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Influence of Irrigation, Soil and Weeding on Performance of Mediterranean Cypress Seedling in Nursery

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1. Introduction

Mediterranean cypress, an evergreen softwood species, is well-known as *Cupressus sempervirens* L. var. *horizontalis* Mill. (Gord). It is an indigenous species of Mediterranean Europe and western Asia, including, Cyprus, Crete, Turkey, Syria, Saudi Arabia, Caucasian and Iran, resembling the Mediterranean climate (Sabeti, 2004). It is belonged to warming period and interglacial climate. Plant structure has a lot of the Mediterranean elements (Sagheb-Talebi et al., 2003). In Iran among the fifth-fold native coniferous trees (*Juniperus communis, J. Sabina, J. polycarpus, Biota orientalis*) it plays a unique role in restoration of deforested area of the Mediterranean zones (Rezaei, 1992); and the most important natural habitats of this species are found in northern regions and in special bio-geographical stations, as well as in warm valleys subjected to the southern winds (Mossadegh, 1996). The best developed Mediterranean cypress forests are found in the Chalous valley, and then, in the valley of Sefid-Roud (Roudbar). As small and isolated areas, it distributes in other parts of the country, particularly in west and south, in provinces of Lorestan, Sistan, Fars, Khozestan and Kohkilouye-Booyerahmad (Zare, 2002). Some scientists believe that the Mediterranean and semi-Mediterranean climates occurred in some parts of Iran are the major reason for distribution of this tree. The components of the flora of these forests include many Mediterranean elements (Asadolahi, 1991).

Although some conifers show better performance in more fertile beds (substrate or medium) but Mediterranean cypress does not care the nutritional quality of soil and is able to survive in poor and dry habitats. It is a resistant tree to hard conditions and in some parts of northern Iran particularly in Marzan-Abad, Roudbar and Manjil it exists on low nutrient, superficial and calcareous soils. It has been known as a low nutrient demanding species; its strong root system makes it able to easily establish on steep slope, rock and cliff. It tolerates well high dry; on rich soil it grows fast and on moist soil the root system forms shallow (Bolandian, 1999).

Since 1980, in dry slopes and semi-arid zones of northern Iran, more than 20.000 ha, have been afforested with this species. This is while that the increased destruction of Hyrcanean forests and the need for development of afforestation and green space in some capable regions have been given rise to producing its seedlings in forest nurseries. In 1996 the seedling production in communal nurseries was 96 million, with majority of this species. In

the nurseries, due to weed competition, drought stress and poor nutrient soil, mortality rate is high and growth is low in the first growing season. Thus, the seedlings should be retained in nursery for next year; consequently, the seedling production would be costly. Generally, in nurseries, increase of seedling production, decreases of mortality rate and costs (especially for weeding and irrigation) are of main importance. Hence, good elaboration of inhibiting factors of growth and establishment and careful understanding of the ecological requirements of species are necessary (Krasowski et al. 2000).
Generally, regarding to increasing the afforestation with Mediterranean cypress in north of country, research on growth performance of seedling production of this species is inevitable (Tabari & Saeidi, 2007). Regarding to above mentioned, this question arises whether poor soils like sandy soils, longer periods of watering and weeding can decrease the nursery cost and improve the production efficiency. Hence, this research aims to determine the best treatment for better growth and higher seedling production by testing the different treatments of soil, irrigation and physical weed control.

