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EFFECT OF SHADE ON GROWTH PERFORMANCE OF FOUR TREE SPECIES: NURSERY STAGE

Abdul Khaliq Chaudhry
Senior Research Officer, Agroforestry, Punjab Forestry Research Institute, Faisalabad

In this study four shading levels were studied at nursery level on four tree species to determine the effect of different shading intensities on their growth performance. The results indicated that all the four species are. not shade, - tolerant at nursery stage. However, light shade may be provided during initial stage of seedling development to achieve higher survival percentage.
Key words: shading effect, tree growth, nursary

INTRODUcnON

The production of high quality planting stock is of prime importance for the establishment of plantations in public or private sector. A quality seedling must have maximum possible survival potential during nursery, lifting, trans-' portation, planting and post-planting environmental stress such as desiccation and high temperature. One of the nursery cultural practices common in Pakistan which influences seedling quality is shading. Heavy shading from natural (trees in the nursery) or artificial sources (chiks) is common throughout the country. Given the prevalent semi-arid to arid environmental conditions, some shading is probably essential, particularly during the initial stages of seedling development..

Shading definitely affects the morphological and physiological performance of developing plants. Shade increases shoot growth at the expense of root growth, hence decreasing the extent of absorption surface relative to transpiration surface i.e. root/shoot ratio (Kramer and Kozlowski, 1979). The effect of natural overhead shading increases the relative proportion of red light reaching the plants, causing stem elongation, an effort by the plant to reach the upper canopy for normal light (Salisbury and Ross, 1978). The leaves of plants grown under normal sunlight are smaller and possess a greater volume and more chlorophyll per unit of leaf area than leaves of plants grown under the shade (Kramer and Kozlowski, 1979). There is a smaller number of stomata and lower mesophyll resistance to CO_2 diffusion in leaves of plants grown under the sun (Boardman, 1977). Shaded plants leaves also might have fewer carbohydrate reserves which could be used to fuel root generation immediately after out planting when the seedling's photosynthetic mechanism is less active due to the shortage of water. The overall effect of heavy shading is to reduce seedlings ability to withstand high temperature and water stress thereby decreasing survival rate. The question therefore arises: What level of nursery shading is necessary to keep the seedlings healthy so that quality seedling having maximum survival potential are produced? The present study was carried out with this question in view.

MATERIALS AND METHODS

This study was conducted at the Punjab Forestry Research Institute, Faisalabad. The layout of the experiment was based on split plot design with four replications. Four shade treatments used in this study were: No shade (control); half-side, a single chik layer having every alternate stick removed; full shade, two layers of chiks superimposed at right angle to each other; full shade-2, the same as full shade but shade to be removed 6-8 weeks prior to out planting ("Kana chiks" were thread-wowen flat pans of *Saccharum munja* sticks). Seedlings of four tree species used in subplots were: *Acacia nilotica, Eucalyptus camaldulensis, Prosopis cineraria* and *Leucaena leucocephala.*

Seedlings of these species were raised in polythene tubes 5 cm x 15 cm, with 40 perforations and filled with thoroughly mixed medium of3~% sand and 66% soil. After presowing treatment, the seeds ofleguminous species, *Acacia nilotica, Prosopis cineraria* and *Leucaena leucocephala* were sown directly in polythene tubes at the rate of 2 seeds per tube. The *Eucalyptus camaldulensis* seeds sown on sand bed were pricked out using seedlings of uniform size with 4 leaves and approximately 4 cm height.. The pricking as well as sowing operations were carried out on the same day. During the germination and post-pricking, the entire experiment was shaded with a single layer of chiks at 80 cm height from the ground. All the tubes were watered twice a day for first 4 weeks and once a day afterwards. The shading treatments were applied 2 weeks post-sowing.

Whole plots were spaced one meter apart so that sufficient space is provided on all the four sides of the whole

plots to keep the shade levels independent.. Subplots were spaced 30 cm apart using Kiln bricks. Shading levels were established by using chiks to cover the plants at specified intensities. Iron frames of 80 cm height were used to support chiks. The chiks were allowed to hang 15 cm above the ground level, approximately the seedling tube height. A subplot consisted of 50 tubes, arranged in an array of 10 x 5 tubes. For a whole plot (50 x 4) 200 tubes were used for all the four species. The total number of plants used under the experiment was 3200 (4 shade treatments x 4 species x 50 plants per subplot x 4 replications). Weedling, shifting and maintenance of seedlings were carried out as per requirements. The survival data were recorded after 2, 12 and 20 weeks of the start of shading treatments. Height, diameter at root collar and fresh and dry weights of seedlings were recorded after 12 and 20 weeks. Five seedlings per subplot (species) were randomly picked to record data in respect of these traits.

