



Research Article

Assessment of agroforestry based two-tier-cropping system in Ambala district of Haryana

■ DEVENDER CHAHAL, AFZAL AHMAD AND J.N. BHATIA

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SUMMARY : In North-Western Indo-Gangetic plains (IGP), Poplar based horti-Agro-Forestry models have been adopted by the farmers. The farmers grow poplar due to its fast growing habit, short duration, compatibility with the different crops, eco-friendly and multi-purpose uses in different industries. Poplar is a deciduous tree and very suitable for horti- agro-forestry system. It has no shading effect on various crops rather adds to soil fertility through its leaf litter. Wheat, oat, sorghum, maize, sugarcane, berseem, turmeric, ginger and potato can easily be grown as inter crops. The results obtained during the course of rotation of six years study (from December 2000 to December 2006) revealed that yield of all the inter sown crops decreased appreciably after two to three years of poplar plantation but this yield loss often compensated by the sale of poplar wood at the end of the rotation. The results of this six year study at KVK farm revealed that in case of poplar plantation the maximum girth size (29.73 inch) was obtained with T₁ (Poplar + Sugarcane) followed by T₂ (Poplar + Turmeric) where the girth size was 28.66 inch, and the minimum girth size (25.06 inch) was with T₅ (Poplar alone). Similarly the maximum timber wood (115.37 t/ha) was also obtained with T₁ followed by T₂ (100.46 t/ha) and the minimum timber wood (54.68 t/ha) was obtained with T₄ (Poplar + Rainfed Wheat/Lentil). Economic analysis showed that the highest net income (Rs.64,355 /ha/annum) was obtained with T₁ followed by T₂ (Rs.59,543 /ha/annum) and the lowest net income (Rs.18,719 /ha /annum) was obtained with T₄ followed by T₅ (Rs. 20188/- ha / annum), where as on the basis of cost of cultivation, the average net return from paddy-wheat rotation which is generally followed in this region was about Rs. 22970 /ha/annum during that period. Hence, the poplar based two-tier cropping system is more economical than the monocropping of agricultural crops and to be a very good alternative to paddy-wheat rotation in Indo-Gangetic plains.

KEY WORDS:

Girth size, Timber wood, Net return

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BACKGROUND AND OBJECTIVES

In Indo-Gangetic plains of India comprising mostly North-Western states *viz.* Punjab, Haryana, Uttar Pradesh, Utrakhand, lower part of Himachal Pradesh and Jammu and Kashmir, commercial cultivation of poplar (*Poplar deltoides* Bartr.) trees has been adopted by a number of farmers. In this region, sugarcane, turmeric, wheat, oilseeds (toria, mustard, gobhi sarson) or pulses (lentil, summer moong, gram and urd) are conventionally grown by most of the farmers as a sole crop.

However, because of minimum support price and better marketing facilities, the adoption of paddy-wheat cropping sequence is increasing rapidly and causing a lot of pressure on areas

covered under these crops as well as on the forest plantation. Therefore, to save the forest and also to maximize the net returns from minimum piece of agricultural land by putting the land in best possible use, the time has come that we should extend the forests to agricultural land by demonstrating the appropriate Horti-Agro-Forestry based cropping models (Deb Roy, 1990., Thind, 2006).

All tree species cannot be grown in such a model called Horti-Agro-Forestry, comprising horti-agricultural crops plus forest tree species. The tree species selected for this purpose should fulfill some requirements *viz.* grow fast, grow straight, shed leaves during winter, have thin crown, have deep taproot system and not harbour

Author for correspondence :

DEVENDER CHAHAL
Department of
Horticulture, Krishi
Vigyan Kendra, AMBALA
(HARYANA) INDIA
Email:devenderchahal@
rediffmail.com

See end of the article for
authors' affiliations

the insect-pests and birds harmful for agricultural crops. Poplar is such a species, which fulfills many of these requirements.