2. Materials and methods

2.1 Sampling

In April 2008 some seeds of Mediterranean cypress (*Cupressus sempervirens*) collected from some elite trees, following 24 hours saturation in water, were sown in 108 plots 1 m × 1 m in an open area of Shahrposht nursery (Nowshahr city, north of Iran,). Based on metrological census of the study site (After Tabari et al. 2002), mean annual precipitation is 1100 mm, mean annual temperature, mean max. temperature of the warmest month and mean min. temperature of the coldest month is 16.4 ºC, 30 ºC and 3.7 ºC, respectively. Number of dry days of year (xerothermique index) is 55 and Pluviothermique index (Q_2) is 143.6. By the classification of Emberger (1932), the climate of nursery is humid with cool winters. Seeds were kept in a suitable place and their purity and viability determined in the laboratory. Twenty seven seedlots (plots) 1 × 1 m were established (seedlot spacing = 50 cm, corridor width =100 cm) with substrates prepared from soils mentioned in Table 1. In early spring 2009, in each seedlot 400 sound seeds, moistened for 24 hours, were sown in 4 rows and covered with a thin (about 3 mm) sand layer. For controlling fungus, Agrotis and larvae, Capton and Diazinon (56%) and Malathion solutions were used. Also, slug was trapped using the Sevin toxin (Toxin 1 kg+Rice bran 12 kg as paste) and Alderin toxin (toxin 400 g in 220 liter water) was applied for controlling the syringe.

Soil type	Sand (%)	Silt (%)	Clay (%)
Loam-Clay (A)*	21	41	38
Sand (B)	83	9	8
Sand-Loam-Clay (C)	47	27	26
Loam (D)	42	49	9

* Common nursery soil

Table 1. Soil type and texture components (%) of substrates for growing *C. sempervirens* seedlings

In early May, following the seeds germination, watering was carried out at one day intervals, except in rainy days, as long as the seedlings did not become woody and reach 5 cm in height. Until commencement of the applied treatments, weeding was accomplished thrice in order to successful establishment of the seedlings produced. Watering treatment began since mid-June and continued to mid-October (4 months) with 4-, 8- and 12-day intervals. During the investigation period three weeding levels (20-, 30- and 40-day) were done manually, without using herbicides, and it was tried to prevent the removal of newly-grown seedlings. After the seed germination, during the care periods no fertilizer was added into the nursery substrate.

2.2 Measurement

The germinated seedlings in the experimental plots were counted and measured in late autumn (after ending the weeding and irrigation periods). In order to determine the differences among means (in different soil treatments, irrigation and weeds control), and the interactions of these factors Duncan's test and General Linear Multivariate (GLM)′ test were performed, respectively. In fact, this research was done as factorial test in split-split plot design with 4 soil, 3 irrigation and 3 weeding treatments whereas in each soil one irrigation or weeding was repeated in 9 experimental plots. Statistical analyses were conducted using the SAS software (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1 Seedling number

The statistical analysis, after square root transformation of data, showed that the frequency of survived seedlings varied in different soils (d.f.=3, F=16.028, P=0.036). The number of seedlings in loam-clay (A), sand (B), sand-loam-clay (C) and loam (D) were 28.6, 37.8, 48.9 and 31.3 individuals in m^2, respectively. In fact, sand-loam-clay soils (C) showed higher efficiency as compared to the other soil textures (Table 2).

By square root transformation it become evident that the number of seedlings varied in different irrigation regimes (d.f.=2, F=50.616, P=0.000). Hence, watering at intervals of 8, 4 and 12 days produced 54.5, 31.8 and 16.8 individuals/m2, respectively (Table 2). The mean number of seedlings in 20-, 30- and 40-day weeding treatments was 34, 36.7 and 32.4 individuals/m^2, respectively, showing a non-significant difference (d.f.=2, F=0.529, P=0.638) (Table 2). As a whole, soil and irrigation treatments separately influenced the efficiency of seedling production, but the interaction of these factors on these characteristics was not significant (Table 3)

3.2 Shoot growth

The analysis displayed that shoot growth varied in different soil textures (d.f.=3, F=2.963, P=0.000). Like frequency, shoot growth in sand-loam-clay (C) was the highest in comparison to the other soils types. Among the four soil texture types, shoot growth in sandy soil (B) was poorest (Table 2). Also, shoot growth was different in irrigation regimes (d.f.=2, F=19.616, P=0.000); it was greatest in 8-day irrigation interval followed by 12- and 4-day irrigation intervals (Table 2).

