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Survival Percentage and Leaf Area Estimation of *Populus deltoides* on Degraded Sites Using Different Plantation Techniques under Temperate Conditions

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ABSTRACT

The plantation of Populus deltoides using different plantation and moisture conservation techniques was done in problematic (degraded) land of the Faculty of Forestry, SKUAST-Kashmir, Benihama Campus, Ganderbal at an altitude of 5850 feet above mean sea level in the year 2013-2014. The existing land of the experimental site was pertaining to three types of land problems namely: degraded underutilized (scrub dominated), degraded pastures/grazing lands, barren rocky/stony waste. The experimental site falls in a mid to high altitude characterized by hot summers and very cold winters. The average precipitation is 690 mm most of which is received from December to April in the form of snow and rains. The plantation of Populus deltoides was laid out in a randomized complete block design (Factorial). Two planting seasons, three pit sizes, three pit types and three moisture conservation measures were analyzed for survival and growth of plantation. There were 54 treatment combinations, which were replicated two times in statistical design. Results showed that out of two planting seasons studied, autumn planting was better compared to spring planting. Among the pit types saucer pits showed better results compared to ordinary pits and ring pits in the experimental site. Growth parameters were also recorded higher in 60×60 cm^3 pit size and under black polythene mulch.

Key words: *plantation, survival, growth, pit, degraded.*

INTRODUCTION

Land is one of the most important resource on which human beings depend. The rate of soil degradation is continuously increasing with the advancement of science & technology, industrial expansion, urbanization and population explosion. The most important cause of land degradation is destruction of forests and other vegetation from sloping lands, river sides and other areas sensitive to damage[13].

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Anthropogenic activities like over grazing, wood cutting and burning have intensified land degradation results in soil deterioration all over the world[7]. Vegetation acts as a protective cover against the forces of wind and water, protecting the soil from being washed or blown away and preserving the physical and hydrographic balance of nature[6]. Plantations can conserve soil on degraded lands by reducing nutrient loss, increasing soil organic matter and improving the soil texture[15]. The plantation forestry is ecologically as well as economically more viable option then traditional forestry. Plantation technology of fast growing species mainly Poplar and Eucalyptus have been taken up by farmers and institutions to boost wood production in the world. Plantation forestry has the potential to augment farmer's income substantially. Tree plantations present an economically attractive alternative to natural forests and might also be a practical option for production on degraded lands. Plantation forestry has been shown to contribute considerably in terms of carbon sequestration, increased soil organic carbon and conservation of biodiversity[2].*Populus deltoides* locally called as '*Fras'* make a striking and important contribution to the landscape and economy of Jammu and Kashmir. Poplars in the state have gained considerable importance in farm and plantation forestry like other neighboring states of Uttrakhand, Haryana and Punjab. Poplars are fast growing trees; they recycle nutrients fast due to their shedding of a large quantity of leaves which decompose early. Poplar timber is being used for making apple boxes, interior wood work, beams, poles, and fuelwood. Poplar is one of the few forest species which is considered ideal for successful inter cultivation with agricultural crops. Poplars are known for their fast growth, easy vegetative propagation and enriching the soil with litter, and provide high production (10-30 M^3/hectare/ year) on a short rotation of 8-12 years[4]. Food and Agriculture organization (FAO) has recommended the introduction of poplars to meet the increasing timber requirement of the world. The poplars have the potential for narrowing down the gap between demand and supply of wood. Therefore, various attempts have been made in the past for raising this economically important species on problematic lands in different parts of the world. Faulty landuse systems and inflated human population have led to land degradation in the hills and plains. The efforts of the planners, foresters and scientists have brought heavy chunk of areas under plantation but success is heading to low year after year. The reason is being the age old practice and poor physico-chemical attributes of such soils (problematic lands). In order to restore the productive potential of such lands, soil working and use of suitable trees with other measures like fertilizer application, moisture conservation etc. are the alternatives for ameliorating these problematic lands. At present the knowledge about the planting techniques on problematic sites is very limited and moreover specific to specific areas. Therefore, there is urgent need to undertake such work on scientific lines to develop techniques in tune with the existing problems.

