Chemical Science Review and Letters ISSN 2278-6783

Research Article

Economics of Entire Transplants (ETPs) Production of Poplar Species through Cuttings under Various Fertilization Regimes

T.A. Rather, S.A. Gangoo, Sheikh Bilal Ahmad, M.A. Islam*, G.M. Bhat, P.A. Sofi and A.A. Mir

Faculty of Forestry, Shere-e- Kashmir University of Agricultural Sciences and Technology of Kashmir, Benhama, Ganderbal-191201

Abstract

The study sought to investigate the economics of entire transplants (ETPs) production of poplar species (*Populus nigra*, *P. ciliata*, *P. alba* and *P. balsamifera*) through cuttings under various fertilization regimes in nursery under temperate conditions of Kashmir. The experiment was laid out in split plot design (SPD) in a well prepared nursery beds of (3.60 m^2) at a spacing of 60cm x 30cm with 36 treatments having the 4 species with 3 levels of N (N_0, N_{75}, N_{150} kg ha^{-1}) and 3 levels of P (P_0, P_{60}, P_{120} kg ha^{-1}) replicated three times during 2013 & 2014. Economic analysis of poplar plantation revealed that maximum benefit cost ratio (BCR) was shown by T_6 (2.62) followed by T_8 (2.51), T_9 (2.47), T_7 (2.32), T_5 (2.30), T_4 (2.33), T_2 (1.96), T_3 (1.93) and T_1 (1.77). However, T_6 (Rs. 639928) signified the highest net present value (NPV) followed by T_8 (Rs. 589859), T_9 (Rs. 583292), T_7 (Rs. 507423), T_5 (Rs. 503054), T_4 (Rs. 509623), T_2 (Rs. 371602), T_3 (Rs. 364887) and T_1 (Rs. 294260). Hence, T_6 (75 N kg ha^{-1} + 120 P kg ha^{-1}) having BCR of 1: 2.62 and NPV of Rs. 639928 has been recommended as the best treatment for ETPs production of *Populus nigra, P. ciliata, P. alba* and *P. balsamifera* through cuttings in nursery under temperate conditions of Kashmir.

Keywords: Poplar, Benefit cost ratio, Economics of nursery, net present value, *P. nigra, P. ciliata, P. alba* and *P. balsamifera.*

***Correspondence**
Author: M.A. Islam
Email: ajaztata@gmail.com

Introduction

Macro propagation of poplars through stem cuttings permit multiplication of superior genotypes which is an ideal option for the cultivation of the species on large scale, thereby augmenting forest productivity [1, 2]. The technique also helps the establishment of clonal seed orchards which will potentially provide adequate supply of quality planting stock of high genetic worth for operational afforestation programmes [3, 4]. The vibrant but fragile forest ecosystem of the Kashmir Himalaya also warrants the development of economical and time saving means for the proliferation of superior clonal stock [5, 6]. Poplars are grown as a cash crop generating employment in rural areas, raw material for wood based industries, revenue through taxation for the state government as well as meeting the objectives of National Forest Policy (1988) and rehabilitation of river banks for their protection and averting soil erosion [7-9]. Poplar wood is white in colour having suitable density with an even texture, easy to saw and work, has good carving quality indices and finishing quality [10]. Due to increasing demand for its wood, poplars culture is likely to expand within the RIPC and also to new locations in northeastern states along the Himalayan range for the benefit of the people and the country [11]. Haryana Forest Department has been growing different clones of *Populus deltoides* initially with the co-operation of WIMCO and now independently, for meeting the demand of farm forestry sector of the state. Progressive farmers have adapted to raising *Populus* nurseries for their own use and some have graduated in to successful nursery men. Rural educated unemployed youth who consider routine agricultural work below their dignity, do not mind becoming nurserymen. As such the idea of ETP (Entire transplants) nursery is rapidly catching on. Also, limited "gold rush" is evidenced in to this sector by urban prospectors, who want to make a quick buck. Many enterprising employees of Forest Department and Private Companies who possess nursery know how have joined hands in nursery raising. Different agencies are selling *Populus* ETPs at different rates commencing from Rs. 5 to 16 per ETP. This activity caters to an annual demand of between 1.5-2.0 million ETPs within and outside the states of Punjab & Haryana [12].

