Pinus Patula - A Prospective Choice For Pulpwood Plantations

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Introduction

India's resources of long fibred pulp are considerably limited. Out of 5.6% of the forest area under conifers, a large portion is not open to any form of extraction. Even the exploitable areas support only poorly stocked forest, thus allowing the annual cut of softwoods of only 1.3 million cu.m./ann. As a result, within the current decade the import of coniferous pulp is likely to rise to 80,000 tons (The Marketing Research Corporation of India, 1970).

The solution lies in expanding production from the indigenous sources supplemented by raising crops of fast growing conifers. Amongst the faster growing indigenous conifers, under ideal conditions chir and *kail* are capable of producing only 5.44 m^3 (site quality III, age 80 years) to 9.25 m^3 (site quality I, age 75 years)/ha/annum and 9.2 m^3 (site quality III, age 80 years) to 17 m^3 (site quality)I,age 60 years)/ha/annum respectively. The demands of resin industry and other forms of conventional uses as timber make it unlikely that the current rotation can be curtailed appreciably and a quicker harvest obtained.

Coming to the alternative of selecting an exotic, the field trials carried out in India have reduced the areas from where probable species can be introduced in this country. These are generally restricted to summer rainfall zone of lower latitudes. Out of the promising species like *Pinus kesiya*, *P. caribaea*, *P. elliotti*, *P. taeda*, *P. oocarpa*, *P. pseudostrobus* and *P. patula*, the last has done remarkably well in upper subtropical and lower temperate zone and in many places in growth it outstrips even the *Cryptomeria-japonica* (M.A. I. of 21.08 cu.m./ha/ann. at the age of 40 years). *Cupressus cashmitriana* which has done exceedingly well in West Bengal, is a species for 1000-1500 m zone and does not pose a rival to patula pine which gets preference generally over an altitude of 14-1500 m and tolerates a wider range of rainfall and soils.

Pinus patula has been widely planted for pulpwood in its native country, Mexico and also in South Africa, Rhodesia, Tanzania, Kenya, Malawi, Uganda, Malagasy etc. and in Queensl and in Australia. The wood is quite light, nearly non-resinous and has a fibre length comparable to other important softwoods used in India as given below:

Species	*Fibre length in mm.*
Abies pindrow	3.64
Cryptomeria Japonica	2.18
Cupressus cashmiriana	2.87
Picea smithiana	2.82
Pinus patula	3.4
Pinus roxburghii	3.60

Natural distribution

Pinus patula is a native of east-central portion of Mexico in provinces of Queretaro, Hidalgo, Mexico, Puebla and Veracruz and in one locality in state Tamaulipas. Most of the natural areas roughly fall between 180 to 210 N latitudes. Altitudinally, the areas are distributed between 1,500m in subtropical zone to 3,000 m in cool temperate zone (Mirov, 1967).

Variety *longepedunculata* is found in cool temperate zone of Oaxaca province between 1900 m to 2000 m (Martinez, 1948).

In its native zone, it generally receives a rainfall of more than 1,000mm mostly during summer months. It attains best development over deep well drained and moist soils whereas on poor gravelly shallow soils, it is replaced by *Pinus teocote*. Brown forest soils are common in its area.

Site selection

Guhathakurta (1972) recommends this species for areas between 1200 m to 2400 m in W. Bengal. In south Indian hills the lower limit will go higher to about 1500 m where it is generally recommended for frost holes. In U.P. and H.P., it has done well in trials at 1500-2000 ms. Except where damage from snow is great, it can tolerate quite low temperature. Mirov (1967) records that it has survived winter cold of—10°C. Seth (1971) analysed the data of current trials and found that results of plantations raised below 1700 m are erratic. Although more trails are still necessary an altitudinal limit of 1500 to 2400 m for northern India

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and above 17-18 in southern India may be provisionally accepted. It has done quite well even in some lowland areas i.e. at Kalsi and Dehra Dun etc. but more field trials are necessary in subtropical region.

It prefers a humid climate with a precipitation of more than 1200 mm mostly as summer rainfall.

Although in Africa and Australia it has been successfully planted up on a variety of soils, good growth is expected only on deeper well drained soils. Shallower, infertile soils are not suitable for raising a fast growing species like this.

