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Restoration of Deforested Areas by Cypress Seedling in Southern Coast of Caspian Sea (North of Iran)

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Abstract

Two-year old cypress (*Cupressus sempervirens* var. *horizontalis* seedlings (1+1) were planted in two planting depths (20 cm and 40 cm) in a lowland deforested area located in south of Caspian Sea, north of Iran. The results after the first and second growing seasons revealed that planting depth influenced survival and vitality such that both variables showed better performance in deeper holes (40 cm). In both periods stem length as well as collar diameter did not increase with increased planting depth. In year two, compared to year one, survival reduced only in holes of 20 cm, vitally declined in both planting depths but growth enhanced. Generally it can be concluded that deeper holes are better suited for plantation of *C. sempervirens* in the site study.

Keywords: Cupressus sempervirens, *planting depth*, *seedlings*, *stem length*, *survival*.

INTRODUCTION

The main objective of each plantation project is to provide the favorable growth and establishment of seedlings. For this purpose, good elaboration of inhibiting factors of plantation sites and careful understanding of the ecological requirements of species are unavoidable (Krasowski et al. 2000). Generally, growth and survival decrease and the costs increase when low quality seedlings are used in plantations. Indeed, by high investment in nurseries, besides a high yield in seedling quality, a decrease in plantation cost is also expected (Wightman et al. 2001). One of the cases in plantation sites, particularly in dry and sandy soils, which may promote growth and survival, is deep planting. In reality, in dry sites deep planting induces to decrease the drought stress; it also prevents seedlings from being turned (twisted) by wind (Schwan 1994). Some investigations on size of planting depth have been carried out in recent decades. Among which, Switzer (1960) believes, depending on site conditions (soil texture, ground water table, etc.), planting depth differs in different species. Hence, Schwan (1994) claims that deep planting improves quality and quantity of seedlings. Besides, South (2000, on Pinus taeda) reports that shallow-planted seedlings are usually damaged by windfall. In spite of above-mentioned confirmations, many earlier researchers accept that deep planting has an adverse effect on softwoods, particularly on Picea sp. (Hosley 1936). More recent, also, Mullin (1964, 1966) and Clearly et al. (1978) showed detrimental effects of shallow planting. In recent years in Iran, a few investigations related to effects of soil on conifers have been reported but less on size of hole for seedling plantation. *Cupressus sempervirens* L. var. horizontalis (Mill.) Gord. is one of the fifth-fold native *coniferous* species (*Juniperus communis*, *J. sabina*, *J. polycarpus*, *Biota orientalis*), in Iran that has a unique role in restoration of deforested area of the Mediterranean zones (Mossadegh 1996). Generally, regarding to increasing the afforestation areas in north of country, research on planting depth in order to improve the qualitative and quantitative characteristics of this species in northern areas of country is needed.

Natural Distribution

C. sempervirens is well-known as Mediterranean cypress. It is indigenous species of Mediterranean Europe and Western Asia regions, including, Cyprus, Crete, Turkey, Syria, Saudi Arabia, Caucasian and Iran, resembling the Mediterranean climate. *C. sempervirens* is belonged to warming period and interglacial climate. Plant structure has a lot of Mediterranean elements (Sagheb-Talebi et al. 2003). In Iran, the most important natural habitats of *C. sempervirens* are found in northern regions. Some scientists believe that Mediterranean and semi-Mediterranean climates in some parts of northern forests of Iran are the major reason for distribution of this species. As small and dispersed areas it also distributes in other parts of the country particularly in west and south, like Lorestan, Sistan, Fars, Khouzestan and Kohkilouye-Booyer-Ahmad provinces (Zare 2002). In northern regions its habitat is repeated in special bio-geographical conditions. Since 1980 in dry slopes and semi-arid areas of northern Iran about 20000 ha have been covered artificially with cypress. Fig. 1 illustrates some natural habitats and artificial areas of *C. sempervirens* in north of Iran.

Ecological Characteristics

C. sempervirens is a tree that tolerates hard conditions. It grows fast in youth. Its height and diameter at breast height reaches 20-30 m and more than 100 cm, respectively. In northern forests of Iran in some parts, e.g. Roudbar and Mandjil, it grows on low depth calcareous soils with poor nutrient. At riverside of Eshkevar (Roudsar) region on silty-loam soil it creates an attractive mixed forest with broadleaves such as *Parrotia persica, Alnus subcordata, Zelkova crenata,* and *Carpinus betulus.* The largest habitat of *C. sempervirens* with about 4000 ha and 350-850 m a.s.l. is observed in south eastern of Chalous. This habitat as pure stands and/or mixed stands, together with *Acer campestre, Acer monspessulanum, Carpinus schuschaensis, Quercus castaneifolia, Cotoneaster nummularia, Fraxinus oxycarpa, Prunus divaitica* etc. is placed on calcareous soil (Asadollahi 1991). Generally, *C. sempervirens* is 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 and coldness (up to -20°C). On rich soil it grows fast and on moist soil the root system distributes at superficial layers (Bolandian 1999). Its dense crown is bended and its branches are broken easily by heavy snow (Zare 2002). It bears seed at < 10 years and afterward produces mast seed annually.

