COMPARATIVE PERFORMANCE OF GROWTH AND SURVIVAL STATUS OF DROUGHT RESISTANT TREE SPECIES IN DISTRICT LAKKI MARWAT, KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

Comparative study on height and survival of twelve plant species planted in 2017 in Roaded Catchments under semi-arid conditions at Mujahid Town, District Lakki Marwat was carried out. Twelve drought resistant tree species were planted in three replications on RCB design. After plantation in 2017 the survival and height data of each plant species were collected every year in June till 2020 and analysed statistically. The result showed that maximum height was gained by *Eucalyptus camaldulensis* and *Acacia albida* than *Acacia nilotica, Acacia ampliceps, Acacia nilotica (Cup), Tamarix aphylla, Acacia farnesiana, Casuarina equisetifolia, Acacia tortilis, Acacia coriacea, Prosopis cineraria and Zizyphus mauritiana*. Mean heights recorded for different species were not significantly different from each other. Maximum survival percentage (100%) were recorded for *Acacia nilotica* and *Zizyphus mauritiana* whereas the lowest survival percentage (19%) was recorded for *Casuarina equisetifolia* in the final year 2020. The mean values of survival among the different species were not significantly different from each other.

INTRODUCTION

Deserts are areas where moisture is deficient and vegetation is sparse and absent in the temperate, subtropical and tropical zones. The area receiving mean annual precipitation of 250 mm or less is considered as desert. Desertification on the other hand, is land degradation in arid, semi-arid and dry sub humid areas resulting from adverse human impacts (UNEP, 1997). Desertification leads directly to soil degradation which make it difficult for any types of trees, shrubs, grasses or crops to grow and leads to increased soil erosion mostly by wind and sometimes by water. Pakistan's total area is 79.6 million hectares out of which 88 percent is arid to semi-arid. Ecologically 51.5, 36.9, 5.4 and 6.2 percent area of the country is arid, semi-arid, sub-humid and

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mixed respectively. Out of total 41 million hectares' arid area only 11 million hectares consist of deserts where mostly the climate is hyper-arid [PCRWR, 1999; Iqbal *et al*., 2000) .

Tree plantations established with natural rainfall and without the use of artificial irrigations is termed as dry afforestation. The activities of dry afforestation techniques in different areas of the country were started soon after the establishment of the provincial forest department in the Indo-Pak subcontinent. In the early thirties and forties, a number of dry afforestation techniques were evolved which emphasized on afforestation of semi-arid areas in the northern parts of the country where deforestation had resulted in widespread soil erosion due to high intensity monsoon rainfall due to which the fertile soil was lost. Afforestation helps to conserve soil and reduce soil erosion which result in not only the improvement of soil structure but also increase soil organic matter and serve as a carbon sink (Thornes, 1990; Cerda, 2001; Munoz-Rojas *et al*., 2016. Oscar, 2001; Cornelis *et al*., 2002; Jackson *et al*., 2002). In arid and semiarid areas mortality rate of plants during afforestation is more due to high temperature and water scarcity during summer droughts (Grossnickle, 2000; Maestre *et al*., 2003). Different techniques were adopted after a number of studies carried out for the purpose of increasing seedlings survival (Maestre and Cortina, 2002).

Realizing the importance of arid areas, the Pakistan Forest Institute Peshawar established field research plots of dry afforestation techniques at Mujahid Town in Lakki Marwat District. The research focused on the selection of suitable drought resistant tree species for arid areas of Khyber Pakhtunkhwa and efficient use of rainfall water through water conservation techniques for the establishment of tree species.

MATERIALS AND METHODS

Experimental site, soil amendment (Dry afforestation techniques) and afforestation

Experimental site for the dry afforestation techniques was established at Mujahid town of Lakki Marwat which was geographically located at X: 32.605399 Y: 70.889066. Plantation were raised on an area of 10.11 acres. Roaded catchments were prepared having 2.5 m long slopes on both sides with 5 % gradient through Tractor and a ditch in the center. Pits of 0.6 m diameter and 0.3 m depth were excavated and 12 plants species were planted for testing in these sites with 3 replications (Fig.1). The distance between plant to plant were kept 10 feet while the distance between row to row were kept 22 feet. The experimental site was cleared from natural vegetation to minimize competition for nutrients and space. The vegetation cover in the area was less than 30%. In August 2017, an

afforestation plan was carried out in the experimental site following the same pattern of plantation in three replications.

