable diameter of about 50 cm at 90 to 120 years depending upon site quality. There are three site qualities identified for its forests. Growth and yield statistics for the three site qualities are given in tables below.

Volume Table on Standard Definitions

Diam.Class (cm)	Locality quality I (Top height 34.75-42.06 m		Locality quality II (Top height 27.74-34.75 m		Locality quality III (Top height 21.95-27.74 m	
	Stem Timber (m ³)	Stem Small Wood (m ³)	Stem Timber (m ³)	Stem Small Wood (m ³)	Stem Timber (m ³)	Stem Small Wood (m ³)
0-10.2	0	0.014	0	0.014	0	0.014
10.2-20.3	0	0.098	0	0.098	0	0.098
20.3-30.5	0.196	0.224	0.196	0.196	0.182	0.154
30.5-40.6	0.776	0.266	0.734	0.154	0.692	0.112
40.6-50.8	1.797	0.154	1.626	0.112	1.500	0.098
50.8-61.0	3.157	0.098	2.888	0.098	2.660	0.070
61.0-71.1	5.125	0.094	4.573	0.056	-	-

Height and diameter growth data for various site qualities extracted from the revised yield tables and applicable to even aged crops in the natural chir zone from Kumaon westward, is given in table below.

Pinus roxburghii - Height and Diameter Growth

Crop Age (years)	I Quality		II Quality		III Quality	
	Height	Diameter	Height	Diameter	Height	Diameter
15	6.7	12.2	3.7	8.1	1.8	4.6
20	10.7	14.7	7.3	10.7	5.2	7.1
30	16.7	19.3	13.1	15.7	9.8	12.2
40	22.3	24.1	17.7	20.8	13.1	17.3
50	26.2	28.7	21.6	25.9	16.5	22.4
60	29.9	33.5	25.0	30.1	19.5	27.4
70	33.5	38.1	27.4	35.6	21.6	32.0
80	36.0	42.7	29.9	39.9	23.8	36.1
90	38.8	46.7	31.8	43.7	25.0	39.6
100	39.3	50.0	32.9	46.7	26.2	42.7
110	40.2	53.7	33.5	49.8	27.1	45.5
120	40.8	56.6	34.1	52.6	28.0	48.0
130	41.5	59.2	34.7	55.1	28.7	50.0
140	42.1	61.5	35.7	57.2	29.0	52.1
150	42.7	63.0	36.3	58.4	29.6	53.1
160	43.3	64.3	36.9	59.7	30.2	54.1

Volumes of commercial timber in round for different diameter and height classes are given in table below

Diameter Class (cm)	Height class (m)					
	12.5-18.3 (m)	18.6-24.4 (cm)	21.7-30.5 (m)	30.8-36.6 (cm)	35.9-42.7 (m)	43.0-48.8 (cm)
30.5-40.6	0.170	0.255	0.311	-	-	-
40.6-50.8	0.510	0.595	0.850	1.218	1.713	-
50.8-61.0	-	1.076	1.501	1.996	2.662	3.398
61.0-71.1	-	1.869	2.407	2.917	3.766	5.069
71.1-81.2	-	2.945	3.441	4.049	5.154	6.909

Harvesting and Its Calendar

Harvesting in chir pine forests is usually avoided during summer months. The forests of the species are highly susceptible to fires particularly in summers. Lops and tops of felled trees are highly inflammatory and easily catch fire. Felling, conversion and transportation of timber is usually completed by end of winters and restarted in monsoons.

In addition to the tangible gains in the form of timber, resin, fuel and needles for cattle bedding, chir forests/plantations also contribute towards control of erosion, lowering of run off rates, increasing water infiltration, shelter for wildlife and recreation. It is not easy to translate such indirect benefits in terms of monetary gains. The species generates employment in the tapping and collection of resin for the poor masses living in the rural areas where lack of development activity restricts employment opportunities. Processing of resin and its by-products in the primary, secondary and tertiary industries provides employment to millions of people throughout the country.

Resin is a major source of revenue for a few states where chir pine forests occur extensively. Resin yield is estimated to be 30 quintals per one thousand blazes for continuous light tapping. In India resin production is about 45000 tons/year.

Markets

Markets and Depots

Some of the important markets and depots of chir pine timber in India are as below:

- **Himachal Pradesh**
Bhadroya (Pathankot), Bilaspur, Dharamshala, Dharampur, Mandi, Mantaruwala (Paonta Sahib), Parwanoo
- **Haryana**
Ambala, Mahendergarh, Rohtak and Yamunanagar.
- **Jammu and Kashmir**
Jammu and Kathua
- **Punjab**
Amritsar, Hoshiarpur, Kiratpur, Ludhiana, Nangal, Pathankot and Roopnagar.
- **Uttaranchal**
Chanderbani, Dehradun, Doiwala, Harbetpur, Haldwani, Jwalapur, Kathgodam, Kotdwar, Nainital, Raiwala, Ramnagar, Rishikesh, Rudraprayag and Tanakpur.

Source Institutions for Detailed Information

1. Forest Research Institute, Dehradun
2. Himalayan Forest Research Institute, Shimla
3. State Silviculturist, J & K Forest Department, Srinagar.

4. State Silviculturist, H.P. Forest Department, Shimla
5. Silviculturist Uttarakhand, Uttarakhand Forest Department, Nainital
6. State Silviculturist, Arunachal Pradesh Forest Department, Itanagar.
7. Dr. Y.S. Parmar, University of Horticulture and Forestry, Nauni, Solan, H.P.

Source: Indian Council of Forestry Research and Education, Dehradun. Chir pine (*Pinus roxburghii*). Dehradun, Forest Research Institute. 21p.