Economic comparison of planting stocks of *Populus deltoides* Bartr ex Marsh under different irrigation frequencies

ULSHEEDA RASHID[1] and DINESH KUMAR[2]

[1]Department of Silviculture and Agroforestry
Dr YS Parmar University of Horticulture and Forestry
Nauni, Solan 173230 Himachal Pradesh, India
[2]Silviculture and Forest Management Division, Forest Research Institute
Dehradun 248001 Uttarakhand, India
Email for correspondence: ulshee27@gmail.com

 Received: 9.1.2019/Accepted: 29.1.2019

ABSTRACT

The present study was conducted during 2011-2012 to estimate the costs of raising different nursery stocks of poplar (*Populus deltoides* Bartr Ex Marsh) and comparison was made with the traditional method of planting ie entire transplants (ETPs). The field trials were conducted under two irrigation frequencies to test the tolerance of these stocks to various moisture conditions. The investigations showed that winter planting of entire transplant with 15-day irrigation was the most remunerative option for planting of poplar. However if winter planting couldn't be done for some reason, monsoon planting of polythene bag plants with 30-day irrigation would be the most suitable alternative.

Keywords: Poplar; planting stock; costs; irrigation; monsoon planting; winter

INTRODUCTION

Plantation establishment is necessary to maintain forest cover and to achieve various forest products and services. Therefore developing specific nursery technique for producing quality planting stock is essential for successful field plantation of a particular species. The planting stock should be capable of yielding high rates of survival of the plantation in order to justify the expenses of plantation.

Poplar (*Populus deltoides* Bartr Ex Marsh) is most widely planted deciduous species in India under different agroforestry systems for number of economic gains owing to its fast growth rates and high demand in the market. It was introduced in India in the late 1950s. It is planted in plains of northwest India, western Uttar Pradesh, Punjab, Haryana and to some extent in the outer plains/valleys of Uttarakhand and Himachal Pradesh. Exotic poplars were initially introduced in India to meet the needs of matchwood industry. Later poplar wood began to be used extensively for making plywood. Wood from poplars is the backbone of vibrant plywood, board, match and paper industries. Poplars provide high cash returns to growers and other communities engaged in their cultivation, management and processing which also contribute considerably to the government exchequer. Its cultivation at farmers' fields reduces pressure on forests and entails massive ecological and environmental benefits besides providing a wide range of other wood products and employment opportunities to various subsidiary sectors (Kumar and Singh 2012).

P deltoides is usually planted during January-February months in winter season when the plants are dormant. The plant is moisture sensitive and needs regular irrigation. When planted in winter season its root system is not sufficiently developed to tolerate the hot dry summer which starts in April and continues till second half of June. As a result the plant fails to survive if not watered well during these months. If planted in monsoon season (July-September) the plant might get enough time to grow and develop adequate root system to withstand its first summer season during

next calendar year. Monsoon planting would therefore provide an alternative season to the growers who cannot plant poplar in winter season due to inadequate irrigation or for other practical reasons.

Poplar nursery stock raised in 3,860 cc polythene bags has been successfully planted with high outplanting success in central India (Gera et al 1993). However the large polythene bag size used in that effort would entail high cost of plant production and transportation thereby limiting its use in operational planting. Moreover no comparison has been made between different planting stocks of poplar in relation to irrigation management.

The present study therefore was aimed at estimating the costs of raising different planting stocks in the nursery, their transportation to the planting site and cost of one surviving plant was calculated in respect of to two irrigation frequencies to test the tolerance of these stocks to low moisture conditions. Planting stock tested in this study was containerised stock (plants raised in polythene bag and root trainer) and container-less stock (bare root plants and entire transplants) as terminology given by Fidelibus and Bainbridge (1994). The plants raised by these methods were compared in the field (monsoon planting) with the traditional entire transplants which were planted out in winter (Fig 1)

MATERIAL and METHODS

The nursery and field studies were carried out at the campus of Forest Research Institute, Dehradun, Uttarakhand. It is located at 30°20′10.31′′ N latitude and 75°59′55.32′′ E longitude at an attitude of 650 m amsl. Dehradun is having sub-tropical climate and experiences about 20°C mean annual temperature and 2,073 mm rainfall annually. Major part of the rainfall is received from mid-June to mid-September and winter showers are mild.