The total nursery stock grown in the country was 48 million, out of which around 25% remain unsold especially from the low quality nurseries [13]. Haryana is one of the leading states in poplar wood usage and also grows

appreciable number of saplings for planting within the state and also for supply to some other states [14]. Jammu and Kashmir, a hilly state with most of its area land locked between hill ranges, has also started growing sizeable number of poplar saplings for local planting by the growers. There is migration of some of the poplar based industry to this state because of low value of wood available there, which has increased the rate of planting and demand of its saplings within Kashmir valley. The state grows approximately 13 to 14 lakhs poplar saplings in the state. Recently, restrictions on transporting planting stock and wood across the state border have been imposed; hence, most of the planting stock is grown within the state itself. However major share of private nurseries is concentrated in south Kashmir followed by central Kashmir, north Kashmir, Jammu region and Ladakh region [11]. Keeping in view the multipurpose uses, rapid increase in growth and demand, it became necessary to determine the economic analysis of ETPs of poplars through cuttings in temperate condition of Kashmir, so that results are expected to be useful for the farmers who would like to undertake cultivation of poplar nursery.

Materials and Methods

The study of economic analysis of different poplar species was carried out in Faculty of Forestry, Wadura, Sopore located at Latitude of 34°-17°N and Longitude 74°-3°E above an altitude of 1524 m MSL. The maximum mean temperature was recorded in July (30.90^0 C and 30.40^0 C) minimum in November (-0.35° C and 0.16° C) during the plantation season *i.e.* 2013 & 2014. Rainfall was highest in the month of August 178.40 mm and September 193.70 mm whereas, minimum in November 17 mm and 19.60 mm, relative humidity was maximum in November 86.17% and October 92.29% minimum in July 48.13% and June 44.43%. The cuttings were taken from phenotypically superior trees already cultivated in and around Srinagar district. The fresh cuttings of 20cm length and 20mm diameter of uniform size were planted/ raised in the second fortnight of February in a well prepared nursery beds of (3.60 m^2) with a spacing of (60cm x 30cm) in three replicates employing split plot design. The total no. of cuttings planted per species was five hundred forty (540). Before planting, the cuttings were dipped in a copper-oxy-chloride 150 WP fungicide solution @ 3g liter^{-1} of water for half an hour. For planting holes were made in the nursery beds with the help of a planting rod, slightly thicker than cuttings with a sharpened lower end. The cuttings were planted in these holes with thinner end up in such a way that the upper portion was just 2 mm above the soil. The soil was firmly pressed around the cutting so that the cuttings come in contact with mineral soil. In order to prevent desiccation losses the cuttings were planted in such a manner that the slanting cut is faced towards east. The cuttings were given flood irrigation just after completion of planting [15]. The study was consisted of 36 treatments having four species *Populus nigra* (S_1), *P. alba* (S_2), *P. ciliata* (S_3) and *P. balsamifera* (S_4) with three levels of Nitrogen and Phosphorus each @ N_0, N_{75}, N_{150} kg ha^{-1} and P_0, P_{60}, P_{120} kg ha^{-1} applied into nine combinations *viz*., $T_1 = N_0P_0$, $T_2 = N_0P_{60}$, $T_3 = N_0P_{120,}$ $T_4 = N_{75}P_{0,}$ $T_5 = N_{75}P_{60,}$ $T_6 = N_{75}P_{120}$, $T_7 = N_{150}P_0$, $T_8 = N_{150}P_{60,}$ and $T_9 = N_{150}P_{120,}$