Shoot growth varied among the weeding levels (d.f.=2, F=2.751, P=0.045), so that the growth was greatest in 20-day weeding and was intermediate in 30-day weeding (Table 2). Soil, irrigation, and weeding, separately and simultaneously (except weeding × irrigation interactions) affected shoot growth (Table 3).

Treatment		Number (m^2)	Shoot growth (cm)
Soil type	Loam-Clay (A)	28.6 ± 4.9 b	26.6 ± 0.7 b
	Sand (B)	37.8 ± 4.9 b	23.2 ± 0.6 c
	Sand-Loam-Clay (C)	48.9 ± 6.5 a	31.0 ± 0.6 a
	Loam (D)	31.3 ± 2.9 b	26.5 ± 0.7 b
Watering regimes	4-day interval	31.8 ± 2.6 b	24.4 ± 0.6 c
	8-day interval	54.5 ± 3.3 a	29.2 ± 0.5 a
	12-day interval	16.8 ± 1.3 c	27.1 ± 0.6 b
Weeding regimes	20-day interval	34.0 ± 2.9 ns	27.6 ± 0.6 a
	30-day interval	36.7 ± 3.2 ns	27.3 ± 0.5 ab
	40-day interval	32.4 ± 2.9 ns	25.8 ± 0.5 b

For each treatment, different letters in column show significant differences.
ns, is non-significant.

Table 2. Mean number and shoot growth (± sd) of *C. sempervirens* in different soil types, watering regimes and weeding regimes

	Number		Shoot growth	
Sources	F	P	F	P
Soil	4.229	0.008 **	35.193	0.000 ***
Watering	20.824	0.000 ***	25.954	0.000 ***
Weeding	0.577	0.564 ns	6.0.18	0.003 ***
Soil × Watering	1.214	0.309 ns	6.530	0.000 ***
Soil × Weeding	0.841	0.542 ns	3.585	0.002 ***
Watering × Weeding	0.827	0.512 ns	2.716	0.029 *
Soil × Watering × Weeding	1.499	0.145 ns	5.354	0.000 ***

ns= non-significant, *, significant at 5%, **, significant at 1%, ***, significant at 0.1%

Table 3. Analysis of Variance for number and shoot growth of *C. sempervirens* in different treatments

4. Discussion

The results of this research showed that soil texture influenced the survival and growth rates of *C. sempervirens* seedlings, whereas sand-loam-clay (C) was the suitable substrate for raising the seedlings. It indicated that with adding sand into nursery soil (loam-clay), the soil probably became a little light and *Cupressus* seedlings could spread their roots easier and attain higher growth and survival. Hassan et al (1994), working on *C. sempervirens* seedlings, showed that the mixed soil with sand, i.e. sand+clay+sponge (1:1:3) produced the highest growth rate. In our research, sandy soils (B) gave rise weak performance in *Cupressus* seedlings. In contrast, the common nursery soil (A) produced better growth as compared to sandy soil (B). Tabari et al (2007) also considered the low growth of *C. sempervirens* in sandy soil in comparison with medium-textured soil and soils containing organic matter. The similar finding was observed in report of Kiadaliri (2002) on the 2-year transplanted seedlings of *C. sempervirens*.

Accordingly, our results showed on sand-loam-clay soils (C), which normally have the higher nutrients contents in comparison with sandy soils (B), the seedling performance was more outstanding. Shahini (1996) found the better growth of pot-planted *Cupressus* seedlings in soils containing organic matter (30% peat moss). The similar finding was detected in work Ahmadloo et al. (2009) on *C. sempervirens and C. arizonica*, Román et al. (2003) on *Pistacia lentiscus*, *Pinus halepensis*, *Picea sitchensis* species, Khasa et al. (2005) on conifer seedlings, and Tsakaldimi (2006) on *Pinus halepensis* seedlings. Significant effects of nutrient and organic matter on the increased growth of other needle-leaved species have been observed in findings of Samuelson (2000), Salifu and Timmer (2001) and Blevins et al. (2006), too. This is seemingly due to proper aeration and water content in soil and easiness in absorption of nutritional elements by plant (Shibu et al., 2006). Indeed, with increasing organic matter in soil, plant is stimulated for nutrient absorption, metabolism activity and better growth (Tichy and Phuong, 1975).

