

LECTURE - 13

LEARNING OBJECTIVE: ECONOMICS OF CULTIVATION-NURSERY AND PLANTING OF *Populus deltoides* Bartr.

Botanical Name	:	<i>Populus deltoides</i> Bartr.
Family	:	<i>Salicaceae</i>
Local Name	:	Poplar, Pharipipal



Plate 13.1 Poplar tree

Introduction

- Poplars are amongst the fastest growing tree species under appropriate agro climatic conditions.
- Poplars can be harvested at short rotations of 8 to 10 years.

- Wood obtained from poplars is eminently suitable for manufacture of match splints, veneering products, artificial limbs, interior paneling, cheap furniture and packing cases etc.
- Poplars with straight and cylindrical bole, moderate conical crowns mostly deciduous during winter months,
- Combine well with inter-cultivation of agriculture crops.
- These features combined with good economic returns and availability of long-term bank loans have made versatile poplars the most popular tree species for planting under agro forestry system in the irrigated tracts of north-western plains of India
- Six indigenous species viz *Populus ciliata*, *P. laurifolia*, *P. gamblei*, *P. alba*, *P. glauca*, are found along water courses in Himalayan region.
- However, success story of poplar plantations in the north-western plains of Uttar-Pradesh, Haryana, and Punjab is based on exotic *P. deltoides* indigenous to United States of America.
- Certain clones of *P. deltoides* have been found to be eminently suitable for a afforestation as well as agro forestry plantation. *P. deltoides* clones G-3, G-48 (Australian selections) and D-121 (American selections) constitute bulk of these plantations.
- Additional clones like D-61, D-67, S-7C-8 and S-7C-15 have also been included in the plantation programme. Poplars can attain 90 cms girth at breast height and mean annual increment of 20m³/ ha at 8 years rotation under good care.

Description

- *Populus deltoides* is a fast growing tall tree with a fairly straight and slim trunk, rather open crown composed of a few large branches and attaining a height of 30 m and girth of 2 m.
- The branches are more or less angled or almost winged, the side branches borne on large branches are shed early.
- Outer bark forms early, furrowed by cork-like ridges and deep fissures.
- The leaves are fairly large, deltoid on short shoots and very large and cordate on long shoots, light green in colour.
- They are 10-18 cm long, acuminate, crenate-dentate with long petiole.

- The male catkins 7-12 cm long, 40-60 stamens per flower and produce wind-borne pollen. The female catkins are 15-25 cm long.
- The female flowers have single-celled ovary with numerous ovules and at anthesis have 2-4 prominent stigmas.
- Fruit ovoid capsules, hanging in loose clusters, opening by 3-4 valves and seed is small and hairy.

Distribution

- *P. deltoides* clones have been cultivated in a number of countries.
- In fact, *P. deltoides* and their hybrids together make about 90 percent of the total cultivated poplars of the world (FAO, 1979).
- Among the countries in which they have been cultivated are West Punjab in Pakistan, Middle East, New South Wales in South Australia, Parana Delta and north eastern continent part of the province of Buenos Aires, Argentina (Singh, 1982).
- In India, it has been successfully cultivated as a forest crop or agroforestry crop in the Punjab plains and in the Terai region of Uttar Pradesh.
- Poplars have been raised at slightly lower latitudes also, but it is only above 28° N, that they had fair success in experimental plantations and on farms.
- On experimental scale, *Populus deltoides* has been successfully cultivated at Jorhat (Assam) at an altitude of 96.5 m (Sharma and Bardoli, 1986).
- In its natural range in the southern part of USA, *P. deltoides* occurs primarily on bottom lands along rivers and other water ways (FAO, 1979).
- In West Punjab (Pakistan) and Middle East, it is cultivated only where irrigation is available.
- In areas where its cultivation has been tried without irrigation, the growth has been very poor.
- In not adequately irrigated plantations in the Middle East, *P. deltoides* is reported to become susceptible to the major wood borer *Melanophila picta* (Singh, 1982).