The fertilizer was applied in two split doses, first in the second fortnight of April after bud burst in cuttings and second dose in the second fortnight of June at the time of weeding/ hoeing in poplar cutting beds. The nitrogen was supplemented through urea and diamonium phosphate (DAP) while phosphorus was supplemented through single super phosphate (SSP) and DAP. The dosage was determined after calculating the percentage of N and P available in different fertilizers. The cultural operations, like irrigation, weeding and singling were carried out from time to time. Uniform irrigation was given to the experimental trial at fortnightly intervals for first two months *i.e.* up to April and from April onwards irrigation was given at ten days intervals [15]. Weeding and hoeing were done as per the requirement at monthly intervals and utmost care was given to the cuttings to avoid any kind of disturbance. Singling was done in the month of July leaving only one promising shoot of each plant to grow and the additional shoots were detached from the plant with the help of sharp sketchers without causing any splinting damage. Benefit Cost Ratio (BCR) and Net Present Value (NPV) have been computed to work out the financial viability of ETPs production of *Populus nigra, P. ciliata, P. alba* and *P. balsamifera* using following formula by discounting @ 12% per annum [16].

$$NPV = \sum_{t=1}^{n} (B_t - C_t)/(1+i)^t$$

Where, B_t = benefits in year t, C_t= cost in year t, n = number of year i = discount rate (12%)

$$BCR = \frac{\sum_{t=1}^{n} (B_T)/(1+i)^t}{\sum_{t=1}^{n} (C_t)/(1+i)^t}$$

Where, B_t = benefits in year t, C_t= cost in year t, n = number of year i = discount rate (12%)

The input costs were calculated for (a) Land rental (b) Planting material (c) Farm equipments (d) Poles for fencing (e) Barbed wire (f) Preparation of land (g) Planting of cuttings (h) Fertilizers (i) Irrigation (j) Weeding cum hoeing (k) Watch and ward (l) Singling (m) Contingency cost and (n) Miscellaneous expenditure. the output costs were. The outputs (income) were computed based on the rate of ETPs differentiated as per the height, diameter and age in the local markets. The income from production of ETPs was calculated per plot basis and then extrapolated into income hectare^{-1} basis.

Results and Discussion

The input costs (land rental, cost of planting material, fencing with poles and barbed wire, land preparation, fertilizer application, equipment, watch and ward, weeding/ hoeing, irrigation and de-budding) for raising ETPs of *Populus nigra*, *P. ciliata*, *P. alba* and *P. balsamifera* (**Figures 1-4**) for commercial purposes decreased successively from first year to second year (**Tables 1** and **2**). The very marginal difference in input cost between 1st and 2nd year was due to the fact that the cost of land preparation and material cost included in the total input cost for the first year has been excluded in the second year while only recurrent cost were included in subsequent year. The total cost component incurred was maximum in T_9 (Rs. 395708) and minimum in T_1 (Rs. 378184) after two years (**Table 3**). The higher input cost in T_9 was due to the additional cost of fertilizers than T_1. The survival (%) as well as growth in terms of height and diameter per plot increased successively with the increase in treatment of fertilizer N and P either individually or in combination (**Table 4**). The maximum survival (%) per plot as well as growth in terms of height and diameter was recorded at T_6, T_8 and T_9 which were found at par with each other but differ significantly over other treatments.

Figure 1 ETPs production of *P. nigra*

Figure 2 ETPs production of *P. ciliata*

Figure 3 ETPs production of *P. alba*

Figure 4 ETPs production of *P. balsamifera*

Table 1 Input cost (Rs. annum^{-1}) of ETP production of poplar species under different treatments in 1st year

Particular	Treatment								
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Land rental	30000	30000	30000	30000	30000	30000	30000	30000	30000
Planting material	55555	55555	55555	55555	55555	55555	55555	55555	55555
Poles for fencing	20000	20000	20000	20000	20000	20000	20000	20000	20000
Barbed wire	40000	40000	40000	40000	40000	40000	40000	40000	40000
Land preparation	34000	34000	34000	34000	34000	34000	34000	34000	34000
Equipments	20000	20000	20000	20000	20000	20000	20000	20000	20000
Planting of material	12000	12000	12000	12000	12000	12000	12000	12000	12000
Irrigation	6000	6000	6000	6000	6000	6000	6000	6000	6000
Fertilizers	0.00	3200	6400	1046	4176	7306	2093	5222	8352
Weeding cum hoeing	9000	9000	9000	9000	9000	9000	9000	9000	9000
Singling /de-budding	6000	6000	6000	6000	6000	6000	6000	6000	6000
Watch and ward	36000	36000	36000	36000	36000	36000	36000	36000	36000
Total	268555	271755	274955	269601	272731	275861	270648	273777	276907
Interest @6.75%	18127	18343	18559	18198	18409	18651	18269	18480	18691
Total expenditure ha^{-1}	286682	290098	293514	287799	291140	294482	288917	292257	295598
Contingency cost @4%	11467	11604	11741	11512	11646	11779	11557	11690	11824
Total expenditure ha^{-1}	298149	301702	305255	299310	302786	306207	300474	303947	307422
Discount factor @ 12% per annum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Discounted cost	298149	301702	305255	299310	302786	306207	300474	303947	307422