Seedlings of suitable size adopted to the type of environment under the study were raised in the project nursery established at Pakistan Forest Institute, Peshawar. After gaining a suitable size the species were planted in the experimental sites. Twelve species namely *Acacia nilotica, Acacia ampliceps, Acacia albida, Eucalyptus camaldulensis Acacia nilotica (Cup), Tamarix aphylla, Acacia farnesiana, Casuarina equisetifolia, Acacia tortilis, Acacia coriacea, Prosopis cineraria and Zizyphus mauritiana* were planted for testing in the experimental sites with 3 replications in Roaded catchments.

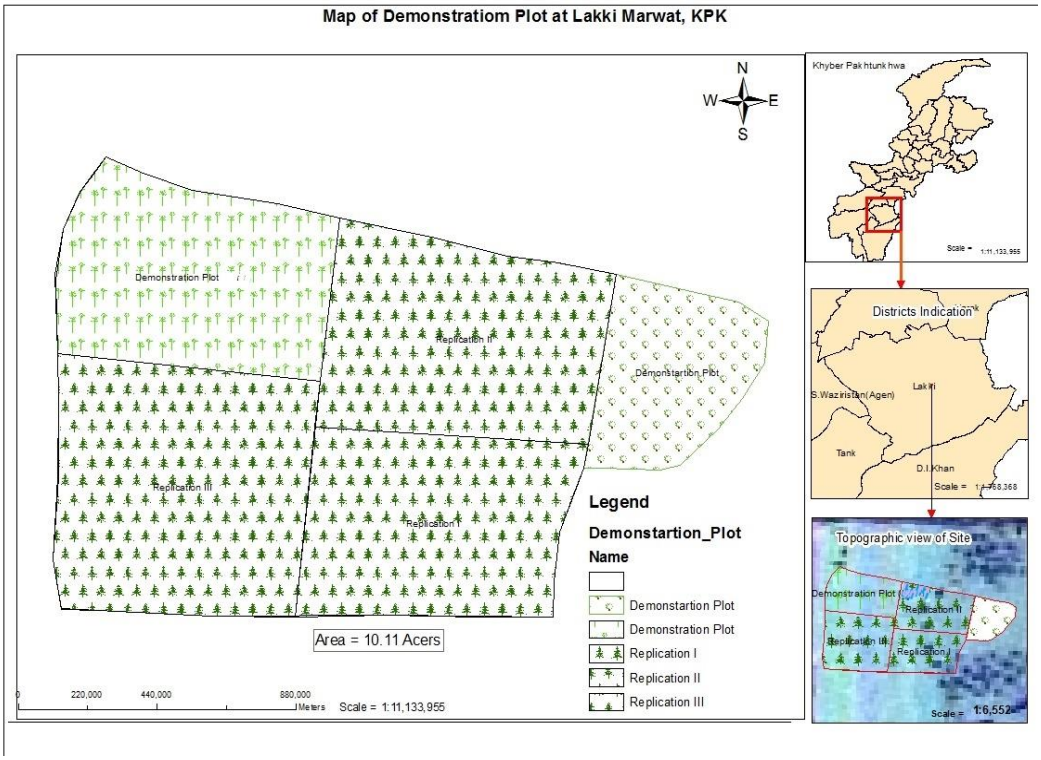

Fig.1. Map of the experimental site in Mujahid town of Lakki Marwat.

Data collection and monitoring of vegetation

Seedlings were assessed once annually in the period 2017– 2020: (i) 11 months following afforestation (June 2018); (ii) 23 months following afforestation (June 2019); and (iii) 35 months following afforestation (June 2020). The final growth and survival percentage were compared with the initial data of height and survival percentage. This frequency enabled assessment of growth and

development of the plants and survival during the dry and wet seasons. The number of surviving plants was determined during the field surveys, and the phenological state of plants was measured according to the criteria of Castro *et al.* (2002) and Gomez-Aparicio *et al.* (2004). A seedling was considered to be alive if living leaves, buds, or stems were observed. The plant height was measured from the ground to the terminal bud of the tallest stem. The growth and survival data of 4 years old plantations were taken, analysed and are presented in this paper.