MATERIALS AND METHODS

In February 2001, 210 bare-rooted *C. sempervirens* seedlings (1+1) in 30 ± 2.5 cm length and 4 ± 0.4 mm collar diameter, produced in an adjacent lowland nursery, were selected to plant in a deforested area of located in south of Caspian Sea, north of Iran (Noor City). Based on Emberger classification (1960) climate with data given in Table 1 is moist with mild winters. For doing the research, firstly soil (with properties given in Table 2) was ploughed and weeds removed by a rotivator. Then on the 1-m rows and 2-m spacing two different

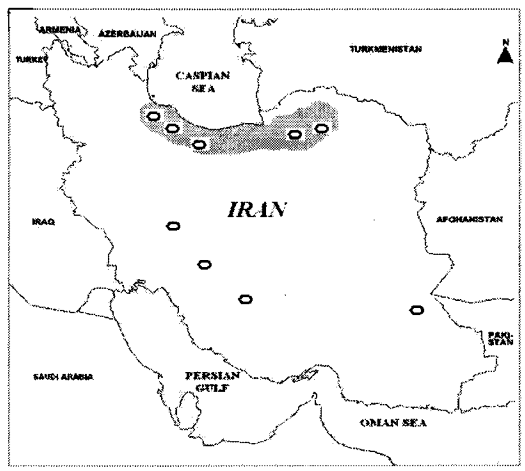

Fig. 1. Distribution of natural habitat (○) and confine of plantation (▒) with *Cupressus sempervirens.*

Fig. 2. *Cupressus sempervirens* seedling planted in 20-cm hole (Photo was taken 5 years after planting).

holes with 20-cm (current method) and 40-cm depths were dug (Figs. 2-4). Seedlings were managed as natural (rainfed and not any weeding after planting). Collar diameter and stem length were measured at the end of the first growing season (November year 1). Vitality or discoloration of needles was recorded in late August according to UN/ECE & UE (Anonymous 1998) classification (Table 3). Survival rate following the seedlings

Table 1. Metrological census of the study site (After Tabari et al. 2002)

Elevation (m)	Mean annual precipitation (mm)	Mean annual temperature (°C)	Mean max. temperature of the warmest month (°C)	Mean min. temperature of the coldest month (°C)	Dry days (xero-thermique index)	Pluviothermique index (Q_2)
-20	1100	16.4	30	3.7	55	143.6

Table 2. Physico-chemical properties of different soil, treatments under plantation of *C. sempervirens* seedlings, in the investigated site.

Texture	Organic matter (%)	pH	EC (mS cm^{-1})	N (ppm)	P (ppm)	K (ppm)
Sandy-Clay	0.1	8	0.07	0.02	2	1.9

Table 3. Discoloration degree of *C. sempervirens* seedlings, based on UN/ECE & UE (Anonymous 1998)

Foliage discolored	Discoloration degree	Vitality grade
Up to 10 %	None	4
10-25 %	Slight	3
25-60 %	Moderate	2
>60 %	Severe	1

counting was determined in late November. All parameters mentioned were measured again at the end of the second growing season (November year 2), due to monitor the effect of planting depth. Likewise, growth percentage of variables recorded in year 2, compared to year 1, was assessed. For this, the following formula was used:

= (Variable year 2 - Variable year 1) × 100/ Variable year 1

Generally, the experiment was as complete randomized design with three replicates. An independent sample t-test was conducted for determining variables measured between two planting depths. Statistical analyses were performed using the SAS software (SAS Institute Inc., Cary, NC, USA). The p value was set at 0.05.

RESULTS

Analysis showed that in both periods survival rate was affected by planting depth (Table 4). It was greater in 40-cm holes than in 20-cm holes (s 5 and 6). A reduction of 3.9% in survival rate of seedlings grown in year 2, compared to those in year 1, was occurred at planting depth of 20-cm (Table 6).

In both periods planting depth did not influence stem length (Table 4) whereas there was not any statistically distinct difference of stem length in two planting depths (Tables 5 and 6). Overall, an increase of 27.8% and 29.0%, respectively at 20-cm and 40-cm holes, was observed in stem growth of seedlings in year 2 over year 1 (Table 6).

Collar diameter was not affected by planting depth (Table 4). It did not differ at two holes in any period (Table 5). An increase of 48.5% at shallow hole and 50.8% at deep hole with collar diameter was appeared in 2nd year over 1st year (Table 6).