RESULTS AND DISCUSSION

Survival: Survival data revealed that the difference in survival of species correlated negatively with the shade.

Table 1. Mean sarvival rate in four tree species under various shade-treatments

Shade treatment! species	Full shade			Full shade-2			Half shade			No Shade		
	Survival rate recorded after 2 (week)	12	20	Survival rate recorded after 2 (week)	12	20	Survival rate recorded after 2 (week)	12	20	Survival rate recorded 2 (week)	12	20
A. nilotica	84	57	35	*71*	29	23	86	66	48	89	69	52
p. cineraria	*71*	29	19	73	37	28	78	59	51	78	47	35
L. leucocephala	81	49	40	88	67	34	89	68	52	91	69	62
E. camaldulenstSl		47	40	CJ7	52	46	98	68	64	SS	69	54

(Table 1). For all the species-the rate of survival of seedlings increased with a decrease in shade intensity. Shade intensities and species varied significantly with respect to percent survival (P = 0.05) after 2nd, 12th and 20th week of study. The interaction between species x shade intensities was non-significant. No shade and half-shade treatments were significantly better than both full-shade treatments regarding the survival of seedlings. No shade and half-shade treatments did not differ significantly. Similarly, full shade and full shade-2 treatments showed no significant difference between themselves. *A. nilotica* and *L. leucocephala* showed the highest survival rate under no shade followed by half-shade treatment.. *P. cineraria* and *E. camaldulensis* showed maximum survival under half-shade (Table 1). It is thus clear that shade for initial 2 weeks is important for getting higher survival. Under full-shade treatments, survival rate was very low after 20 weeks. The survival rate of *E. camaldulensis* was significantly better than *P. cineraria* and *A. ni/otica. L. leucocephala* also significantly better survival than *P. cineraria.*

Growth: Growth of seedlings of all the four species concerning height and collar diameter was measured after 12 and 20 weeks of the start of study (Table 2). Half-shade and no shade treatments were significantly better than both the full shade treatments with respect to seedling height.. *L. leucocephala* gained significantly better height than *P. cineraria, E. camaldulensis* and *A. ntlotica.* All the species put on maximum height under half shade treatment followed by no shade treatments except *P. cineraria.* In case of *E. camaldulensis* height gain after 20 weeks was maximum under no shade. Under full shade treatment, height gain was negligible from 12th to 20th weeks in all the species. Under full sliade-2, height gain was comparatively better when shade was removed six weeks prior to out planting. Height gain of *P. cineraria* under full shade-2 was even more than no shade treatment due to removal of shade six weeks prior to completion of the study. Therefore, it may be stated that after removal of shade, height of *P. cineraria* increased very rapidly indicating that at nursery stage, extended period of shade proved injurious for this species.

The shade treatments and species differed significantly at 5% probability level with respect to diameter at root collar (ORC) growth. It was observed that no shade and half-shade treatments allowed better ORC growth, while both the full shade treatments adversely affected the ORC growth.

After 12 weeks, ORC growth was maximum under no shade treatment for all the four species. The *E. camaldulensis*

showed maxim ORC growth followed by *L. leucocephala* while *A. nilotica* and *P. cineraria* were at par. After 20 weeks, ORC growth of *E. camaldulensis* and *A. nilotica* was maximum under no shade treatment, whileL *leucocephala* and *P. cineraria* exhibited maximum ORC growth under half-shade treatment followed by no shade and full shade treatments. In all the species, ORe of seedlings increased with decreasing shade intensity, indicating that these species are not really shade tolerant.. The ORC growth of *L. leucocephala* reached maximum during July and August with the onset of monsoon rains/increase in humidity in half-shade treatment which could be attributed to its nature of beinz a species of