The farmers grow poplar due to its fast growing habit, short duration, ease of regeneration, good market demand, compatibility with different crops, eco-friendly and multi-purpose uses in different industries. Poplar is a deciduous tree and much suitable even for horti-agro-forestry based multi-storey cropping system. Poplar plantations intercropped with agricultural crops have better growth than those without intercrops and growth of trees is variable under different intercrops. During initial stage, it has least effect on various crops rather adds to soil fertility through its leaf litter. Wheat, oat, sorghum, maize, sugarcane, berseem, turmeric, ginger or potato can easily be grown as an intercrop. However, at early age poplar cause less adverse effects on under forestry crops but at later stages reduces the crop stand due to more production of leaf litter. Kohli *et al.* (1997) also reported that allelopathic effect of poplar trees played a vital role in growth suppression of associated crops or under forestry vegetation.

Thus to make the poplar based two-tier-cropping system more remunerative in different regions, there is a need to select few most suitable intercrops having good demand in nearby market and also boost up the growth of poplar trees. Keeping this in view, a study was initiated to assess the performance of poplar plantation intercropped with different crops and to select the most remunerative intercrop for cultivation under poplar plantation during the six years of cropping period.

RESOURCES AND METHODS

The study was conducted at the demonstration farm of Krishi Vigyan Kendra, Ambala (Vill. Tepla), Haryana for the six years cropping period of poplar plantation from December 2000 to December 2006. The farm is situated at 30°18'20" N, 26°55'46" and 265m above mean sea level. Annual rainfall during six years cropping period varied considerably and the maximum rainfall (1100 mm) was received in 2006-07, whereas, minimum rainfall (275 mm) was recorded in 2005-06.

The experimental soil (0-15cm depth) was sandy loam in texture, normal in pH level (7.8), normal in EC (0.21 ds/m), low in organic carbon (0.34%), low in available N (206 kg/ha), medium in available P (P_2O_5 35 Kg/ha), medium in available K (K_2O 225 kg/ha) and rich in micronutrient (Zn 1.4 ppm, Fe 32.04 ppm and Mn 21.60 ppm). Experiments were carried out by cultivating different crops in combination with popular block plantation (plot size 8x40m) for 6 successive years. For poplar plantation (G-48 clone), plant to plant spacing of 4m was kept in both directions (*i.e.* East-west and North-south) to facilitate the movement of tractor in both directions for easy inter-culture operations and to maintain a sufficient tree population (600 trees/ha) for good returns and the poplar saplings were planted in the month of February 2001.

During first year of poplar plantation, all the recommended cultural practices, even gap-filling of dead saplings were carried out uniformly in all the plots as followed in sole poplar crop. In the next five years, the application of fertilizer doses at the increasing rate of 50 g NPK in 2:1:1 ratio per year per tree and the pruning operations were adopted uniformly in all the plots. Thick and vertical branches competing with leader shoot or main stem were pruned during the leafless period in second, third and fourth years of planting.

The growth parameters *viz.*, girth size, clear bole length and weight of timber wood of 10 selected trees, having good commercial value in each plot, were measured in December, 2006 and average values were calculated. Observations about number of survived trees up to harvesting stage in each plot were also recorded and converted into the survival percentage of poplar trees under different agro-forestry systems.

Girth at breast height (GBH) was measured by measuring tape at the height of near about 1.37 m from ground level just before the uprooting of the tree. The clear bole length, having commercial value (*i.e.* girth size > 10 inch) was also measured with measuring tape just after the uprooting of tree. For collecting data on production of timber wood by poplar plantations, the timber wood logs obtained from 10 selected trees in each plot were weighed according to their girth sizes as well as commercial values in local market and the total timber wood production in each plot was calculated. Similarly, on the basis of commercial values of different girth size logs, the gross income from poplar plantation under different agro-forestry systems was calculated.

In this study five poplar based crop combinations (intercrops) were assessed. In first combination (poplar + sugarcane), sugarcane crop (cv. CoS-767) was inter sown first time in February 2001 just after the transplanting of poplar saplings and subsequently two ratoon crops were also taken during the next two cropping seasons. During the fourth year (2004-05), sugarcane crop (cv. CoS-8436) was again planted after the preparatory tillage in the month of February and in the next cropping season (2005-06) ratoon crop was also obtained. So, during this course of six years rotation, five sugarcane crops were grown successfully by adopting general recommended practices as followed in sole sugarcane crop at KVK farm. In second combination (poplar + turmeric), first time the turmeric crop (cv. Rajapuri) was seeded in March, 2001 and in the next five years four more crops were grown. So, during the six years cropping period of poplar, total five turmeric crops were grown successfully by adopting general recommendations as followed in sole turmeric crop. In third combination (poplar + wheat/oilseed crops), first time wheat crop (cv. PBW-299) was sown in late November, 2000 before the plantation of poplar saplings and in the next year the same cultivar was grown. But in the year 2002-03, oilseed crop (toria cv. T-9) was followed by the late sown wheat crop (cv. PBW-373). During the next