SOIL

- *Populus deltoides* can survive on soils varying from sandy loam to fairly stiff clay, but it makes its best growth on moist, well-drained, deep, medium-textured, alluvial soils that are fertile and well-aerated (Baker and Broadfoot, 1976).
- The nursery plants perform better on clayey soil than on sandy soil (Bonner, 1967). Coarse sands and heavy clayey soils deficient in organic matter are unsuitable.

Artificial Regeneration: Poplars can be raised by the following methods.

(i) By Sexual Reproduction:

- The tree produces seed at intervals but it has low germination percentage.
- The seed of *Populus deltoides* has been germinated under laboratory conditions with germination percentage varying from 5.25 to 19.25%.
- The medium of germination, i.e. two parts soil and one part is of river sand duly sterilized proved most effective and gave higher survival and best shoot development.
- Germination tests conducted about the viability of seed after 6 years of storage showed that -20°C storage was superior to -50°C storage in maintaining seed viability (Tauer, 1979).
- *Populus deltoides* flowered for the first time in May, 1982 in Terai (U.P.).
- Poplar seeds are very minute and 14,000 seeds weigh one kg (Beniwal and Singh, 1989).
- The plant is rarely raised by seeds.

(ii) Vegetative propagation:

- Cuttings

Cuttings 18-25 cm long and 1-2.5 cm thick having at least four buds are directly planted in the field in well worked soils, keeping one bud above the ground. The soil around the cuttings is thoroughly compacted.

- Sets

A set is one year old cut back plant without root or a long stem cutting which consists of one year growth. The root portion left in the nursery can again be used to produce

plant/set/cuttings for the next planting season. Sets are planted in 75 cm to 1 m deep pits. The length of set is about 3.5 m or more.

- Bag plants

These can be raised in polythene bags of 15cm x 23cm x 150 gauge filled with soil mix and treated with 5% aldrex. Cuttings are planted in these bags in February in the year of planting. Vigorous plants are not obtainable by this method.

- Stumps (Root-shoot cuttings)

These are prepared from one year old nursery plants keeping 25 cm long root and 3 cm of shoot.

- Entire transplants (ETPs)

This is the best method for transplanting poplars. These are one or two year old plants raised from cuttings in the nursery. While removing these plants, the root is cut at 25 cm depth and all side roots more than 10 cm long are also trimmed. The plants are taken out with naked root and without foliage.

Nursery Techniques

i) *Site Selection*

- Soil type and irrigation facility are the two important considerations for the selection of site for nursery.
- Poplar (*Populus deltoides*) needs preferably sandy loam, deep, fertile, well drained, neither alkaline nor too acidic, free from underlying impervious layer and rich in organic matter.
- Coarse sand in areas where the water table drops below in winter and which are subject to summer drought, soils with top-layer removed by erosion and site with laterite occurring within 60 cm of surface are considered unfit for poplar cultivation.
- Assured irrigation is essential besides other requirements of a good nursery site. As poplars are very sensitive to zinc deficiency, zinc sulphate @ 25 kg/ha should be applied in the area at the time of site preparation (Lal, 1991).

Site Preparation :

- A light preparatory irrigation should be given so that the soil has proper moisture at the time of ploughing.
- The field should be levelled after ploughing. One deep ploughing upto 25-30 cm depth is desirable.
- Phosphatic and Potassium fertilizers should be added at this point. After addition of fertilizers, one more harrowing should be arranged.

Clones:

A lot of good quality clones have been developed and launched commercially. Some of them are G-48, S₇C₁₅, S₇C₈, L-34, L-49, L-52, Uday, Kranti, WS-39, WSL-22, WSL-27, WSL-32, WSL A-49, and PL-1 to PL-7 etc.

ii) *Selection of cuttings*

- Cuttings from the main stem of the *Populus deltoides* give better results than those obtained from branches.
- One year old plants from existing nurseries are used for preparation of cuttings for the new nurseries.
- Diseased, dying off-type and suppressed plants must be culled from the beds where stock is reserved for preparation of cuttings for the new nurseries.
- The plants can be cut 2 cms. from ground level and the resultant sets should be graded and formed into bundled and should be transported to the new nursery site immediately and stored there in the storage pits, which should be kept full with fresh water to be replenished every day.
- Cuttings made from ripened one year old wood of the main stem give better results.
- Only well lignified shoots should be used; too tender shoots are not suitable for cuttings.
- Cuttings obtained from young, healthy and vigorous plants perform better.
- The length of cuttings should be 18-25 cm and these should contain four buds.
- When cuttings are taken from the trees, the age of trees and of the parts of trees from which the cuttings are taken markedly affect rooting (Zsuffa, 1976).