MATERIALS AND METHODS

The plantation of *Populus deltoides* using different plantation and moisture conservation techniques was done in problematic (degraded) land of the Faculty of Forestry, SKUAST-Kashmir, Benihama Campus, Ganderbal at an altitude of 5850 feet above mean sea level. The existing land of the experimental site was pertaining to three types of land problems namely: degraded underutilized (scrub dominated), degraded pastures/grazing lands, barren rocky/stony waste. The experimental site falls in a mid to

high altitude characterized by hot summers and very cold winters. The average precipitation is 690 mm most of which is received from December to April in the form of snow and rains. The mean metrological data for the plantation season was obtained from the meteorological observatory Ganderbal. The total rainfall received during the experimentation period was 281.2 and 418.80 mm during 2013 and 2014, respectively. The minimum temperature ranged from -1 to -6^{o}C and 3.4 to 14.1^{o}C, and maximum temperature from 17.7 to 24.4^{o}C and 21.7 to 32.5^{o}C and the average maximum relative humidity from 74.5 to 95.1 % and 70.4 to 90.8 %, whereas mean minimum relative humidity ranged from 43.1 to 78.7 % and 37.1 to 80.1 % during the plantation season of *Autumn* 2013 and Spring 2014, respectively.

Experimental details

The experiment was laid out in randomized completely block design with two planting seasons i.e., autumn season and spring season 2014, three pit types (PT_1: Ordinary pit, PT_2: Saucer pit and PT_3 : Ring pit), three pit sizes (PS_1: 30×45, PS_2: 45×60 and PS_3: 60×60) and three mulching treatments (M_0: Control, M_1: Ordinary mulch, M_2: Black polythene**)** with three replications were tested to study survival and leaf area estimation of Populus deltoids plantation on problematic site under temperate conditions. The seedlings were planted at a spacing of 2 x 2 m by line planting in the experimental fields. No plantprotection measure with regard to disease/insect pest control was taken due to non- observance of such problems.

RESULTS AND DISCUSSION

The main aim of establishing *Populus deltoides* on problematic sites using different pit shapes, size and moisture conservation measures is to standardize the out planting techniques with seasons in problematic sites existing in temperate region. Survival percentage and leaf area were measured after one growing season. Both the parameters were found higher for autumn planting compared to spring plant. The reason being seedlings planted in autumn planting got established before spring planting was done. In this context, two planting seasons, three pit shapes, three pit sizes and three mulching materials were studied to characterize and evaluate for survival and growth of the species. Survival percentage of *Populus deltoides* was studied in this investigation using two planting seasons and different planting techniques. It was found that both the planting seasons significantly influenced survival percentage. Highest survival percentage was recorded for autumn planting (76.53 percent) followed by spring planting (67.88 percent). This is due to the reason that seedlings planted in autumn season got sufficient time period compared to seedlings planted in spring season for their roots to establish. On the other hand, the time period between two planting seasons is almost three months which is sufficient for establishment of roots. Similar results were observed by Lahiri and Mazumdar[9] in *Eucalyptus hybrid* and *Eucalyptus tereticornis*. Table 1 of the present investigation revealed that among three pit types highest survival percentage was recorded for PT_2 (saucer pit), followed by PT_1 (ordinary pit) and PT_3 (ring pit) in both the planting seasons. Similar finding was recorded by Mehta[10] for *Acacia* plantation on alkali soils in Haryana. Pits of different sizes affected survival percentage of *Populus deltoides* on problematic sites in both the seasons. It was found that PS_3 (60×60 cm^3) recorded highest survival percentage, followed by PS_2 (45×60 cm^3) and PS_1 (30×45 cm^3). The reason being pits of higher sizes store enough water during rains compared to pits of smaller sizes which is essential for establishment of

