



## **PAULOWNIA FORTUNEI : A WONDER TREE FOR AGROFORESTRY SYSTEMS**



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## FOREWORD



'The wonder tree' *Paulownia* is well known and accepted by farmers since 1960's in China. The productive *Paulownias* are being tried in different countries and showing good performance. Many of them have given high performance potential in certain localities in India. Since, India faces huge timber shortage for her domestic and industrial requirements therefore, to bridge gap between timber demand and supply, *Paulownia* may play a substantial role. Fast growing *Paulownia* is the recent introduction and now it has been grown in many states of the country. Its systematic introduction as an agroforestry species was initiated for the first time in Doon Valley of Uttarakhand during 1998. People, who have noticed its fast growth on Indian soil sites are increasingly seeking technical advice and propagation material for its raising. CSWCRTI has worked extensively on this species for the last 15 years and has been instrumental in its systematic introduction. In China, *Paulownia* is claimed as the "Champion of fast growing trees". There is a saying among farmers that "it looks like a pole in one year, an umbrella tree in 2 years and can be sawn into boards in 5 years".

There are various types of *Paulownia* - intercropping systems on flat agricultural lands. Among the different systems, generally the best is *Paulownia* + wheat - maize for young stands. The *Paulownia* crop intercropping (PCI) has all the good characteristics with high economic values for planting in multiplefunction agroforestry systems. As a useful ecological system to promote the productivity of land PCI has been adopted as new farming system in India. However, further improvement on PCI is needed to achieve higher yield.

Salient features of the *Paulownia* based agroforestry system developed by CSWCRTI, Dehradun have been described for the benefit of the farmers and user agencies in this brochure. I am quite confident that the production potential of a larger cultivated area in India can be significantly increased by using this technology.

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# PAULOWNIA FORTUNEI: A WONDER TREE FOR AGROFORESTRY SYSTEMS

## INTRODUCTION

- ❖ *Paulownia* - a fast growing multipurpose tree species indigenous to China is a recent introduction in India.
- ❖ It has a wide range of distribution and can be grown upto 2400 m above mean sea level both on hills and valleys.
- ❖ All the *Paulownia* species except *P. catalpifolia* may be grown in sub-tropical region while *P. fortunei*, *P. kawakamii* and *P. australis* are suitable for tropical zone.
- ❖ Out of nine commercial species, *Paulownia fortunei* is best suited for Indian climatic conditions.
- ❖ It is an ideal agroforestry tree species which effectively protects the under storey crops and favourably modifies the micro-climate.
- ❖ In India there is a great scope of *Paulownia* cultivation with field crops, plantation crops, oil seed crops, medicinal plants, vegetables, grasses and other cash crops to fulfill food, fodder, fuel, timber and other requirements.

## IMPORTANCE

- ❖ It is grown for beauty and highly prized wood, used extensively for buildings, paper making, timber, furniture, plywood, musical instruments, packing cases, boards, charcoal etc.
- ❖ The flowers are ideal source of nectar; leaves are desirable fodder for livestock as they contain high amount of protein (18%) and nitrogen (3.28%) and are an excellent source of green manure. It possess many medicinal properties also.
- ❖ *Paulownia* can also be used for reclamation of mined areas, degraded bouldery riverbed lands and other wastelands.
- ❖ Under best management practices and adequate silviculture care, it can grow to a height of 7.5 m in the first growing season (Photo 1). However, under optimum conditions, it can produce useful timber within five to six years.



Photo1: Luxuriant growth (7.5 m) of *Paulownia* seedlings under nursery conditions

## ABOUT THE TECHNOLOGY

- ❖ Technology was developed for crop production as inter crops in *Paulownia* based agroforestry system under rainfed conditions of Doon Valley (Photo 2).
- ❖ *Paulownia* grew successfully in association with maize and wheat crops with a higher survival rate over the time tested poplar species.



Photo2: *Paulownia* + maize based agroforestry system on farmer's field under rainfed condition

- ❖ *Paulownia* clone-GP out performed among all the clones of the two species (*Paulownia* and poplar) which recorded maximum survival and growth (height, collar diameter, DBH and crown).
- ❖ *Paulownia* and poplar did not have any negative effect on growth and yield parameters of maize and wheat crop which indicates the compatibility of both the crop with trees.

