PAUOWNIA FORTUNEI: A WONDER TREE FOR AGROFORESTRY SYSTEMS

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"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 multiple function 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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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 up to 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.

IMPORTANT

- 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.

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.
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-C01 (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).

**Height**

- There is no significant difference in the height of Paulownia and Populus when grown under rainfed agroforestry system. This is due 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-C020.

**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 cm²) was recorded in Paulownia clone-C03 followed by Paulownia clone-GP (876.6 cm²) and minimum (147.3 cm²) 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
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-C020 and C03.

Tree biomass production

- Maximum fresh leaf yield (14.8 q ha⁻¹) was obtained from Paulownia clone-GP followed by Paulownia clone-C020 (14.3 q ha⁻¹) and minimum (4.5 q ha⁻¹) from Poplar clone D-121.
- Maximum annually lopped fuel wood (32.5 q ha⁻¹) was recorded in Paulownia clone-GP followed by Paulownia clone-C020 (28.4 q ha⁻¹), whereas it was minimum (4.5 q ha⁻¹) in Poplar clone G-48.
- Highest total biomass production was obtained from Paulownia clone-GP (47.3 q ha⁻¹) followed by Paulownia clone-C020 (42.7 q ha⁻¹) and minimum (9.6 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.

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 m³ to 25 m³ ha⁻¹ yr⁻¹.
- Total biomass of *Populus* under agroforestry at the age of 8 years varied from 86 t ha⁻¹ to 126 t ha⁻¹ in Dehradun and Haldwani areas, respectively. In one ha area (with 400 trees) it fetched about ₹ 1,50,000 ha⁻¹ yr⁻¹ 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 (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 m³ 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.

[Photos: Growth of *Paulownia* (3 year) in agroforestry system under rainfed condition, Growth of *Paulownia* (5 year) in Agroforestry System under Doon Valley condition]