Seed source

The old plantations, hmature enoug to produce viable seeds are only a few and till the current plantations of west Bengal and Tamilnadu. etc. start bearing viable seeds, the seed will have to be imported from Mexico or from east and south African countries like Malawi. Great care is, however, required in selecting the provienance. For a species like this growing over a long range of climate and soil, the emphasis should be to choose a locality resembling the planting site as for as possible, taking due care that growth and quality of the selected provenance is satisfactory. The matter is further complicated by the presence of large variations in wood properties of individual stems of even the same stand (Kirbu and Karanja, 1970)

In east Africa where some selection of seed trees has been done, even the conservative estimates (Patterson 1966) indicate that a gain of 10 to 13% in volume production has been achieved and the stem defects have been reduced by 5 to 25%. An intensive and repeated selection is, therefore, bound to bring considerable improvement in yield as well as in quality of the wood. Judicious selection of seed trees with desirable trails, is, therefore, essential.

In selecting seed trees with the object of raising pulpwood plantations foresters have mainly confined their attention to growth rate, presumably for lack of knowledge of in other inheritable wood qualities (Anderson, 1968). Paper industry can do much in laying guide lines for such selections. It would be worthwhile to depute trained staff to collect the seed from the trees of desired character so that the genetical quality of the forest is ensured from the beginning. Another alternative is to obtain seed from the beginning. Another alternative is to obtain seed from the seed orchards raised in countries like Malawi.

A rough bark variety which does not show nodal swelling has been evolved in south Africa. This is more vigorous and in form approaches *P. greggi*. A variety *longepedunculata loock* has also been reported from Mexico. Trials with main Mexican provenances of Hidalgo and Oaxaca etc. as well as rough barked type evolved in south Africa and the progeny of selected trees and orchards from Kenya and Malawi is desirable (Lamb, 1970; Anderson, 1968).

Collection, pretreatment and germination of seed

The seeding starts quite early but prolific seeding of viable seed occurs generally only after 12-15 years of age. Twigs bearing mature cones are lopped before the cones open and and dried under sun till they open. Seed may be extracted by gentle thrashing. In Mexico mechanical means of dewinging are used. This can also be done effectively by rubbing seeds between moistened hands.

Proper drying of seed is important. It stores well in dry sealed containers where the moisture % is less than 8%. In Mexico the dried seeds are reported to have maintained viability for some years at lower temperature of about 4°C (FAO, 1955; Ganguli, 1967).

About 110 to 116 seeds weigh a gram. On sowing, the complete germination takes some time, it starts in about 3 weeks and may continue upto 7 weeks. This necessitates some pretreatment to hasten garmination. The common method that can be adopted is to soak it for a day or two in water at ambient temperature. In Tamilnadu, soaking the seed in hydrogen peroxide for a day or two has given good results. Stratification has not been tried anywhere and needs experimentation.

Like *chir* a good method may be to sow preprsouted seeds directly in containers. This may cut out expenditure involved in pricking out and in maintenance of germination beds. Danger of defective pricking out operation is also obviated. Sprouting can be done by putting the seed in acidified moist saw dust (Kotar, 1958). Another method is to mix seeds in moist vermiculite and store them in polythene bags till they start germinating. (Watkins, 1958).

Germinative capacity is high. Ouden and Boom (1965) report it to be 80%. A similar high value has been observed in Kerala in case of South African seed but the reported figures mostly fluctuate between 40

to 60%. A kg. of seed is reported to give about 44,000 (South Africa—Poynton, 1957) to 55,000 (Malawi—Coldwell, 1958) plantable seedlings. A greater margin will however be required for indenting seed for our purposes.

Nursery

Seeds are broadcast in nursery beds (W. Bengal) or in germination boxes filled with sandy soil (Tamilnadu). Soil of the germination boxes or beds is sterilised by using boiling water as in Tamilnadu or formalin as in Andhra Pradesh Paper Mill trials and thiram as in U.P. Experiments at Forest Research Institute (Reddi and Misra, 1970) have indicated that fungicides like copper oxychaloride 50% dust (Blitox), Zinc dimethyl dithio carbomate 80% dust (Cuman) and Zinc ethylene—bis—dithio-carbomate 65% dust (Zineb) may be safely and effectively used for preventing damping off in pine nurseries at rates of 23 gm, 27 gm and 31 gm of dust per sq. m. area respectively, forked 15 cm deep in the soil. These may be used for sterilisation a day or two before sowing. The soil should be well drained and contain larger proportion of sand to help drainage and subsequently pricking out.