Statistical analysis

The experiment was planned in Randomized Complete Block Design (RCBD) and means were compared using least significant difference test (LSD) (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Comparative Height study of Various Plant Species

The result in table-1. showed that the mean maximum growth in height was gained by *Eucalyptus camaldulensis* (9.5 ft) followed by *Acacia albida* (7.3 ft) and the lowest (2.2 ft) by *Casuarina equisetifolia.* The result showed that the mean height among the different plant species were not significantly different from each other.

The result also showed that mean height recorded for different plant species during different years were significantly different from each other.

It is clear from the Table 1 that the growth in plant heights during different years after transplantation increased gradually year after the year in all types of plants in the research site. The increase in growth rate was minimum after first year i.e. in 2018 which gradually increased during the second year i.e. in 2019 and finally reached to maximum in the year 2020 in all types of plants. The decrease in growth rate during the first year may be due to the summer drought and low rainfall in the research area because establishment and development of roots by the saplings is minimum in the initial years due to which it could not tolerate stress of droughts resulted into low growth in heights (Bochet *et al*., 2007).

The result in Fig.2. showed that all the plant species showed growth in height during different years i.e. the lowest heights were recorded in the initial years whereas the increase in heights of plants were recorded during the years 2018, 2019 and 2020. The initial heights (ft) recorded for *Acacia nilotica Acacia ampliceps Acacia albida, Acacia coriacea Acacia nilotica (cup), Tamrix aphylla,*

Acacia farnesiana, Casuarina equisetifolia, Acacia tortilis, Eucalyptus camaldulensis, Prosopis cineraria, Zizyphus mauritiana were 1.1, 1.3, 1.1, 1.1, 1.1, 1.1, 1.1, 1.0, 1.1, 1.1, 1.0 and 1.1 respectively whereas the final height in the year 2020 for these species were 9.3, 11.0, 14.2, 7.7, 10.4, 9.2, 9.7, 4.0, 11.2, 19.6, 4.0 and 10.3 respectively. The result showed that highest growth in height was recorded in *Eucalyptus camaldulensis* followed by *Acacia albida* while the lowest height (4.0 ft) was recorded for *Casuarina equisetifolia* and *Prosopis cineraria.*

Table 1. Mean values of height of different plant species calculated after analysis using statistics 8.1 software two-way ANOVA (LSD) was used to test for significant differences (P<0.05) for marginal means of variables

S.No	Species	Average Height (ft)				Mean
		Initial Height	2018	2019	2020	
1	Acacia nilotica	1.1	2.7	5.6	9.3	4.7e
2	Acacia ampliceps	1.3	3.0	6.8	11.0	5.5c
3	Acacia albida	1.1	4.7	9.1	14.2	7.3b
4	Acacia coriacea	1.1	2.2	4.2	7.7	3.8f
5	Acacia nilotica (cup)	1.1	3.2	6.2	10.4	5.2cde
6	Tamrix aphylla	1.1	2.8	5.7	9.2	4.7e
7	Acacia farnesiana	1.1	2.8	5.7	9.7	4.8de
8	Casuarina equisetifolia	1.0	1.5	2.4	4.0	2.2g
9	Acacia tortilis	1.1	3.2	6.5	11.2	5.5c
10	Eucalyptus camaldulensis	1.1	5.6	11.8	19.6	9.5a
11	Prosopis cineraria	1.0	1.7	2.6	4.0	2.3g
12	Zizyphus mauritiana	1.1	3.2	6.5	10.3	5.3cd
Mean		1.1d	3.1c	6.1b	10.1a	

Average values followed by the same letter are not significantly different at LSD 0.05.

