A SPECIAL IPC[1] WORKING PARTY ON COMMUNICATION AND OUTREACH (WP-COM) HIGHLIGHT SERIES:

'GLOBAL APPLICATIONS OF FAST-GROWING TREES IN AGROFORESTRY SYSTEMS'

Stabilizing Root Systems of Poplar Trees in Agroforestry Systems

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Overview

In agroforestry, food crops and timber trees are integrated on the same land area without compromising yield and/or degrading natural resources. In the northwestern states of India, poplars (*Populus deltoides* Bartr. ex Marsh.) have become favorite trees among agroforestry adopters. Poplars improve timber supply and provide additional income, including through employment of rural poor.

Though poplar trees have successfully been integrated into Indian farms (Fig. 1), their shallow root systems compete with inter-cultivated agricultural crops for nutrients and moisture. Poplars propagated through cuttings prominently develop adventitious root systems, but these roots tend to grow profusely in the upper soil horizon, thereby competing with agricultural crops, and leading to reduced crop yield.

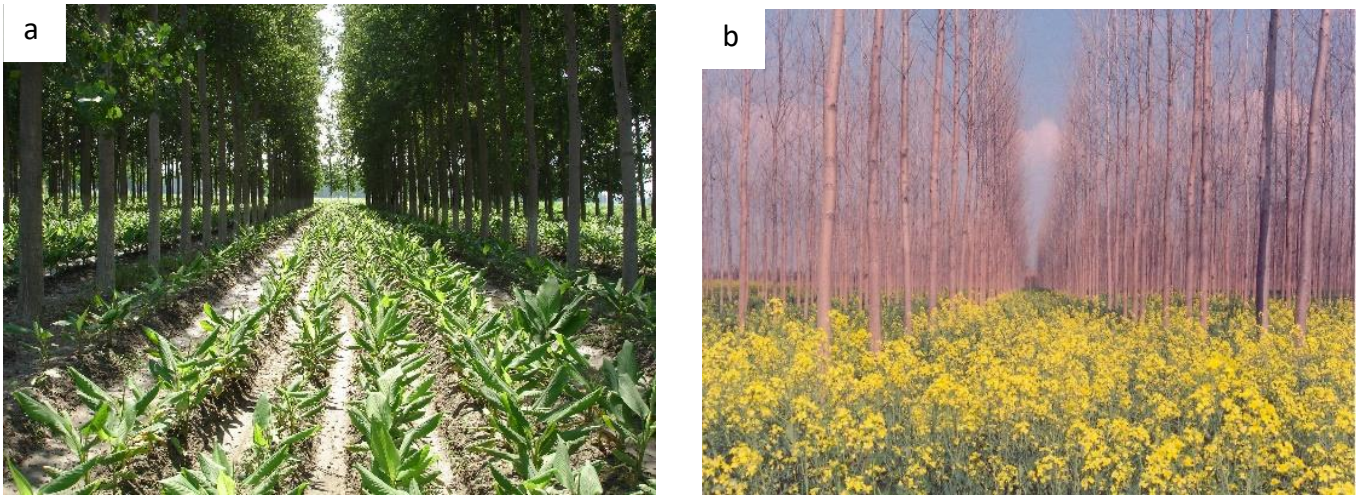

Figure 1. Remunerative poplar-based agroforestry models: a) poplar-turmeric model, and b) poplar-marigold model.

There is a need for methods to minimize root competition between poplars and annual crops in agroforestry systems. One option is to dig trenches on both sides of the tree rows, however, this limits mechanical cultivation and restricts total workable area in agroforestry plots. Another option is to implement polyethylene sheets on both sides of the tree rows, or around the trees at a distance of 1 m, to restrict tree roots from extending horizontally.

[1]The International Commission on Poplars and Other Fast-Growing Trees Sustaining People and the Environment (IPC)

All photos by the authors.

Outcomes

In field trials, 1 m^3 pits lined with polyethylene sheets led to the development of fibrous root systems, as compared to the thick roots produced in 1-m^3 pits without polyethylene lining (Fig. 2). During the first year, the polyethylene sheets prevented poplar roots from extending beyond the sheet lining. In pits with polyethylene sheets, fibrous roots were common, and the direction of root growth was restricted as they circled along the polyethylene sheet.

Figure 2. *Populus deltoides* root systems and the effects of polyethylene lining on *Populus* root architecture.

Plants with smaller-diameter roots tend to have greater physiological capacity for resource uptake and greater ability to respond to changes in their resource environment than those with larger-diameter roots. This results in enhanced growth and biomass production for plants with smaller-diameter roots. In light soils, poplars grown in 1-m^3 pits produced 53 percent more aboveground biomass than those grown in traditional auger holes (20-cm diameter and 1-m deep). However, growing poplar trees in 1-m^3 pits on light soils poses the risk of eventual uprooting of the trees. The shallow root system in these pits would not be able to support the trees against strong winds as the crowns get heavier.

A good knowledge of belowground interactions between trees and agricultural crops is needed to properly manage these components and maximize the benefits from tree-crop combinations. Studies on root architecture are also essential to guide farmers in selecting the correct method of planting to avoid competition with inter-cultivated crops. Inserting polyethylene sheets around planting pits plays a critical role in redirecting horizontal tree roots downward to source nutrients from lower soil horizons instead of top layers, thereby minimizing competition with inter-cultivated agricultural crops, and providing stability against strong winds for the poplar trees.

Keywords: *Populus*, root competition, root architecture, root management

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