The experiment on the comparison of containerized (polythene bag and root trainer) and container-less (bare root and entire transplant) production methods was conducted in the field. The polythene bag, root trainer and bare root stocks were outplanted during monsoon season (1 July 2011) in pits of 30 x 30 x 45 cm leaving the planting spots of entire transplants without pits or plants at that time. Entire transplants were planted during mid-January (16 January 2012) in pits of 90 cm length and 23 cm diameter. Planting was done in the campus of Forest Research Institute, Dehradun, Uttarakhand. Four types of planting stocks viz polythene bag, root trainer, bare root, entire transplant and two irrigation frequencies (I_{15}: Fortnightly, I_{30}: Monthly) with three replications were evaluated. The data recorded were statistically

Fig 1. Outplanted stocks of monsoon and winter planting

analysed using randomised complete block design. The spacing used was 3 x 3 m. The plants were maintained in the field for 48 months (52 months cutting age) (till July 2014).

The following observations were recorded:

Per cent survival: The number of surviving plants was recorded twice during the first year (6 and 12 months) and finally at 48 months (52 months cutting age). The number thus obtained was expressed as a percentage of the number of plants planted in the plot.

Estimated volume: The estimated volume was calculated at 48 months (52 months cutting age) after outplanting using the following formula (Dhanda and Verma 2001):

$$V = 0.0045 + (0.000026*D*D*H)$$

where V= Estimated volume (under bark) of the stem (m^3), D= Diameter at breast height (cm), H= Height (m)

Cost estimation: The costs of the various nursery production methods were worked out for 10,000 plants for each production method at prevailing market rates in nursery as well as plantation. Costs of sand, soil, farmyard manure, fertilizers, pesticides, containers, cuttings, water, labour (for soil mixture or bed preparation, filling of containers, singling, weeding, irrigation, wrenching etc), hired equipment etc were considered for calculating nursery cost.

Cost of root trainer and its stand was calculated by dividing its price by service life (10 years) and was worked out per surviving plant. Costs of lifting, packing (for bare root plants), loading, transportation (over 70 km distance) and unloading were worked out to determine the transportation cost. Costs of soil mixture, manure, fertiliser, irrigation water, labour (for pit digging, planting, soil working, irrigation, pruning etc) were added to compute the cost of planting and plantation maintenance. The costs of land of the plantation site, watch and ward, yield loss in agricultural crop due to competition with trees and opportunity cost would be generally same for all methods and were not taken into account.

The costs were finally calculated on per plant basis. Compounding of cost was done at 9 and 6 per cent rate of interest.

RESULTS and DISCUSSION

Monsoon plantation (done with polythene bag, root trainer and bare root stock) registered greater survival than winter plantation (done with entire transplant) (Table 1). Nevertheless the growth of surviving entire transplants was better than other three stocks. It therefore becomes pertinent to integrate survival and growth in one yardstick to judge the worth of different stocks for practical application by comparing the economics of different production methods. The cost of different production methods was worked out using 9 per cent rate of interest at 52 months age of cutting. The present cost of production of one plant in the nursery was lowest for polythene bag (Rs 7.57) followed by root trainer (Rs 8.71) while cost was highest for traditional entire transplant (Rs 15.76). The unit transportation cost was highest for polythene bag plant (Rs 1.85) followed by root trainer (Rs 1.40) and lowest for bare root (Rs 0.74). Cost of planting and plantation maintenance varied with irrigation frequency.

At 30-day irrigation: Using irrigation at 30 days if the cost of plantation maintenance was also included (exclusive of costs of land of plantation site, watch and ward, yield loss in agricultural crop due to competition with tree and opportunity cost) and survival rate was considered the compounded cost of one surviving plant at 52 months from the present (ie at 52 months from time of planting of cutting) would be lowest for monsoon planting with polythene bag (Rs 130.49) followed by root trainer (Rs 148.14). The cost of one surviving plant from standard method of winter entire transplant planting would be highest ie Rs 579.83 (Table 1).