## METHODOLOGY

- ❖ Study was carried out on farmers' fields in Doon valley to evaluate the performance of *Paulownia fortunei* and *Populus deltoides* as the tree component of the agroforestry system in combination with maize-wheat crop rotation.
- ❖ One-year-old plants of *Paulownia fortunei* (C020, C03 and Guozhou Provenance) and *Populus deltoides* (G-48 and D-121) of uniform size were planted in 45x45x60 cm pits at 6x5 m spacing during the last week of December, 1997.
- ❖ No fertilizer or manure was added in the pits.
- ❖ Maize (in *kharif*) and wheat (in *rabi*) were grown in combination with *Paulownia fortunei* and *Populus deltoides*.
- ❖ Growth parameters of *Paulownia fortunei* and *Populus deltoides* were recorded in the month of November and December every year.

## TREE GROWTH AND BIOMASS PRODUCTION

### Survival

- ❖ Highest survival (87.5%) was recorded in *Paulownia* clone-GP followed by *Paulownia* clone-C0<sub>3</sub> (86.5%). Since, poplar grow well under irrigated conditions, therefore, its survival was adversely affected due to rainfed conditions.
- ❖ *Paulownia* clones have the capacity to survive and perform better even under adverse edapho-climatic condition. Therefore, it showed higher survival over the poplar under the rainfed conditions of Doon valley.

- ❖ The survival of *Paulownia* was 150% higher as compared to the poplar which varied from 33.9% in poplar clone (D-121 and G-48) to 87.5% in *Paulownia* clone-GP (Photo 3).



Photo 3: Flowering of *Paulownia* (2<sup>nd</sup> year) in agroforestry system

### Height

- ❖ There is no significant difference in the height of *Paulownia* and *Populus* when grown under rainfed agroforestry system. This is due to the genetic makeup of the clones and its interaction with the micro-site where the trees are grown.
- ❖ Height varied from 4.6 m in poplar clone G-48 to 4.9 m in *Paulownia* clone-GP. The tallest plants were of the *Paulownia* clone-GP followed by the *Paulownia* clone-CO20.

### Collar Diameter and Diameter at Breast Height

- ❖ Diameter at breast height (DBH) and collar diameter (CD) indicated a significant variation between the clones but not within the clones of *Paulownia* and poplar species.
- ❖ Maximum DBH (8.7 cm) and CD (13.2 cm) was observed in *Paulownia* clone-GP whereas minimum DBH (3.5 cm) and CD (4.7 cm) was recorded in poplar clone D-121.
- ❖ Collar diameter in *Paulownia* was almost 3 folds higher than poplars which were not affected in presence of crops.

### Leaf area

- ❖ Leaf size of trees showed significant difference between *Paulownia* and poplar. However, maximum leaf area (949.6 cm<sup>2</sup>) was recorded in *Paulownia* clone-C03 followed by *Paulownia* clone-GP (876.6 cm<sup>2</sup>) and minimum (147.3 cm<sup>2</sup>) with poplar clone D-121.
- ❖ Leaf area measured in *Paulownia* was more than Poplar indicating bigger leaf size which reduces gradually over the years (Fig. 1). The reduction of leaf size in subsequent years is

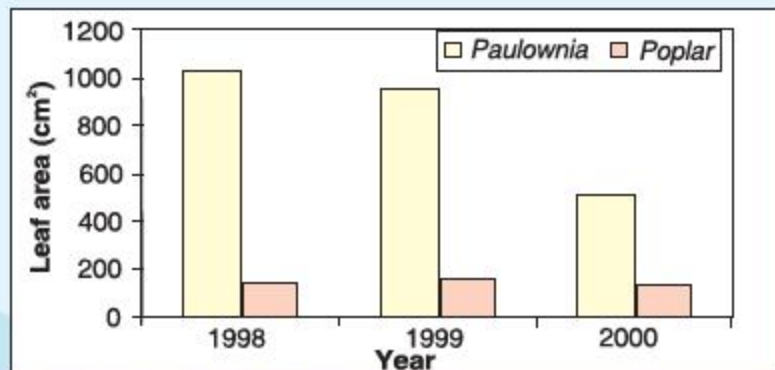


Fig. 1: Leaf size reduction in *Paulownia* over the years under agroforestry system

advantageous in agroforestry as it determines the amount of shade casted on the ground.

### Leaf nutrients

- ❖ Leaf nutrient contents (NPK and protein) were higher in *Paulownia* as compared to poplar which indicates its excellent fodder quality as well as a green manure.
- ❖ Maximum nitrogen (3.02%) and protein contents (18.84%) were observed in leaves of *Paulownia* (clone-GP) while higher phosphorus and potassium were recorded in *Paulownia* clones-CO20 and CO3.