Preparation of cuttings

- Cuttings should be prepared with a very sharp and fairly heavy tool to obtain a very clean and smooth cut.
- During the preparation of cuttings, the cut must be given at a point of the set which is fully supported on a log/beam of wood to prevent splitting of cuttings.
- Maximum number of available cuttings from each plant down to one centimeter diameter can be used for planting.
- All cuttings must be submerged under fresh water in drums immediately after preparation of the cuttings.

Treatment of cuttings

- Before planting, cuttings are soaked in water for 24 hours
- Cuttings should be treated with Aldrin (250 ml of Aldex 30 EC in 100 litres of water) and thereafter Emisan (250 g in 100 litres of water) for 10 minutes each and then only planted in the nursery.

iii) *Planting of cuttings*

- For production of healthy and vigorous entire plants, planting of cuttings at 80 cm x 60 cm is the best spacing (Chaurvedi, 1981).
- To produce one year old plants, spacing of 1-1.4 m between the lines and of not less than 40 cm between the plants is normally adopted (FAO, 1965).
- The best time of planting cuttings in the nursery is January to February.
- Cuttings made earlier than January and later than March do not perform well in open conditions (Chaturvedi, 1981).



Plate 13.2 Poplar nursery

- Planting rods with the lower ends flattened and sharpened like a screw driver should be used for making the planting holes.
- Each cutting with its thinner end up should be planted in the hole in such a way that the upper portion is just 2 cms above the ground level.
- After planting the soil around each cutting should be compacted gently but firmly without injuring the bark of the cutting in any way.

Irrigation in Nurseries

- Irrigation should be provided as soon as the planting of cuttings in any bed is completed.
- The first irrigation should be medium heavy so that about 5 to 7 cms water is uniformly above ground level at the time of irrigation.
- Soil moisture in the nursery bed should be kept high during rooting of cuttings.
- Subsequent irrigation should be light and the interval may vary between 7 to 10 days depending upon the type of soil.
- Light sandy soils will need frequent irrigations whereas medium to heavy soils will need irrigation at longer intervals.
- The top soil should not be allowed to develop cracks and become absolutely dry.
- Irrigation should be applied at 10 to 15 days interval depending upon the type or soil and need of individual nurseries till onset of monsoons.

- Proper and effective drainage of excess water during rainy season is essential to prevent lodging and collar rot.
- After the rainy season one to two irrigations per month is adequate.

Fertilizer application:

- As the poplar plants grow very fast, the nursery soil has to be enriched frequently. Urea, Super phosphate, Murate of Potash and plentiful supply of Farm Yard Manure are essential for maintaining the growth of cuttings.
- Application of well decomposed compost or farm yard manure @ 200 to 250 quintal per hectare nursery area at the time of soil working is very helpful for the growth of poplar.
- The quantity of fertilizer will depend upon the type of soil.
- Nursery beds are depleted of fertility after producing plants for one year, if no fertilizer is applied.
- After the rains have set in, 2g of urea per plant is given;
- Regular debudding and hoeing will depend upon the incidence of weeds and grasses.
- Singling of collar shoots should be done during April-May when the most vigorous shoot has attained a height 30-35 cm.
- Debudding is done by gently rubbing with gunny bags the newly formed buds upto 2/3 rd height of plant from the base from June to October.
- Sufficient care should be taken to ensure that the young leaves are not damaged.