plantation. These results are in agreement with Singh *et al.*[5] for tree plantations on highly alkaline soils. All the three mulching treatments significantly affected survival percentage. Highest percentage survival was recorded for M_2 (black polythene), followed by M_1 (ordinary mulch) and M_0 (control) in both the seasons. Similar results were recorded by Porfit and scott[14] for *popular* seedlings. Factorial means were evaluated to determine the best possible factor for survival. It was found from the table that highest survival percentage was recorded for M_2 (81.47 percent), followed by M_1 (72.21 percent) and lowest for M_0 (62.95 percent). Applying black polythene mulch around the base of tree has been associated with increased growth and survival compared to control and ordinary mulch. Among the three pit types studied, PT_2 recorded highest survival percentage (77.85 percent), followed by PT_1 (70.36 percent) and PT_3 (68.50 percent). Similar results were recorded by Meena *et al.*[11]. It was also observed from the Table that all the three pit sizes affected survival. Highest survival percentage was recorded for PS_3 (85.26 percent), followed by PS_2 (70.36 percent) and lowest for PS_1 (61.10 percent). The reason being greater the pit size greater is the rain water storage. Similar results have also been reported by Dagger *et al.*[5] for Prosopis species in salt effected soils. The leaf area of *Populus deltoides* is significantly affected by planting season, pit types, sizes and different moisture conservation measures. Table 2 of the present study reveals that highest leaf area growth (915.81 cm^2) was recorded for autumn planting and minimum (907.40 cm^2) for spring planting. Similar finding was recorded by White *et al.*[16] who reported bigger branch size and maximum number of branches in autumn season planting. Leaf area increases with increase in branch size and number of branches. It is also evident from the Table that all the pit types affected leaf area growth of *Populus deltoides.* Highest leaf area was recorded for PT_2 (saucer pit), followed by PT_1 (ordinary pit) and PT_3 (ring pit) in both the planting seasons. Similar result was recorded by Kumar *et al.*[8] who reported higher leaf area in saucer pit planting pertaining to higher shoot and branch size in *Leucaena leucocephala*. Pits of different sizes affected leaf area of *Populus deltoides* on problematic sites in both the seasons with highest recorded for PS_3 (60×60 cm^3), followed by (45×60 cm^3) and PS_1 (30×45 cm^3). Limited rooting space is considered a major problem for growth of trees. Pits of larger size provide greater space for root growth and development, which is largely responsible for above ground development of trees. Similar finding was reported by Buhler[3]. All the three mulching treatments significantly affected leaf area in both the seasons. Highest leaf area was recorded for M_2 (black polythene), followed by M_1 (ordinary mulch) and M_0 (control). Adams[1] reported that black poly mulches reduce weed growth, increase availability of nutrients, water in soils, increase plant height and leaf area in forest plantations. Factorial means were also evaluated to determine the best individual factor for leaf area. It was found from the table that highest leaf area was recorded for M_2 (914.88 cm^2), followed by M_1 (911.76 cm^2) and lowest for M_0 (908.16 cm^2). Among the three pit types studied, PT_2 recorded highest leaf area (922.78 cm^2), followed by PT_1 (908.33 cm^2) and PT_3 (903.70 cm^2). This finding was in agreement with Nielsen *et al.*[12] who reported maximum leaf area in saucer pit planting on degraded sloppy sites. It was also observed from the Table that all the three pit sizes affected leaf area, with highest recorded for PS_3 (912.79 cm^2), followed by PS_2 (911.50 cm^2) and lowest for PS_1 (910.52 cm^2).