Very heavy sowing in germination beds/boxes may induce damping off, whereas, a lower density may result in wastage of space. In Kenya, seed is sown at a @ of 15 gm/sq. m. This is generally considered low and figures five times than this are suggested provided the season is not dull and wet (Parry, 1956). For India, seed being more valuable and technique yet not standardised, it is suggested that a lower quantity of about 30-40 gm/sq. m. should be adequate unless sufficient check to control damping off is possible.

The seedlings are pricked out when they attain a height of 5 to 6 cm. pricking may result in severe discolouration and checking of the growth and should, therefore, be avoided. The best time for pricking is when the whorls of cotyledons have appeared and the centre of the whorls is just beginning to break up into the first tuft of leaves (Parry, 1956).

In India, pricking out is mostly done in containers filled with mycorrhiza inoculated soil. Soil containing rootlets obtained from stands of available pine species can be used for mycorrhizal inoculation. In Tamilnadu containers of 13 cm×25 cm size have been used successfully, although, the optimum size has yet not been arrived. In Tamilnadu, 13-15 months old seedlings are planted out whereas about 21 year old seedlings are used for planting in U.P. and 6 to 9 months old seedlings in Kerala. In West Bengal, seedlings are pricked out in transplant beds from where two year old transplants are planted out with ball of earth.

In south Rhodesia pricking out is done in raised beds at 5 cm×5 cm and the root pruning is started early when the tap root is still brittle and is followed by regular pruning at 3-4 weeks interval. About 12-15 months old seedlings are used for planting. The use of 'swaziland' beds has become common in south Africa. This is a raised bed supported by wooden baulks. This is placed on about 2-5 cm thick layer of sifted soils lying over a compact platform and filled with fertile soil. Undercutting is done by drawing a piano wire under the baulks. The practice is said to produce transplants with fibrous roots. (Stubbing, 1958; Hiley, 1959).

The planting size differs from place to place and initially it is safer to rely on 40-50 cm tall stock as done in South Rhodesia. In U.P. 45 cm tall plants are used. In Malwai, the optimum size for planting is considered as 23 cm. thus reducing nursery and transport cost, appreciably. It needs trial in areas where conditions are not adverse.

Watering should be gradually reduced to harden the seedlings. Unnecessary shade should be avoided and even where needed for protection, it should be removed in stages well before planting time. Studies reveal that under Mexican conditions a six months old seedling of *Pinus patula* requires a shade of a degree, somewhere between 0 to 33% (Vela 1968). If plants are kept in bags for longer period frequent shifting of bags is necessary lest the roots may come out of the container.

Planting

Clearfelling followed by burning is first prerequisite in moist areas as in Bengal but may be avoided in drier tract or in grasslands. Planting is mostly done in 30 cm^3 pits. In west Bengal where planting is done by taungya cultivaters 60 cm wide contour terraces are made before digging pits. After allowing soil of the pit to weather for a month, earth is refilled and the potted or balled seedlings are planted during rains. Spacing vary from 1.8 m×1.8 m (W. Bengal) to 3 m×3m (Tamilnadu).

In Malawi, contour ploughing in 1.37 m wide strips is done mechanically and planting is done in middle of such ploughed strips at 2.13m×2.74m. This has given very good result in

short grass areas and has obviated the need of frequent weedings. Wherever ploughing is not feasible 25 to 45 cm deep pits of 30 cm diameter are dug manually but the results are not as good as in ploughed strips (Coldwell, 1968). In grassy areas of south India feasibility of such complete soil working in strips is worth exploiring.