In any period vitality or foliage discoloration was affected by planting depth (Table 4). It was of better quality in deeper holes but never exceeded moderate quality (Table 5 and 6). In year 2, compared to year

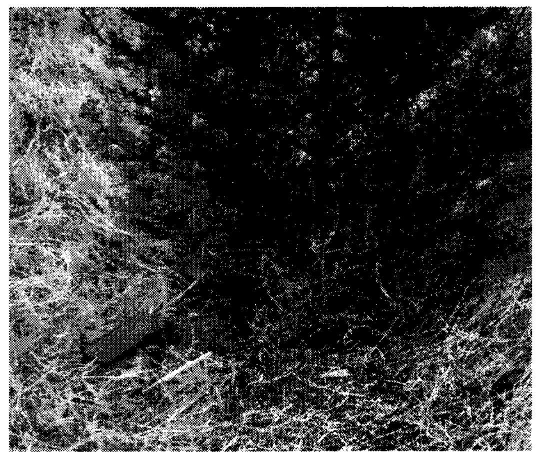

Fig. 3. *Cupressus sempervirens* seedling planted in 40-cm hole (Photo was taken 5 years after planting).

Fig. 4. A perspective of *Cupressus sempervirens* plantation (Photo was taken 5 years after planting).

Table 4. Significant effect (P value) for characteristics measured of *C. sempervirens* seedlings growing on two planting depths in two consecutive years.

Parameter	Survival		Stem length		Collar diameter		Vitality	
Period	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Planting depth	0.010 *	0.003**	0.756 ns	0.810 ns	0.873 ns	0.607 ns	0.002 **	0.020*

* = Significant at 5% level, ** = Significant at 1% level, ns = Non significant

Table 5. Average values of *C. sempervirens* seedlings in different planting depths, in the 1st growing period.

Planting depth	Survival (%)	Stem length (cm)	Collar diameter	Vitality grade
20 cm	71.4 ± 15.3 b	46.7 ± 5.1	6.6 ± 0.7	1.5 ± 0.3 b
40 cm	81 ± 11.7 a	46.5 ± 5	6.5 ± 0.9	2 ± 0.4 a

-Within columns, values followed by different letters are significantly different at $p \leq 0.05$.

Table 6. Average values of *C. sempervirens* seedlings in different planting depths, in the 2nd growing period.

Planting depth	Survival (%)	Stem length (cm)	Collar diameter	Vitality grade
20 cm	68.6 ± 16.4 b (-3.9)	59.7 ± 6.7 (27.8)	9.8 ± 0.9 (48.5)	1.1 ± 0.4 b (-26.7)
40 cm	81 ± 11.7 a (-)	60 ± 7.2 (29)	9.8 ± 1.1 (50.8)	1.4 ± 0.5 a (-30)

-Within columns, values followed by different letters are significantly different at $p \leq 0.05$.
*Value within bracket shows increase or decrease percentage of growth in the year 2 over the year 1.

1, a decline of 26.7 to 30.0% at planting depths was appeared in vitality of seedlings (Table 6).

DISCUSSION

By the current study, it appears that at the end of the study periods, even-though collar diameter as well as stem length does not differ at two hole depths (20 and 40 cm) but survival and vitality are more favorable in deeper holes. This, in reality, agrees with findings such as Sternberg et al. (2000, on coniferous), which assert survival enhances with increasing planting depth, due to enough moisture at lower layers of soil. Similar results with *Pinus banksiana*, *Picea mariana* and *Picea glauca* are reported by Schawn (1994). According to Schawn (1994), growth, as well as survival, is influenced by some physiological and environmental factors such as nutrient quality, water content, root formation, root system, soil inflammation and layers temperature. As a matter of fact, some of which are interrelated whereas variation in one or more causes to reaction of seedling. As a whole, on dry and drained soils, increased survival and growth in deep-planted seedlings is due to adequate moisture of lower parts of soil (Slocum and Maki 1956, McGee and Hatcher 1963, Cleary et al. 1978, Lantz et al. 1989). However, in much rainy years deep planting may negatively effect on growth and in dry seasons raise survival (Koshi 1960). It is also underlined that with increased soil depth fertility reduces but growth and survival enhance (Sutton 1978). In literature, a few reports are referred to deep planting on moist and fertile soils. Deep planting is not always advised by some people, such as Switzer (1960) and Sutton (1978) and in some references the opposite may be reported. It can be referred to the findings of Armstrong (1969), which seedlings grown on organic matter perform low (36%) and high (89%) survivorship, respectively at deep holes and shallow holes.

Generally, as appeared in the investigation, because survival and vitality response better to increased planting depth, deeper hole (40 cm) can be recommended instead of shallow hole (20 cm) for *C. sempervirens* plantation in the lowland deforested areas of south of Caspian Sea.

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