Planting Entire Transplants (ETPs)

- The best time for planting poplar is during the months of January-February before the opening of new buds. One year old ETPs of 3 m length containing 25 cm root portion give most satisfactory results.
- The depth of planting will depend upon the soil type, depth of water table, size of planting stock, etc.
- As poplar is a fast growing species, the soil requires to be incorporated with fertilizers
- A basal dose of 2 kg good FYM, 50 gm super phosphate and 5 gm urea per plant is needed. Nitrogenous fertilizer should be applied in split doses, first dose of nitrogen as 75

g urea should be applied during the first week of June, second dose of 150 g urea during first week of July and third dose of 250 g urea during second and third week of August.

- Application of fertilizer must be followed by light irrigation.
- The best spacing under agro-forestry systems is 5 m x 4 m *i.e.* 500 plants per hectare.

Application of Manure and Fertilizers

Well decomposed farmyard manure which is rich in macro as well as micro nutrients essential for the plants should be applied to the total area under poplars while preparing the land for inter-cultivation of Rabi and kharif crops. Application of nitrogenous potassic and phosphatic fertilizers as well as micro nutrients will depend on the fertility status of the land. 50 gms of single super phosphate 25 gms muriate of potash is used at the time of planting.

Inter-cultivation of Agricultural Crops

Any traditional crops except paddy can be grown reasonably well in between the lines of poplars during the first 2 years. Subsequently shade tolerant crops like ginger, turmeric and colocasia can be raised as less sunlight penetrate to the ground during active growth period of poplars because the crowns cover most of the canopy. Short duration winter vegetables or rabi crops like wheat lentils toria etc. can also be raised as most poplar clones are leafless during autumn. However intercrop yield decreases with the increase in age of poplars. Care should be taken to avoid physical injuries to the stem of poplars during inter-cultivation operations.

Inter-cropping :

It is desirable to grow field crops as inter crops in block plantations of poplar. All *rabi* and *kharif* crops can be grown during the first three years except paddy. However, inter-cultivation of sugarcane be preferred for first two years as it is more profitable. Third year onwards cultivation of wheat, cabbage, chilly, tomato, barley, coriander, turmeric, ginger, strawberry, oats, berseem, sarson etc. can be raised throughout the rotation.

Plant Protection Measures :

Certain insects and pathogens are known to damage the poplars. Among the important ones are the following :

- Leaf defoliator : These are active during the rainy season particularly *Pygaera* species. The caterpillar of these moths feed on leaves. The insect can be controlled by collecting and destroying the infested leaves. Spray of Monocrotophos 36 SL @ 600 ml (Monocil / Monolik / Nuvacron / Corophos / Lumphos) per acre.
- Termites : The risk of termite damage is likely where irrigation and inter cultivation operations are inadequate. The soil should be treated with Aldrin or Gammexene (BHC) (0.15%) and frequent irrigation arranged.
- Stem and shoot borer : These can be controlled by pushing a small wick of cotton dipped in any liquid fumigant in the holes through which frass is being pushed out by the borer. All holes must be closed with mud paste after such treatment.
- Leaf Webber : The young larvae scrap the leaf surface along with veins and feed on epidermis of leaves by webbing 2 and 3 leaves with silken threads. The pest is active from April to November with peak period from July to October. For controlling the same measures as indicated under leaf defoliators can be adopted.
- Bark Eating Caterpillar : Nocturnal feeding larvae make L-shaped holes and wet silken threads entangled with fecal pallets. Pest is active throughout the year. Prune severely infested branches and spray suspension of 100 g Carbaryl 50 WP (Sevin / Hexavin) in 10 litres of water during September to October at feeding sites.
- Case Worm : The pest is active throughout the year. The caterpillars feed on bark from December to March, on leaf buds during March and April and on leaves from April to November. For controlling this a spray of Carbaryl 50 WP (Sevin / Hexavin) @ 1 Kg per acre is recommended.
- Leaf Hopper : The leaf hoppers are active from April to November with peak period of their activity from July to October. A spray of Oxydemeton-methyl 25 EC (Metasystox) @ 300 ml or dimethoate 30 EC @ 250 ml per acre is recommended.
- Rot of cuttings : Black dots appear on the cuttings at ground level and decay of bark takes place. Dip the cuttings for 15 minutes in 0.5 percent solution of Emisan-6 before planting.
- Leaf Spots : Brown to dark brown leaf spots of variable sizes appear on leaves. Severe infections lead to premature defoliation. Spray the crop with 0.25 percent Copper Chloride (Biltox 50) or Indofil M-45 at 15-20 days interval starting with first rain. Two to three sprays may be given.