### Tree biomass production

- ❖ Maximum fresh leaf yield ( $14.8 \text{ q ha}^{-1}$ ) was obtained from *Paulownia* clone-GP followed by *Paulownia* clone-CO20 ( $14.3 \text{ q ha}^{-1}$ ) and minimum ( $4.5 \text{ q ha}^{-1}$ ) from Poplar clone D-121.
- ❖ Maximum annually lopped fuel wood ( $32.5 \text{ q ha}^{-1}$ ) was recorded in *Paulownia* clone-GP followed by *Paulownia* clone-CO20 ( $28.4 \text{ q ha}^{-1}$ ), whereas it was minimum ( $4.5 \text{ q ha}^{-1}$ ) in Poplar clone G-48.
- ❖ Highest total biomass production was obtained from *Paulownia* clone-GP ( $47.3 \text{ q ha}^{-1}$ ) followed by *Paulownia* clone-CO20 ( $42.7 \text{ q ha}^{-1}$ ) and minimum ( $9.6 \text{ q ha}^{-1}$ ) in Poplar clone D-121.
- ❖ Tree survival, growth characteristics and biomass yield of two tree species indicated that over all *Paulownia* performed better (Photo 4) than poplars among all the treatments except leaf area over the years. The *Paulownia* clone-GP recorded the maximum survival, height, collar diameter, DBH, leaf yield, fuel wood and total biomass.



Photo 4: *Paulownia* on farmer's field with ground nut crop under rainfed condition in Doon Valley

## CROP PERFORMANCE

### Maize

- ❖ There is no adverse effect of *Paulownia* and poplar on growth and yield of maize. No yield reduction of maize under the *Paulownia* and poplar based agroforestry system was observed.
- ❖ *Paulownia* + wheat-maize (1 to 4 years) stands are the best system. Hence, maize crop can successfully be grown in association with the two species without having any reduction in growth and yield under rainfed conditions of Doon Valley.

### Wheat

- ❖ *Paulownia* and poplar did not have any significant negative effect on growth and yield parameters of wheat when grown in association with these trees.
- ❖ This indicates compatibility of intercrop with the *Paulownia* and poplar in agroforestry practice under rainfed conditions.
- ❖ Maximum plant population, height of plants and number of leaves were recorded under *Paulownia* followed by poplar.
- ❖ Thus, these trees have great potential under agroforestry situations in similar agro-climatic conditions of India.

## ECONOMICS OF THE SYSTEM

- ❖ *Populus* species has proved most successful in Northern India on large scale under agroforestry practices with a yield variation from 10 m<sup>3</sup> to 25 m<sup>3</sup> ha<sup>-1</sup> yr<sup>-1</sup>.
- ❖ Total biomass of *Populus* under agroforestry at the age of 8 years varied from 86 t ha<sup>-1</sup> to 126 t ha<sup>-1</sup> in Dehradun and Haldwani areas, respectively. In one ha area (with 400 trees) it fetched about ₹ 1,50,000 ha<sup>-1</sup> yr<sup>-1</sup> within a short rotation of 7-8 years in addition to the normal crop yields.
- ❖ *Paulownia* grows faster than poplar and produces useful timber within five to six years. *Paulownia* can be harvested twice in the same duration with double income due to short rotation.

## BENEFITS OF THE TECHNOLOGY

- ❖ Growth and production showed that the *Paulownia* performed better than time tested agroforestry species - poplar and other indigenous tree species under rainfed conditions.
- ❖ *Paulownia* was found suitable for agroforestry system (Photo 5) integrating *Paulownia* + wheat and *Paulownia* + maize as it does not have any competition with these agricultural crops.
- ❖ Light penetration is good for all times (40-50%); in *Paulownia* it is 20% higher than Poplars and 38% more than *Robinia*, therefore, increased yields of intercrops can be realized.
- ❖ *Paulownia* adds more organic matter and nitrogen to the soil. Highest nitrogen



Photo 5: Growth of *Paulownia* (3 year) in agroforestry system under rainfed condition

(3.02%) content was present in the leaves of *Paulownia* clone-GP.

- ❖ Under best management practices and adequate silviculture care, *Paulownia* can grow to a height of 7.5 m in the first growing season and can give an annual increment of 8-9 cm in DBH and 0.2 m<sup>3</sup> in volume production. However, under optimum conditions, it can produce useful timber within five to six years.

## SCOPE OF THE TECHNOLOGY

Prospects of *Paulownia* farming are bright in Indian conditions (Photo 6) due to its easy establishment with incredibly fast growth rate. Early results on growth performance of *Paulownia* indicate great promise of the species in certain localities. Hence, it is highly desirable to grow this species with agricultural crops in agroforestry system for leaf fodder, fuelwood and wood for small timber for rural housing and wood based industries. There are numerous potential sites for introduction and farming of *Paulownia* in India where biophysical conditions are similar to those of naturally growing and planted *Paulownia* in China.



Photo 6: Growth of *Paulownia* (5 year) In Agroforestry System under Doon Valley condition