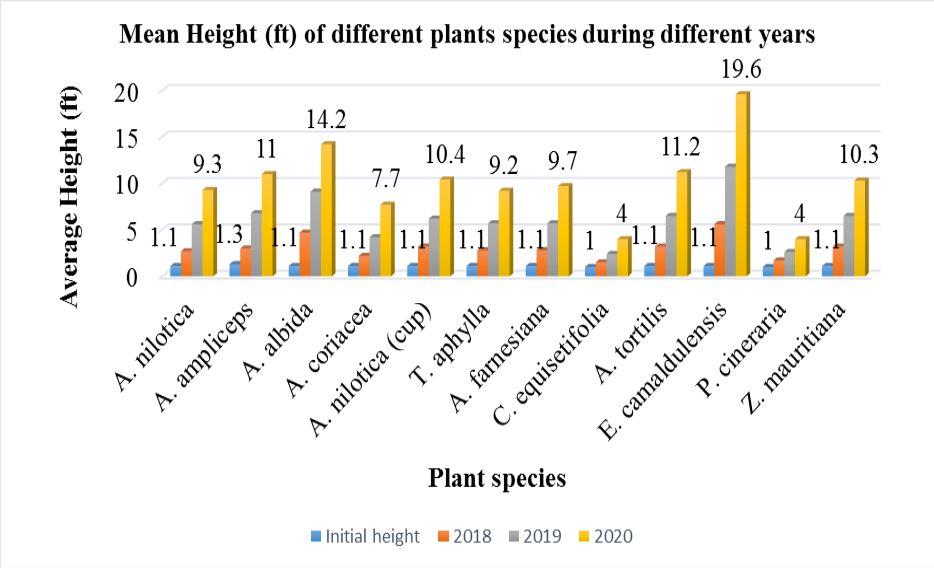

Fig. 2. Showing Mean Height (ft) of different plants species during different years.

In a similar study conducted by Sardar (1992), found that the growth rate of *A. albida* was highest amongst all the species which had attained average height of 1.3 meters in four years. Noor and Shah (1995) found that the average height gained by *Acacia tortilis* was highest when growth and biomass of five tree species planted in roaded catchment were studied at Dagarkotli in arid conditions.

Comparative Survival status of different species

The result in Table 2 showed that the maximum survival percentage was recorded for *Acacia nilotica* and *Zizyphus mauritiana* (100%) followed by *Acacia albida* with 97% survival whereas the lowest survival percentage (19%) was recorded for *Casuarina equisetifolia*. The result showed that mean values of survival among the different plant species were not significantly different from each other.

Table 2. Survival Percentage of different plant species and their mean values calculated after analysis using statistics 8.1 software two-way ANOVA (LSD) was used to test for significant differences (P<0.05) for marginal means of variables

S.No.	Species	Survival percentage (%)				Mean
		Initial Survival %	2018	2019	2020	
1	*Acacia nilotica*	100	100	100	100	100a
2	*Acacia ampliceps*	100	75	61	55	73e
3	*Acacia albida*	100	98	97	97	98a
4	*Acacia coriacea*	100	82	72	69	81d
5	*Acacia nilotica (cup)*	100	97	95	95	97ab
6	*Tamrix aphylla*	100	86	80	74	85d
7	*Acacia farnesiana*	100	98	96	95	97ab
8	*Casuarina equisetifolia*	100	43	30	19	48f
9	*Acacia tortilis*	100	98	96	96	97.5ab
10	*Eucalyptus camaldulensis*	100	94	89	88	93bc
11	*Prosopis cineraria*	100	90	87	84	90c
12	*Zizyphus mauritiana*	100	100	100	100	100a
Mean		100a	88b	84c	81c	

Average values followed by the same letter are not significantly different at LSD 0.05.

The result also showed that survival percentage recorded for different plant species in initial year and the year 2018 were significantly different from each other whereas the survival percentage recorded for different plant species in the year 2019 and 2020 were not significantly different from each other.