two *Rabi*-cropping seasons, wheat (cv. PBW-373) and gobhi sarson (cv.GSL-2) crops were grown in 2004-05 and 2005-06, respectively. All these six crops were grown by adopting general recommended package of practices as followed in sole crops.

In fourth combination (poplar + rainfed wheat/lentil), first time rainfed wheat cultivar (PBW-396) was sown in late November, 2000 and in the next two successive years the same cultivar was grown with early November sowing. But in the next three *Rabi*-cropping seasons (year 2003-04, 2004-05 and 2005-06), instead of wheat, lentil crop (cv.Sapna) was grown with poplar plantation. However, in this combination, 2-3 irrigations were applied to wheat at critical stages of the crop, but no irrigation was applied to lentil crop.

In fifth combination (poplar alone), however, no crop was grown under Poplar plantation but most of the recommended cultural practices were carried out as usually followed in monoculture plantation of poplar trees. All necessary plant protection measures were also adopted uniformly for controlling disease and pest incidence in poplar as well as other inter sown crops during this period.

The net returns in respect of inter sown crops under poplar plantations were worked out on the basis of year wise input cost, labor cost, inter-culture operation cost, irrigation cost, harvesting cost and output prices in local market. Similarly, net returns from poplar plantations were calculated on the basis of cost of cultivation (year-wise) and market value of harvested timber wood.

OBSERVATIONS AND ANALYSIS

The results obtained from the present investigation have been discussed in the following sub heads:

Poplar growth performance:

The commercially important poplar growth parameters *viz.*, girth size (GBH), Clear bole length (girth size > 10 inch), production of good quality timber trees (Nos./ha), survival percentage of timber trees up to harvesting stage and production of timber wood (t/ha) were significantly influenced

by the cultivation of annual or seasonal crops during the six years of cropping period (Table 1).

The maximum girth size (29.73 inch), largest clear bole length (31.44 ft.) and highest production of quality timber wood (115.37 t/ha) were obtained with sugarcane cultivation (T_1) followed by turmeric cultivation (T_2) where girth size 28.66 inch, clear bole length 28.11 ft. and production of timber wood 110.46 t/ha were recorded. The minimum girth size (25.06 inch) was recorded with control (T_5), whereas, shortest clear bole (25.44 ft.) and the lowest production of timber wood (54.68 t/ha) was recorded with rainfed wheat/lentil cultivation. Data (Table 1) revealed that significantly more girth size, longer clear bole and higher timber wood production in poplar plantation were recorded with T_1 and T_2 as compared T_3 , T_4 and T_5 (control). This can be attributed to the timely application of inter-culture operations, fertilization and irrigation in inter sown crop, which also coincided with the active growth period of poplar trees. Gill *et al.* (2008) also reported more girth size and higher plant height of poplar trees when inter-cropped with turmeric as compared to wheat crop.

Other growth parameters *viz.* production of good quality timber trees (no. /ha) as well as survival percentage of timber trees up to the harvesting stage were also significantly influenced by the cultivation of inter sown crops. However, these two parameters were also observed significantly higher in poplar sole crop (T_5) as compared to intercropped with wheat/oilseed crop (T_4) and rainfed wheat/lentil crop (T_3) and this can be attributed to the water stress conditions in these plots during the months of March, April and May which coincided with the flush of new leaves in poplar plantation.