Table 2 Input cost (Rs. annum^{-1}) of ETP production of poplar species under different treatments in 2nd year

Particular	Treatment								
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Land rental	30000	30000	30000	30000	30000	30000	30000	30000	30000
Cost of planting material	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Poles for fencing	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Barbed wire	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Land preparation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Equipments/repairing	6000	6000	6000	6000	6000	6000	6000	6000	6000
Planting of material	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Irrigation	6000	6000	6000	6000	6000	6,000	6000	6000	6000
Fertilizers	0.00	3200	6400	1046	4176	7306	2093	5222	8352
Weeding cum hoeing	9000	9000	9000	9000	9000	9000	9000	9000	9000
Singling /de-budding	6000	6000	6000	6000	6000	6000	6000	6000	6000
Watch and ward	36000	36000	36000	36000	36000	36000	36000	36000	36000
Total	81000	84200	87400	82046	85176	88306	83093	86222	89352
Interest @ 6.75%	5468	5684	5900	5538	5749	5961	5609	5820	6031
Total expenditure ha^{-1}	86468	89884	93300	87584	90925	94267	88702	92042	95383
Contingency cost @4%	3459	3595	3732	3503	3637	3771	3548	3682	3815
Total expenditure ha^{-1}	89927	93479	97032	91087	94562	98038	92250	95724	99198
Discount factor @ 12% per annum	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Discounted cost	80035	83196	86358	81067	84160	87254	82103	85194	88286

The net return in 1st year was negative as ETPs are unsalable at this stage, hence, the ETP production of poplar species under different treatments (**Figures 5-8**) in nursery was evaluated after two years of growth on the basis of nearby periodical market surveys (**Table 5**). The net return from the ETPs production was maximum from T_6 (Rs. 1033389) followed by T_8 (Rs. 979000), T_9 (Rs. 979000), T_5 (Rs. 890000), T_7 (Rs. 890000), T_2 (Rs. 756500), T_1 (Rs. 672444), T_4 (Rs. 90000) and T_3 (Rs. 75600) (Table 4). The analysis of BCRs after discounting @ 12% per annum

indicated that the BCR was maximum for T_6 (2.62) followed by T_8 (2.51), T_9 (2.47), T_4 (2.33), T_7 (2.32), T_5 (2.30), T_2 (1.96), T_3 (1.93) and T_1 (1.77) (**Table 6**). However, the NPV of ETPs production was highest for T6 (Rs. 639928) followed by T_8 (Rs. 589859), T_9 (Rs. 583292), T_4 (Rs. 509623), T_7 (Rs. 507423), T_5 (Rs. 503054), T_2 (Rs. 371602), T_3 (Rs. 364887) and T_1 (Rs. 294260). Hence, as T_6 ($N_{75}P_{120}$) provides maximum cash flow of Rs. 639928 and benefit cost ratio of 2.62 is the most appropriate for the ETPs production of poplar species under temperate conditions.