In south Africa plantations are mostly done in prepared pits at 2.74 m × 2.74 m spacing. From Swaziland beds, the soil is cut into sods to fit 10 cm deep boxes of 25 cm × 30cm internal size for transporting to planting site. Here the soil in boxes is cut criss cross to isolate plants for inserting in pits. (Hiley, 1959). In Malagasy seedlings having roots coated with clay and fertilizers have been used. (Huguet, 1958; Vignal, 1956). In small scale trials in U.P. naked rooted plants gave a survival % 24 against 68% for container raised plants, under similar conditions (Joshi 1972). Wide fluctuations in rains preclude the use of naked root seedlings in most parts of India and for such a species liable to check on planting container raised seedlings appear best choice.

In India at the time of planting the collar of seedling is kept at the ground level. For comparatively lower rain fall zone as in parts of west Himalayas a little deeper planting is likely to be more successful. Experience in lower rainfall areas of Tanzania indicates that by deep planting of transplants upto 10 cm above the root collar, the survival % has improved. (Dick, 1969). Trials at Muguga arboratum, Kenya, also confirm this observation. Here burying of small seedlings upto 50% had no deleterious effect on survival % and resulted in stimulation of height growth.(Griffith, 1957).

Fertilisation

A fairly fertile soil is required for proper growth of this species. It takes, N.P. and B in large quantities (Goor, 1965/66). N and P deficiency was noted to produce symptoms of mild chlorosis, stunted growth, shorter needles and lack of branching (Anon, 1970). Deficiency of B results in crooked growth of the leader and may be responsible for dying back. Frequent check in growth and chlorosis observed in *Pinus patula* nurseries has been attributed to nutritional deficiency at the critical stage when seedling has exhausted its reserves and has yet to develop a satisfactory root system (Parry, 1956).

For nursery stage East African Agriculture and Forestry Research Organization has recommended use of a N.P.K. mixture (Amm. Sulphate 3 parts, Double superphosphate, 3 parts and Potassium chloride 1 part) at rate of 2 kg./cu. m. of soil.

The areas suitable for its plantation in south Indian hills are generally deficient in nutrients and will require addition of fertilisers. Till the composition and doses of fertiliser for this species are fixed for various sites, the recommendations for fertilising wattle plantations in Nilgiris may be followed, provisionally, on similar type of soils.

Boron deficiency has yet not been reported from any trial of *P. patula* in India. This can be remedied by applying borate fertiliser in dosage of about 50 cm/plant as prescribed for pine and rose gum plantations of Zambia.

Weeding

It will depend on the site. In areas with low grasses, complete soil working at the time of planting may give so much impetus to growth that intensive weedings may not be required. The current working plan of Darjeeling Division prescribes 3 weedings and cleanings in 1st year, two each in second year and third year and one in fourth year. In Tamilnadu, three weedings are done in September, November and February. Here all vegetation around the plant in a 2 sq. m. patch is completely scraped and hoeing is done after planting.

Pruning

Although prunings are generally not given necessary attention in pulpwood plantations, it facilitates debarking and reduces the number of branches to be removed later on (Sherry, 1961). *Pinus patula* has slender branches which can be neately pruned with ease (Parry 1956,). In East Africa general recommendations for pulpwood plantations of this species are to prune them once upto the height of 7' (2.13m) at the age of 7 years. No pruning is done in India although Lamb (1970) recommends that first pruning be done when the plant reach a height of 10 m i.e. in about 6th year.

Tending

It has a vigorous and spreading crown and responds to thinnings intensively. In south Africa, it has been noted that in a stand with a stocking of nearly 3,000 trees/ha. natural thinning commences in about 9th year (Poynton, 1957).

For pulpwood plantations, where volume increment is sole criterion, some workers suggest that a spacing of 2.44 m × 2.44 m in good sites and 2.74 m × 2.74 m in poorer sites be adopted and the crop be left

unthinned. (Marsh, 1963). Contrary to this Joubert (1966), while working out its financial rotation found that the most profitable silvicultural practice under south African conditions would be to raise crop at a stocking of 1334 trees/ha and ten reduce it to 741 stems/ha. in 10th year for final felling in 15th year. For East African countries general recommendations are that thinnings be done at the age of 7 years to reduce stem numbers from 1384/ha to 988/ha for working at a shorter rotation of 15 to 20 years (Patterson, 1967).