Economics:

The viability of any horti-agro-forestry system depends upon the economic feasibility and the best treatment or cropping system not fetching appropriate economic return as compared to paddy-wheat cropping sequence in this region may not be acceptable to the farmers. By keeping in view, the economic yield of poplar as well as inter-sown crops was converted into monetary terms. From the present study, it is apparent (Table 2) that inter cropping of poplar plantation

Table 1: Commercially important poplar growth parameters influenced by intercropping of various crops

Sr. No.	Treatments	Girth size (inch)	Clear bole length (ft.)	Production of quality timber trees(Nos./ha)	Survival % age of trees upto harvesting stage	Production of timber wood (t/ha)
T ₁	Poplar+Sugarcane	29.73	31.44	557	77.97 (92.86)*	115.37
T ₂	Poplar+Turmeric	28.66	28.11	542	74.41 (90.33)	100.46
T ₃	Poplar+Wheat/Oilseed crops	25.60	26.55	486	64.26 (81.06)	71.21
T ₄	Poplar+Rainfed wheat/Lentil	25.33	25.44	445	59.28 (74.16)	54.68
T ₅	Poplar alone (control)	25.06	25.88	548	76.01 (91.35)	67.07
	S.E.±	0.22	0.15	14.64	5.76	2.23
	C.D. (P=0.05)	0.51	0.34	33.77	13.29	5.15

* Original values are given in parenthesis

Table 2 : Economics of two tier-cropping systems based on poplar plantation and intercropped with various crops for six years

Sr. No.	Treatments	Gross return from poplar (Rs./ha)	Cost of cultivation of poplar (Rs./ha)	Net return from poplar (Rs./ha)	Net return from other crops (Rs./ha)	Total net return in six years (Rs./ha)	Average net return /ha/ annum
T ₁	Poplar+Sugarcane	376464	24600	351864	34264	386128	64355
T ₂	Poplar+Turmeric	278760	24600	254160	103100	357260	59543
T ₃	Poplar+Wheat/Oilseed Crops	203184	24600	200784	16781	217565	36261
T ₄	Poplar+Rainfed Wheat/Lentil	118800	24600	94200	18116	112316	18719
T ₅	Poplar alone(control)	145728	24600	121128	Nil	121128	20188
T ₀	Paddy+Wheat cropping sequence*	--	--	--	--	137820	22970

* Average net return from Paddy-wheat cropping sequence at KVK farm is depicted just to compare the economic feasibility of two-tier-cropping systems. Note :- Gross returns from poplar block plantations were calculated on the basis of local market price of timber wood for that financial year (2006-07) :

Over-size (>24" girth size) :	Rs.3800/t
Under size(18-24" girth size) :	Rs.2600/t
SOKHTA (10-18" girth size) :	Rs.1900/t

with sugarcane (T₁) and turmeric (T₂) crops during the six years of cropping period was found highly economical and resulted in 2-3 times more net returns as compared to poplar sole crop (T₅) as well as intercropped with wheat/oilseeds/pulses (T₃ and T₄) on the *Rabi* cropping seasons of this period. Further more, the highest net returns from poplar plantation was obtained with T₁ (poplar + sugarcane), whereas, the highest net return from other crops was obtained with T₂ (poplar + turmeric) during the course of six years cropping period. This may be attributed to more adverse effects of increased canopy size of trees on sugarcane as compared to turmeric when grown as intercrops during the second half cropping period of poplar plantation. Interestingly, the averages net return obtained with T₄ (poplar +rainfed wheat/lentil) was lower than T₅ (control). This might be due to comparative higher mortality in these plots resulted in production of less number of timber trees.

To find out the economic feasibility of these horti-agro-forestry based two-tier cropping systems, the average net return/ha/annum was also compared even with paddy-wheat cropping sequence as commonly followed in this region. During this period, the average net return from paddy-wheat cropping sequence was obtained Rs. 22970/ha/annum at KVK farm.

Conclusion:

Conclusively, it has been established from the study that poplar, sugarcane and turmeric based two-tier cropping system

is highly remunerative and more economical than the mono cropping of poplar as well as other horti-agricultural crops and to be a very good alternative to paddy-wheat rotation in Indo-Gangetic-Plains (IGP).

Authors' affiliations :

AFZAL AHMAD, Department of Agronomy, Krishi Vigyan Kendra, Tepla, AMBALA (HARYANA) INDIA

J.N. BHATIA, Department of Plant Protection, Krishi Vigyan Kendra, AMBALA (HARYANA) INDIA

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