Figure 5 Nursery of Poplar ETPs

Figure 6 Nursery of Poplar ETPs

Figure 7 ETPs of poplar for sale

Figure 8 ETPs of Poplar for sale

Table 3 Total input cost (Rs.) of ETP production of poplar species under different treatments after two years

Particular	**Treatment**								
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**
Discount cost @ 12% annum^{-1} (1st year)	298149	301702	305255	299310	302786	306207	300474	303947	307422
Discount cost @ 12% annum^{-1} (2nd year)	80035	83196	86358	81067	84160	87254	82103	85194	88286
Total discounted cost annum^{-1} @ 12%	378184	384898	391613	380377	386946	393461	382577	389141	395708

Further, it is inferred that the production of ETPs of poplars in nursery of not less than 1.0 ha is economically a better proposition. The findings gets support of the study [17] which showed that overall benefit cost ratio of poplar nursery plantation worked out to be 2.25 and the net present value was Rs. 409225. However, discounted cash flow of plantation results in constant annual net returns per acre over the entire rotation was Rs. 22156. A study [12] revealed that poplar nursery activity by resident farmers already practicing agriculture on not less than 1.0 ha is economically a better proposition, hence, novices are advised to raise not less than one ha of nursery. The study [15] which reported cost benefit ratio on farm land at eight years rotation was 1.86 and 1.70 for 12% and 15% discount rate of interest by including Rs. 5000 as opportunity cost against a net loss due to agricultural crops. Five year old poplar planted at 5m x 4m spacing along with *mentha* intercrop under agroforestry gave net returns of Rs. 44385 ha^{-1} through trees and Rs. 65886 through crops [18]. The single row plantation alone with field bunds gave a net return of Rs. 11067 ha^{-1} and Rs. 41250 ha^{-1} over a period of three and seven years, respectively. Benefits from raising nursery stock are much higher (100.9 per cent) within one year.

Table 4 Total output cost (Rs.) of ETP production of poplar species under different treatments after two years

Treatment	Mean height (cm)	Rate/ plant (Rs.)	Survival/ plot (No.)	Output/ plot (Rs.)	Output ha^{-1} (Rs.)	Discount factor@ 12% per annum (Rs.)	Discounted output ha^{-1} (Rs.)
T_1	116.65	17	16	272.00	755555	0.89	672444
T_2	127.45	18	17	306.00	850000	0.89	756500
T_3	131.97	18	17	306.00	850000	0.89	75600
T_4	146.09	20	18	360.00	1000000	0.89	890000
T_5	153.43	20	18	360.00	1000000	0.89	890000
T_6	160.02	22	19	396.00	1161111	0.89	1033389
T_7	146.55	20	18	360.00	1000000	0.89	890000
T_8	161.06	22	18	396.00	1100000	0.89	979000
T_9	161.16	22	18	396.00	1100000	0.89	979000

Table 5 Rate (Rs.) of ETPs of Poplar species after grading in local markets

Height (cm)	Collar diameter (mm)	Rate/plant (Rs.)
100-120	9mm-12mm	17.00
121-140	9mm-12mm	18.00
141-160	13mm-15mm	20.00
161-180	13mm-15mm	22.00
181-200	16mm-18mm	26.00
200 above	16mm-18mm	30.00

Table 6 Benefit cost ratio (BCR) and net present value (NPV) poplar ETPs production under different treatments in temperate conditions

Treatment	Discounted output @ 12% Per annum (Rs. ha^{-1})	Discounted input @ 12% per annum (Rs. ha^{-1})	BCR	NPV (Rs. ha^{-1})
T_1	672444	378184	1.77	294260
T_2	756500	384898	1.96	371602
T_3	756000	391613	1.93	364887
T_4	890000	380377	2.33	509623
T_5	890000	386946	2.30	503054
T_6	1033389	393461	2.62	639928
T_7	890000	382577	2.32	507423
T_8	979000	389141	2.51	589859
T_9	979000	395708	2.47	583292
Mean	796215	386989	2.25	409225

Conclusion

To produce high-quality ETPs of *Populus nigra, P. ciliata, P. alba* and *P. balsamifera*, one must start with cuttings of phenotypically high-quality trees. Treatment of the cuttings with a combination of N (75 kg ha^{-1}) and P (120 kg ha^{-1}) is the prerequisite "bottom line" for sound survival and growth of the ETPs which is often poorly understood and poorly treated. Further, the production of ETPs with the treatment yields maximum financial returns as depicted by the highest benefit cost ratio and net present value.

Acknowledgements

We are thankful to the field level staffs for helping in collection of data during the field work. We are also deeply indebted to all the scientists of the Faculty of Forestry, Benhama, Ganderbal for providing logistic support in preparation of the manuscript.