Table 2. Growth of four tree species under vanous shade treatmentS

Shade treatmentJ species	Full shade		Full shade-2		Half shade		No Shade	
	12 (week)	~	12 (week)	~	12 (week)	~	12 (week).	~
Mean height (cm) after 12 and 20 weeks of shading								
A. nilotica	~	23	22	26	31	51	~	41
P. cineraria	24	25	22	29	25	51	~.	~
L. leucocephala	21	25	30	33	38	73	ZJ	S0
E. camaldulensis	15	18	16	22	36	40	24	43
Mean diameter at root collar (mm) after 12 and 20 weeks of shading								
A. nilotica	1.2	1.2	1.2	2.1	1.8	3.0	1.8	3.4
P. cineraria	0.9	0.9	0.8	0.9	1.5	2.4	1.8	1.8
1.. leucocephala	1.4	2.0	1.6	2.5	1.9	5.1	2.0	4.0
E. camaldulensis	0.8	1.1	1.0	1.5	2.0	3.1	2.1	42

humid and subhumid tropics. Champion (1987) was of the view that shade bearers are those plants which are capable of regeneration and development under a more or less complete canopy of other species, whilst light demanders required more light for regeneration and development. According to Singh (1982), *P. ctneraria* is an evergreen and a strong light demander species. Dense shade kills its seedlings or adversely affects seedling growth .:However, light shade may be beneficial for reducing evapotranspiration. The *A. nilotica* is also a strong light demander. The *E. camaldulensis,* as a rule is intolerant to shade but in early youth seedlings endures a little of shade (Troup, 1921) and (Hocking, *1993). L. leucocephala* may tolerate only partial shade but grows best in full sunlight.. Seedlings cannot withstand thick shade of weeds or trees (NAS, 1983).

Green and Dry Weights: Under the effect of different shade intensities, green and dry weight of seedlings after 12 and 20 weeks differed significantly (Table 3). No shade and half-shade treatments were significantly better than full shade and full shade-2 treatments. Similarly, species performance. was also significantly different.. The *L. leucocephala* showed significantly better green and dry weight than that of *P. cineraria,.* while the difference in green and dry weight of *A. nilottca andE. camaldulensis* andP. *cineraria* was non-significant.. After 20 weeks, *A. nilotica* and *E. camaldulensis* weights were maximum under no shade treatment followed by half-shade and full shade treatments, while *P. cineraria* and *L. leucocephala* weights were maximum uner half-shade treatment.. Green and dry weights of all the species increased with decreasing shade intensity, inddicating that seedlings of tree species under trial are not shade tolerant.. It was observedd that all the four species showed minimum survival percentage, height and ORC growth under full shade treatments. Seedlings undder the two latter treatments were physically weak and thin as is clear from their green and dry weights.

Table 3. Weights of four tree species under various shade treatments

Mean weight (cm) after 12 and 20 weeks of shading								
Shade treatments/ Species	Full shade		Full shade-2		Half shade		No Shade	
	12 (week)	~	12 (week)	~	12 (week)	~	12 (week)	~
A. nilotica	0.6	0.7	0.6	1.6	1.6	4.3	12	4.3
P. cineraria	0.4	0.4	0.3	0.9	1.1	3.7	1.4	1.6
L. leucocephala	1.0	1.2	1.2	2.2	1.9	12.9	2.1	7.1
E. camaldulensis	0.4	0.6	0.5	1.4	2.1	5.5	2.1	6.9
Mean dry weight (g) of seedlings after 12 and 20 weeks of shading								
A. nilotica	0.2	02	0.2	0.7	0.8	1.9	0.7	2.1
P. cineraria	0.1	0.1	0.1	0.4	0.5	2.0	0.7	0.7
L. leucocephala	0.5	0.6	0.6	1.0	0.9	4.8	0.8	32
E. camaldulensis	0.2	0.2	0.2	0.5	1.1	2.1	1.1	2.9

Groninger et a1. (1996) observed that shade decreased total biomass for all the species. According to Jisheng (1986), 90% of tree biomass comes from photosynthesis products. The yield and biomass production of the plants correlates positively with the net photosynthetic capacity. It appears that the species having higher content of chlorophyll has a higher rate of photosynthesis and growth, indicating that a direct relationship exists between chlorophyll content, photosynthesis and growth. The total *dry* weight yield of a field crop is the product of the length of the growing season and the crop growth rate. Solar energy, if not limited by other factors such as water and nutrients availability, controls dry matter production by crops (Driscoll, 1990). According to Kramer and Kozlowski (1979), among the factors, genetic control of anatomical changes in leaves, changes in chlorophyll, respiration rates, photosynthesis and various metabolic changes in competitive situations are important.

Conclusions: All the four species studied are light demander and need no shade at nursery stage. However, light shade may be given at early stage of seedling development to enhance survival percentage. The pattern of seedling growth was not uniform among the four species. No consistent relationship existed between shade and species. Seedlings of all the four species studied were physically much weaker under both the full shade treatments than those in half shade or in open.

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