



Effect of Irrigation Density on Seedling Morphology in Taurus Cedar (*Cedrus libani* A. Rich.)

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Abstract

Irrigation was one of the most important nursery practices for both cost and quality of seedlings. We aimed to determine relation between the irrigation density and seedling quality in Taurus Cedar grown in Egirdir Forest Nursery at southern Turkey based on second year morphological data to contribute nursery practice of the species. Irrigation experiments were designed for each 3, 5 and 7 days as two replicates in the nursery. And also a treatment was put present nursery irrigation practice as control. Until germination the sowing was humidity, while after germination the seedlings were irrigated each 3 (III), 5 (V) and 7 (VII) days, and also present irrigation regime of the nursery called control (C). Seedling morphology was compared for the densities and also traditional irrigation treatment to contribute nursery practice of the species based on second year data. The results showed that all irrigation density had different effects on seedling morphology.

It is needed to collect more data on from different nurseries and irrigation densities to draw accurate conclusion. However, the differences among irrigation densities showed different irrigation densities could be applied according to climatic (i.e., arid area) and edaphic characteristic of afforestation area.

Keywords: Taurus cedar; Irrigation density; Growth; Morphological properties.

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1. Introduction

Seedling quality is one of the most important factors in economical and biological success in plantation forestry. The seedling quality is related to many nursery practices such as irrigation, fertilization, soil and also environmental conditions of nursery. Irrigation and its density has crucial importance for morphologically, physiological and ecological of plants in these applications. Among these, application of restricted watering has been proved to promote osmotic adjustments and changes in cell wall elasticity [1,2] and to increase root growth capacity [3,4].

However, water demand of plant cannot be cover by precipitation or present water in the soil because of insufficient precipitation or unsuitable periods. In this situation, the water demand of plants is covered by irrigation periodically. The period and amount of the irrigation has important role in seedling quality and production cost of seedlings. For instance, over-irrigation causes loss of nourishment and oxygen insufficiency, excess water causes greensickness in the plants and thus prevents seedling development to reach the desired levels [5], and reducing tolerance of plants against to frost and drought [6], and also delaying maturation of the plants [7].

In tree nurseries seedlings are exposed to repeated periods of wetting and drying during which water and aeration conditions in the growth medium change. In nurseries the amount and timing of irrigation in greenhouses are usually adjusted after visual and tactile evaluation of the growth medium, or after seedling trays have been weighed and average water loss has been determined gravimetrically. Due to variations in atmospheric conditions and growth media properties, maintenance of sufficient water and oxygen availability for seedlings requires more accurate information about the irrigation regime [8].

However, while many studies are carried out on plant growth and water regime in different plant species [9,10,11,12,13,14,15,16]. It is very limited on Taurus Cedar (*Cedrus libani* A. Rich.).

We aimed to determine relation between the irrigation density and seedling quality in Taurus Cedar grown in Egirdir Forest Nursery at southern Turkey based on second year morphological data to contribute nursey practice of the species.

2. Material and Methods

2.1 Materials

This study was conducted in 2+0 year containerized Taurus cedar seedlings, grown Isparta/Egirdir Forest Nursery (latitude 38° 05'N, longitude 30° 45' E, altitude 1450 m) at southern part of Turkey, originated local seed stand called Isparta-Kapidag (latitude 37° 53'N, longitude 30° 52' E, altitude 926 m) in 2008. The texture of the soil used in seedling growth was clay loam with an organic substance index varying between 3 to 6 %, its lime content is between the values of 5.41 and 7.61. According to the results of seedling soil in polyethylene bags it was determined that the soil mixture was of clay loam texture, had 11.31% available water capacity, was salt-free, near natural, contained 3.91% organic substances and was calcareous. Also the irrigation water used

(C2-S1) was determined to contain medium levels of salt and low levels of sodium.

2.2 Methods

Irrigation experiments were designed for each 3, 5 and 7 days as two replicates in the nursery. And also a treatment was put present nursery irrigation practice as control. For the purpose the same type soil mixture and amount (850 g/seedling bag) was used in growth of seedlings in the experiments. 3 to 5 seeds were sowed in each polyethylene bags in March of 2006. Until germination the sowing was humidity, while after germination the seedlings were irrigated each 3 (III), 5 (V) and 7 (VII) days, and also present irrigation regime of the nursery called control (C).

10 seedlings chosen randomly were sampled from each irrigation treatment and replication at the end of second growing season which was also planting age of the species in 2008.

Root collar diameter (RCD), seedling height (SH), stem dry weight (SDW) and root dry weight (RDW) were measured in sampled seedlings.

Collected data was analyzed for Analysis of variance and Tukey test by SPSS 16.0 statistical packet program.

3. Results

Seedlings showed the highest performances for height, diameter and stem dry weight for each three days irrigation, while root dry weight was the highest for each five days irrigation. Control and weekly irrigation (VII) showed similar performance for the characters (Table 1).