Our study also showed the positive effect of watering on survival and growth of *Cupressus* seedlings, whereas the most frequent and the highest shoot length occurred in 8-day irrigation. No difference of growth was detected in findings of Johnson (1990), working with *Pinus taeda* and *P. elliottii* seedlings. In the present research, watering with shorter interval (4-day) showed a weakened function compared with medium interval (8-day). This may be due to high growth of herbaceous species and their competitive effect causing shorter growth and higher mortality for *Cupressus* seedlings.

Numerous studies have addressed how the performance of planted or naturally established woody seedlings are affected by herb competition (Morris et al., 1993; Caldwell, et al., 1995; Rey Benayas et al., 2002, Jose et al., 2003) and other limiting factors. However, their interactive effects on the performance may have complex interactions receiving little attention. Weeds compete with seedlings for resources (especially water and nutrient) and influence negatively growth (Davis, 1999; Lof et al., 1998; Duplisis et al., 2000; Lhotka and Zakzek., 2001; Mirzaei et al., 2007) but they also diminish radiation and may increase winter low temperatures at the ground level, indirectly effecting the seedling establishment and growth (Rey Benayas et al., 2005). In the current study, weeding and its interaction with soil and also with watering had a positive effect on shoot growth, a finding in line with Kolb and Steiner (1990) and Lorimer et al. (1994). In contrast to Neary et al (1990), who illustrated that early growth of *Pinus taeda* and *P. elliottii* did not reduce with weed control; in our study weed control significantly affected growth, but no did seedling production. Weed control improved shoot growth where the watering interval was 20 days. The minimum shoot growth was detected where the seedlots were removed from herbaceous species in 40-day intervals.

5. Conclusion

According to the findings of this investigation, although the better watering treatment for *C. sempervirens* seedling is 4-day interval but the 8-day interval can be recommended without that the growth and production efficiency is decreased. This is while that water consumption can be economized, too. Regarding to the little differences of growth and the importance of seedling production affected by weeding, for saving the laborer costs, 30-day weeding can be as well applied rather than 20-day one. Likewise, due to the low differences of seedling production and shoot growth presented by soil treatments, loam soil (D) and even sand soil (B) can be suggested for growing *C. sempervirens* seedlings in forest nurseries, if weed control and watering are utilized well.

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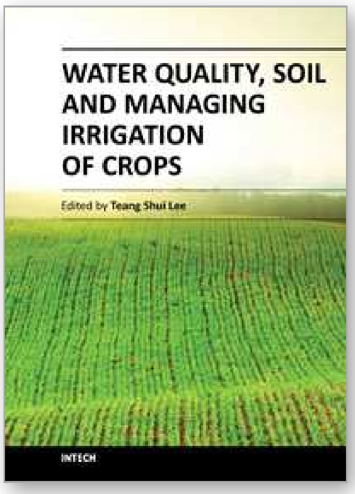

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The book entitled Water Quality, Soil and Managing Irrigation of Crops comprises three sections, specifically: Reuse Water Quality, Soil and Pollution which comprises five technical chapters, Managing Irrigation of Crops with four, and Examples of Irrigation Systems three technical chapters, all presented by the respective authors in their own fields of expertise. This text should be of interest to those who are interested in the safe reuse of water for irrigation purposes in terms of effluent quality and quality of urban drainage basins, as well as to those who are involved with research into the problems of soils in relation to pollution and health, infiltration and effects of irrigation and managing irrigation systems including basin type of irrigation, as well as the subsurface method of irrigation. The many examples are indeed a semblance of real world irrigation practices of general interest to practitioners, more so when the venues of these projects illustrated cover a fair range of climate environments.

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