Table 1: Effect of planting season, pit shape, pit size and moisture conservation measures on percentage survival of *Populus deltoides*

Season→	Autumn planting												Spring planting												Factor Means			
Pit type→	PT_1			Mean	PT_2			Mean	PT_3			Mean	PT_1			Mean	PT_2			Mean	PT_3			Mean				
Pit size / Mulching	PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		Mulching	Pit size	Pit Type	Season
M_0	50.00	66.66	83.33	66.66	66.66	66.66	83.33	72.21	50.00	66.66	83.33	66.66	50.00	50.00	66.66	55.55	50.00	66.66	66.66	61.10	50.00	50.00	66.66	55.55	62.95	61.10	70.36	**76.53**
M_1	66.66	66.66	83.33	72.21	66.66	83.33	100	83.33	50.00	66.66	83.33	66.66	50.00	66.66	83.33	66.66	66.66	83.33	83.33	77.77	50.00	66.66	83.33	66.66	72.21	70.36	**77.85**	67.88
M_2	83.33	83.33	100	88.88	83.33	83.33	100	88.88	66.66	83.33	100	83.33	66.66	66.66	83.33	72.21	66.66	83.33	100	83.33	66.66	66.66	83.33	72.21	**81.47**	**85.26**	68.50	
Mean	66.66	72.21	88.88	75.91	72.21	77.77	94.44	81.47	55.55	72.21	88.88	72.21	55.55	61.10	77.77	64.80	61.10	77.77	83.83	74.06	55.55	61.10	77.77	64.80				

CD ($p \leq 0.05$): M=1.38, P_T =1.10, P_s=2.48, S=3.77, M× P_T =1.57, M× P_s =3.48, M×S=3.11, P_T × P_s =2.57, S× P_T =2.38, P_s ×S=4.38, M× P_T × P_s ×S=NS

Table 2: Effect of planting season, pit shape, pit size and moisture conservation measures on leaf area growth (cm^2) of *Populus deltoides*

Season→	Autumn planting												Spring planting															
Pit type→	PT_1			Mean	PT_2			Mean	PT_3			Mean	PT_1			Mean	PT_2			Mean	PT_3			Mean	Factor Means			
Pit size / Mulching	PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		Mulching	Pit size	Pit Type	Season
M_0	906.53	906.88	907.12	906.84	923.30	925.11	927.15	925.19	903.10	903.19	904.42	903.57	900.01	900.54	900.98	900.51	910.13	912.43	916.31	912.96	899.12	900.09	900.53	899.91	908.16	910.52	908.33	**915.81**
M_1	910.42	911.09	917.58	913.03	927.81	929.52	930.01	929.11	904.98	905.13	905.77	905.29	902.32	903.10	903.77	903.06	917.33	917.98	918.13	917.81	901.12	902.58	902.98	902.23	911.76	911.50	**922.78**	907.40
M_2	918.40	920.13	922.22	920.25	931.13	932.43	932.98	932.18	906.51	906.82	907.03	906.79	905.23	906.12	907.53	906.29	918.81	919.30	920.10	919.40	903.16	904.48	905.53	904.39	**914.88**	**912.79**	903.70	
Mean	911.78	912.70	915.64	913.37	927.41	929.02	930.05	928.83	904.86	905.05	905.74	905.22	902.52	903.25	904.09	903.29	915.42	916.57	918.18	916.72	901.13	902.38	903.01	902.18				

CD ($p \leq 0.05$): M= 2.11, P_T =4.23, P_s= 0.48, S= 5.10, M× P_T = 2.50, M× P_s = 2.19, M×S = 1.48, P_T × P_s = 2.76, S× P_T =1.77, P_s ×S= 2.34, M× P_T × P_s ×S= 1.79

CONCLUSION

The current study suggested that out of two planting seasons, survival and leaf parameter showed higher results for autumn planting compared to spring planting. Saucer pit recorded highest leaf growth and survival compared to other two pits. Similarly, bigger sized pit (60×60 cm^3) were seen influential in increasing survival percentage and leaf growth of seedlings. Among the mulching materials applied, black polythene mulch showed better results than ordinary grass mulch and control.

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