Table 1: Averages of the morphological characteristics for the treatments

Treatments	SH	RCD	SDW	RDW	SDW/RDW
	(cm)	(mm)	(g)	(g)	
III	13.77	3.15	2.3	2.15	1.07
V	11.28	2.97	2.17	2.23	0.97
VII	10.49	3.08	1.72	2.11	0.81
C	10.49	3.08	1.72	2.11	0.81

The diameter, height and stem/root rate of the seedlings are significantly affected from irrigation densities according to results analysis of variance (Table 2). It was also emphasized by results of the Tukey test (Table 3). Tukey's test showed that the 7 days irrigation implementations and the nursery (control) implementations were in the same group, while the values of the 3 and 5 days interval irrigation implementations were gathered under another group for ratio of dry weights (Table 3).

Table 2: Results of analysis of variance for the seedling characteristics

Variables	Source of variance	Sum of squares	df	Mean squares	F	P values
SH	Between groups	404.533	3	134.844	22.866	P<0.001
	Within groups	1155.823	196	5.897		
	Total	1560.356	199			
RCD	Between groups	38.754	3	12.918	49.706	P<0.001
	Within groups	50.678	195	.260		
	Total	89.433	198			
SDW/RDW	Between groups	1.642	3	.547	4.669	P<0.05
	Within groups	22.981	196	.117		
	Total	24.623	199			

Table 3: Results of Tukey’s test

SDW/RDW		RCD		SH	
Treatments	Homogeneous groups*	Treatments	Homogeneous groups*	Treatments	Homogeneous groups*
VII	a	V	a	VII	a
C	ab	VII	a	V	a
V	bc	III	a	C	b
III	c	C	b	III	b

*; the same letters showed similar groups.

It was also determined that present nursery irrigation practice (Control) had significant effect on the diameters of seedlings and provided a bigger growth in diameter in comparison with the other irrigation densities (Table 3). The diameters of the seedlings subjected to other irrigation implementations were close to each other and no significant difference could be found among them. Results of Tukey’s test was also emphasized that different irrigation densities had significant effect on the height (Table 3). The seedlings of treatments III and C showed higher height growth than that of treatments V and VII (Table 3).

4. Discussion

All seedlings treated by different irrigation densities were in first quality class according to seedling quality classes of the Turkish Standards Institute (TSI) prepared in 1988 [17] (Table 4). However, Treatments III and V

showed higher growth performances than that of VII and C for averages. On the other hand, when the daily evapotranspiration and transpiration (mm/days) were evaluated in terms of the irrigation densities, it was showed that the daily water consumption was reduced from the irrigation in treatments III and VII. This reduction was statistically significant for Taurus Cedar, and also a significant amount of excess water was consumed by the end of the C treatments. This indicated that, in terms of daily water consumption, the least water consumption was achieved with the weekly irrigation. In other words, it was possible to assert that the irrigation carried out with weekly and until bringing the soil to field capacity for the most economical irrigation method in terms of water conservation. Considering that the seedlings grown in a highly humid environment may cause a problem of compatibility in semi-arid and semi-humid areas this conclusion is deemed important [18,19].

Table 4: Standard values for the quality of seedlings and irrigation density

Seedling Type and Age	Seedling Quality Class	Seedling Properties According to standard values (TSI)	Irrigation Density			
			3 days	5 days	7 days	Nursery
Taurus cedar (2+0)	I	RCD (min.2mm)	3.15 mm	2.97 mm	3.08 mm	4.07 mm
		SH (min 12 cm)	13.77 cm	11.28 cm	10.49 cm	13.57 cm
		S/R (0-3)	1.07	0.97	0.81	0.87
		Evapotranspiration	2.8 mm/day	2.6 mm/day	2.2 mm/day	4.4 mm/day
		Transpiration	1.7 mm/day	1.8 mm/day	1.4 mm/day	2.3 mm/day

Similar studies in this study are shown below. As seen from the irrigation work must be done at the right time.

In a study, when exposed to water stress Taurus cedar (*Cedrus libani* A. Rich.) renewing the roots of seedlings was determined to be higher than the well-watered seedlings [18].

Seedling morphology was generally similar between subirrigation and overhead irrigation, concurring with results for other tree species [20, 21, 22]. The notable exception was the interaction between container type and irrigation method, whereby Copperblock™ containers had smaller RCD when subirrigated than when overhead irrigated [23].

Water in different applications depending on the cover of pine seedlings grown best in morphological features of seedlings growing medium moisture deficit (100%) was obtained from the application (RCD: 3.4mm; SH: 16.9cm). Minimum water (60%) of the morphological characteristics of the seedlings were determined bad (RCD: 1.5 mm; SH: 8.2 cm) [24].

In the study, Five-month-old *Pinus halepensis* Mill. seedlings were subjected to 4 irrigation treatments for 8 weeks. water relations; the influence of watering regime on morphological parameters was very important in *Pinus halepensis*. Seedlings from the most frequently watered treatment (T4) had larger height, diameter, and dry weight. Root system growth was stimulated by watering, as seedlings from T4 had the lowest shoot to root ratio [14]

5. Conclusion

It is needed to collect more data on from different nurseries and irrigation densities to draw accurate conclusion. However, the differences among irrigation densities showed different irrigation densities could be applied according to climatic (i.e., arid area) and edaphic characteristic of afforestation area.

The morphological data could be supported by physiological data and also field performances of irrigation densities.

Present irrigation density of the nursery could be changed because of the lowest growth performance.

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