In India plantations are still immature and detailed data is wanting to fix up thinning regime.

Management

Pinus patula is being raised either for timber or for pulpwood in Central Africa and also in Australia. Decision in advance regarding object of raising its plantations will be essential as the pruning and thinning regime and also the rotation will have to be fixed accordingly. It's light nearly non-resinous wood (Little 1962: Poynton 1957) may find market only as packing case timber. It may be noted here that much difficulty was encountered in disposing off *pinus radiata* timber grown in Palni hills. Moreover, better timber species like *cypress* or *P. pseudostrobus* and many hardwoods being available, it will have to face a tough competition as timber. It is, therefore, presumed that most of the area under this species is likely to be managed for pulpwood production or plywood-cum-packing timber.

Maximum annual increment of volume as evident from African data is likely to fall between 14 to 20 years. For producing a suitable pulpwood log of 25 cm diameter (o.b.). Patterson (1967) recommends, a rotation of 20 years. It may be noted that a higher diameter is required as top logs of this species in Africa have been found to be very knotty and consequently the lower limit of top diameter is 15 cm (o.b.). The crop-diameter of 25 cm can be produced on some sites even at lower age. Burgers (1971) has shown in a recent analysis of C.C.T. plots of South Africa a stand of a stocking lower than 850 stems/ha. can produce this diameter even in 15 years, but making a provision for underestimates the recommendations of Patterns appear quite sound. His conclusions are further corroborated by the fact that at the age of 20 years denser wood of better quality would be produced. Patterson (1967) reports following data :—

Age	No. of stems/ ha.	Mean fibre length in mm	Mean density oven-dry kg/m³
15	988	3.3	387.7
20	988	3.4	405.3

This increase of 5% in density with a slight increase in fibre length fully justifies adoption of a rotation of 20 years. This is also nearer to a financial rotation of 25 years provisionally estimated for Ugandan softwood plantations (Kingston, 1970).

For India, data for weight increment and quality of pulpwood at various ages will have to be collected. Till then, the African studies may be used as guide line.

Growth

The highest M.A.I. recorded in India is for 33 year old plantation at Raman-3 at 2270 m altitude in Bengal Himalayas. It gave a M.A.I. of 37.06 cum/ha. (Ghosh 1968). Guhathakurta (1972) further reports growth data for two plantations of Darjeeling division, One 19 year old plantation at a stocking of 1800 stems/ha. giving M.A.I. of 25.04 cum/ha and the other 38 year old at a stocking of 1950 stems/ha giving 22.26 cum/ha. The crops do not appear to have received any thinning.

Data from other localities is mostly available for either young crops or for the individual stems. Checks being common in initial stages and planting defects effecting the early growth considerably it will be proper to compare the yields when more data of higher age oahgoo available.

In west Bengal growth for the first five years is reported to be slow. A similar instance has been reported from some high level plantations of Uganda and Malawi, where in early stages height increment was slower but accelerated later. This is generally attributed to a lower rate of evapotranspiration (Kingston, 1970).

Seth (1971) estimated productivity of *Pinus patula* plantations by comparing early height increment with sample plot data from south Africa showing similar growth trend. Although the estimates can be considered only tentative and rought, the indications are that M.A.I. of 13 to 37 cum/ha would not be an overestimation. It is, therefore, clear that if proper care is taken in site selection an annual production of over 20 cum/ha can be expected.

Growth data reported from some other countries is given below :—

Country	Age in years	MAI in cu.m./ha.	Source
1. Mexico	38	25.5	Huguet, (1958)
2. South Africa and Malagasy	30	10-20 (30 cu.m. in some better sites)	—do—
3. East Africa	30	26.6	Patterson (1967)
4. Uganda	17-18	21 (approx)	Kingston (1970)

Our yield figures, therefore, compare quite favourably.

Conclusion

Pinus patula has proved a promising species in humid and sub-humid areas of upper subtropical zone and lower temperate zone. As large areas of this zone have only poorly stocked forests of less valuable species, it provides a good scope for augmenting the productitity and for meeting up increasing demand of long fibred raw material to a large extent. Need is, however, to standardise the planting technique and management practice for which much can be drawn from the experience already existing in other countries particularly in Africa.

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