- Pink Disease : Girdling of branches in young plants leads to death of parts. The height of tree is stopped due to repeated death of the leaders. Pink to Salmon colored mycelial growth appears on branches. Use resistant varieties or two to three prophylactic spray of Bordeaux mixture during two to four years of age at the beginning of the summer monsoon.
- Sunscald canker : Bark is killed due to insolation by heat and canker develops on the southern side of the stem. Protect from insolation and other injuries by white washing the main stem upto two meters from the ground level.
- Bark Bursts and Canker : Water oozes out through the wounds resulting in cankers. Avoid injury and high water table sites. Clean the wounds and apply Bordeaux paste or Emisan-6.

9. Yield and Returns

- Under reasonably good care poplars can attain 90 cm girth at breast height and mean annual increment of 20m³/ha (under bark) at 8 years rotation.

10. Utilization

- *Populus deltoides* has a medium hardwood, light, free from knots, easy to saw and work.
- The wood has good nail holding power and strength coefficient of *Populus deltoides* is comparable to well known woods used in packing cases and hence can be used for making cases for fruit and food stuffs.
- High yield pulps (71-80 percent) having excellent strength properties for newsprint could be prepared.
- Young poplars of 2-3 years age group are an excellent source of cellulose fibre for making various grades of fine paper, packing paper, newsprint, etc.
- An experiment conducted at Forest Research Institute, Dehradun indicates that *Populus deltoides* wood is suitable for preparation of hardboards, and that bark to the extent of 20 percent helps in improving the physical and mechanical properties of board compared to boards prepared alone with wood.
- Most of the poplar wood is used in the match and plywood industry.
- The species is suitable for making general purpose plywood, marine plywood, concrete shuttering plywood. It is also considered suitable for the manufacture of artificial limbs,

sports goods and for structural uses such as false ceilings, partition and almirah shelves, etc.

- It has also been found suitable as line supports for overhead power and telecommunication lines.
- The white furniture made out of poplar wood is becoming popular in towns of Punjab.

A-C Zone : Upper Gangetic Plains Region
Situation : Irrigated

Tree-Crop Combination: Agrisilviculture
Tree : *Populus deltoides*
Crops : Paddy, Wheat

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.				Benefits Per Ha.				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	22000	4320	3360	29680	0	7200	5600	12800	-16880
2	12000	4104	3192	19296	0	6840	5320	12160	-7136
3	12000	3888	3024	18912	0	6480	5040	11520	-7392
4	12000	3672	2856	18528	0	6120	4760	10880	-7648
5	12000	3456	2688	18144	0	5760	4480	10240	-7904
6	12000	3240	2520	17760	0	5400	4200	9600	-8160
7	0	3240	2520	5760	600000	5400	4200	609600	603840
Net Present Value at 15% Discount Factor				82,292				272,533	190,241

Assumptions :

Tree : *Populus deltoides* : Rotation 7(1)

1. No. of trees/ha. = 500

2. Income per tree : Rs.1200 (in the 7th yr.)

3. Expenses per ha. : Yr.1 = 22000 , Yr.2 & onwards = Rs.12000

Crops :

1. Yield per ha. Rice Wheat
 1600 kg. 1400 kg.

2. Sale price per kg. Rs.4.50 Rs.4.00

3. Expenses per ha. Rs.4320 Rs.3360

Note : 1. There is reduction in area under crop from 2nd to 7th year due shade effect of tree

2. Investment includes expenses on trees for 6 years and expenses on crop in the first year.

Analysis :

Benefit Cost Ratio at 15% Discount Factor :

3.31

Net Present Value in Rs. at 15% Discount Factor :

190,241

IRR :

68%

Investment

Year 1 Rs.29680

Year 2 to 6 Rs.60000

Total Rs.89680

Source: Report of the task force on greening India for livelihood security and sustainable development. Planning Commission, Government of India, July-2001.