It is clear from the Table 2 that the survival percentage in the initial year was 100% and after first year in 2018 it was reduced to 84% which indicated that most mortality occurred during the first summer, i.e. between 6 and 12 months after plantation. This may be due to summer droughts and low rainfall during the summer season resulted in to the production of stress which may be responsible for the initial increase in plant mortality due to the limited root development of the saplings and their inability to access water contained in the lower layers of the soil profile (Maestre and Cortina, 2002). The result showed that the mortality rate among all the plants species reduced gradually year after the year. This may be due to the establishment and development of roots by the saplings due to which it could tolerate stress of droughts.

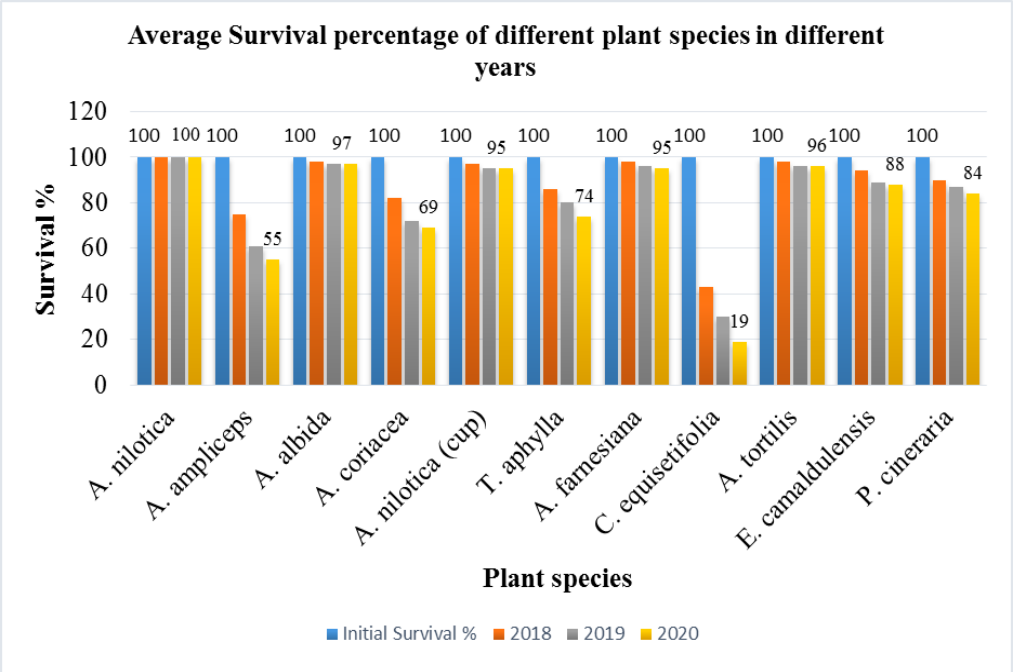

Fig. 3. Showing survival (%) of different plants species during different years

The result in Fig.3 showed that the initial survival percentage for all the plant species were 100%. Whereas the final survival percentage in the year 2020 recorded for *Acacia nilotica Acacia ampliceps Acacia albida, Acacia coriacea Acacia nilotica (cup), Tamrix aphylla, Acacia farnesiana, Casuarina equisetifolia, Acacia tortilis, Eucalyptus camaldulensis, Prosopis cineraria* and *Zizyphus mauritiana* were 100, 55, 97, 69, 95, 74, 95, 19, 96, 88, 84 and 100 respectively. The result showed that the greatest survival percentage was recorded for *Acacia nilotica* and *Zizyphus mauritiana* (100%) while the lowest survival percentage (19) for *Casuarina equisetifolia.*

Sardar (1992) while studying the comparative status of growth and survival of different plant species found that the survival and establishment of *L. leucocephala* were highest followed by *A. albida* with survival percentage of 87% and 76% respectively.

CONCLUSIONS

Result of the study revealed that *Eucalyptus camaldulensis* and *Acacia albida* were promising high yield tree species for dry afforestation programmes in arid environment and their survival percentage were 88% and 97% respectively.

Zizyphus mauritianai and *Acacia nilotica* (cup) may be selected for plantation in mixture with *Eucalyptus camaldulensis* and *Acacia albida* because these are good fodder trees and have got positive effect on ground vegetation.

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