References

[1] Masoodi TH, Ahmad H, Gangoo SA, Sofi PA, Bhat MA and Islam MA, Ecological occurrence of Himalayan Poplar (Populus ciliata Wallich. Ex. Royle.) and its nursery evaluation under temperate conditions of Kashmir. The Bioscan, 2014, 9(2), p. 585-588.

[2] Gangoo SA, Masoodi TH, Shah M and Islam MA, Management of exotic poplars for production of quality timber and reducing cotton menace in Kashmir. The Indian Forester, 2015, 141(5), p. 514-519.

[3] Kaushik A, Negi R, Barthwal S and Singh YP, Mapping Research on Poplar (Populus spp.) in 'Forest Science Database', Forestry Bulletin, 2012, 12(1), p. 151-156.

[4] Sofi PA, Bhat SA, Masoodi TH, Islam MA, Bhat GM and Malik AR, Propagation of Himalayan maple (Acer caesium Wall.) through seed and softwood cuttings. Journal of Applied and Natural Science, 2016, 8(3), p. 1235-1240.

[5] Aslam M, Syed A, Rater MS, Salatia HS and Seth CM, Auxin induced rooting in Taxusbaccata Linn. Stem cuttings. Indian Journal of Forestry, 2007, 30(2), p. 221-226.

[6] Islam MA, Masoodi TH, Gangoo SA, Sofi PA, Bhat GM, Wani AA, Gatoo AA, Singh A and Malik AR, Perceptions, attitudes and preferences in agroforestry among rural societies of Kashmir, India. Journal of Applied and Natural Science, 2015, 7(2), 976-983.

[7] Kumar D and Singh NB, Status of Poplar Introduction in India. Forestry Bulletin, 2012, 12(1), p. 9-14.

[8] Islam MA, Sofi PA, Bhat GM, Wani AA, Gatoo AA, Singh A and Malik AR, Prediction of agroforestry adoption among farming communities of Kashmir valley, India: a logistic regression approach. Journal of Applied and Natural Science, 2016, 8(4), p. 2133-2140.

[9] Singh H and Mavi HK, Economic analysis of poplar based agroforestry system under riparian wet land conditions of Punjab. Indian Journal of Economics and Development, 2016, 12(1), p. 191-196.

[10] Bhardwaj SD, Panwar P and Gautam S, Biomass Production Potential and Nutrient Dynamics of Populus deltoides under high density Plantations. The Indian Forester, 2001, 127(2), p. 144-153.

[11] Dhiman RC, Status of poplar culture in India. Forestry Bulletin, 2012, 12(1), p. 15-32.

[12] Singh RDR and Vashista US, Economic viability of raising Entire-Rooted Transplants (ETPs) of Populus deltoides in nursery and effect of economics of scale. The Indian Forester, 2001, 127(1), p. 11-15.

[13] WSD (WIMCO Ltd., Wimco Seedlings Division), Annual research report, 2011, Rudrapur, WIMCO Ltd.

[14] Dhiman RC and Jagdish C, Expanding poplar culture and plywood industry. Plyworld, 2012, p. 29-31.

[15] Chandra JP, Poplar-A cash crop for North Indian Farmers. The Indian Forester, 1986, 112(8), p. 698-710.

[16] Rana RK, Kaushal P, and Negi YS, Benefit cost analysis of agro-forestry trees in eroded soils. A case study of upper swan catchment in district UNA (H.P). The Indian Forester, 2000, 12(126), p. 1297-1308.

[17] Dhillon A, Sangwan V, Malik DP, and Luhach MS, An economic analysis of poplar cultivation. The Indian Forester, 2001, 127(1), p. 87-90.

[18] Sing K, Ram PO, Singh AK, and Hussain A, Poplar (Populus deltoides Bartram, ex. Marshall) in forest and agroforestry systems. The Indian Forester, 1988, 115(11), p. 814-817.

Publication History
Received 08th Apr 2017
Revised 16th Apr 2017
Accepted 19th Apr 2017
Online 30th Apr 2017