These cost figures were translated into volume produced per unit cost. Maximum volume 0.00115 m^3/Re would be produced by polythene bag production method with monsoon planting while entire transplants with winter planting would account for the lowest volume return of 0.00041 m^3/Re. Thus polythene bag method of monsoon plantation was proved to be the most cost efficient while applying irrigation at 30-day interval.

At 15-day irrigation

Using irrigation at 15-day intervals if cost of plantation maintenance was also included (exclusive of cost of land of plantation site, watch and ward, yield loss in agricultural crop due to competition with tree

Table 1. Cost, survival and yield of poplar plant produced by different production methods with 30- and 15-day irrigation frequencies (per plant basis)

Planting stock production method	Field plantation time	Cost at present rate				Cost, survival and yield after 52 months				
		Nursery (Rs)	transport (Rs)	Planting and plantation maintenance (Rs)	Sum of costs (Rs)	Total compounded cost @ 9% /year (Rs)	Survival in field (%)	Cost of one surviving plant in field (Rs)	Estimated volume (m^3)	Volume produced per unit cost (m^3/Re)
At 30-day irrigation										
Entire transplants	Winter	15.76	0.90	74.00	90.66	110.40	19.04	579.83	0.235	0.00041
Root trainer	Monsoon	8.71	1.40	82.40	92.51	112.85	76.18	148.14	0.090	0.00061
Bare root	Monsoon	9.24	0.74	82.40	92.38	112.67	71.42	157.76	0.108	0.00068
Polythene bag	Monsoon	7.57	1.85	82.40	91.82	111.84	85.71	130.49	0.150	0.00115
At 15-day irrigation										
Entire transplants	Winter	15.76	0.90	137.00	153.66	183.91	85.71	214.57	0.269	0.00125
Root trainer	Monsoon	8.71	1.40	150.80	160.91	193.83	80.95	239.44	0.096	0.00040
Bare root	Monsoon	9.24	0.74	150.80	160.78	193.65	76.18	254.20	0.124	0.00049
Polythene bag	Monsoon	7.57	1.85	150.80	160.22	192.82	90.47	213.13	0.193	0.00091

Cost excludes cost of land of plantation site, watch and ward, yield loss in agricultural crop due to competition with tree and opportunity cost; Cost of one surviving plant in field= Total compounded cost x 100/Survival per cent in field; Volume produced per unit cost= Estimated volume/Cost of one surviving plant in field; Winter plantation: 10½ months nursery phase, 41½ months plantation phase; Monsoon plantation: 4 months nursery phase, 48 months plantation phase

and opportunity cost) and survival rate was considered the cost of one surviving plant at 52 months from planting of cutting would be lowest for monsoon planting with polythene bag (Rs 213.13). Cost of one surviving plant would be highest for bare root plantation method (Rs 254.20) closely followed by root trainer plantation method (Rs 239.44). Cost of entire transplant plantation method would be Rs 214.57 per surviving plant (Table 1).

When these cost figures were converted to volume produced per unit cost the maximum volume 0.00125 m^3/Re would be produced by traditional entire transplant production method followed by polythene bag (0.00091 m^3/Re) while root trainer would give the lowest yield of 0.00040 m^3/Re invested.

The trees resulting from 15-day irrigation would have greater diameter than trees of 30-day irrigation implying greater market price for the former than the latter as poplar wood price increases considerably with increase in diameter class (Dhiman 2012).

CONCLUSION

With 30-day irrigation frequency the maximum volume of 0.00115 m^3/Re would be produced by polythene bag production method while winter planted entire transplant would give the least volume per unit investment ie 0.00041 m^3/Re. With 15-day irrigation the maximum volume of 0.00125 m^3/Re would be produced by the winter entire transplant plantation method followed by polythene bag monsoon plantation method (0.00091 m^3/Re).

Thus entire transplant method of winter plantation emerged as the most cost efficient production method while applying irrigation at 15-day interval.

ACKNOWLEDGMENT

Authors are grateful to the Forest Research Institute, Dehradun, Uttarakhand for facilitating the work.

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