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Survival, Growth and Vitality Effects of Man-Made *Fagus orientalis* Seedlings after Cleaning *Sambucus ebulus* in a Caspian Forest Site

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Abstract: Survival, growth and vitality of 3-year-old man-made oriental beech (*Fagus orientalis* Lipsky) seedlings were examined in a 200 m^2 canopy gap of mountain beech forest, occupied by elder (*Sambucus ebulus* L.) in a Caspian forest site (Northern Iran). In mid-June 2000, two treatments including (a) cleaning *Sambucus* (b) leaving *Sambucus* were made at four plots of 2.5×2.5 m within the gap. The results two years after examination (cleaning treatment) and at the end of the growing season (late November) revealed that height growth as well as survival and vitality quality was significantly of better condition in controlled area than in *Sambucus* cut area. It implies that in the small gaps, the characteristics of *F. orientalis* seedlings do not decline under *Sambucus* competition. It is suggested that in such gaps, cleaning *Sambucus* can be avoided during early years.

Key words: Cleaning, *Fagus orientalis*, height growth, *Sambucus ebulus*, survival, vitality quality

INTRODUCTION

In the Caspian forests of Iran some canopy gaps of oriental beech (*Fagus orientalis* Lipsky) are occupied by invasive herbal vegetation of bramble (*Rubus fructicosus*), fern (*Pterilium aquilinum*) and particularly elder (*Sambucus ebulus*), due to the technical and harvesting problems (Amani and Hassami, 1999; Sagheb-Talebi *et al*., 2003). Similar happenings are also observed in *Fagus sylvatica* stands of Europe (Mosandl, 1984). In spite of realities which growth and establishment of some broadleaved species are not threaten when grown under herbaceous vegetation with crown canopy <40% (Mosandl and El-Kateb, 1988), establishment of *F. sylvatica* and other tree species is poor (Linhart and Whelan, 1980). Generally if resources competition i.e., for light (Tabari *et al*., 2005), water (Fotelli *et al*., 2000; Kolb *et al*., 2003) and nutrients (Minotta and Pinazuti, 1996; Milberg and Lamont, 1997; Marler and Strom, 2001) between sapling and ground vegetation is the primary mechanism limiting height growth, sapling growth increases when herbal vegetation cuts (Chrimes *et al*., 2004).

It expects the *F. orientalis* seedlings to show greater survival and growth after cutting and removal of *Sambucus ebulus*. As a whole, not any distinct investigation on qualitative and quantitative of *F. orientalis* seedling growing under *Sambcus ebulus* has been yet reported. The intent of this research is (a) to indicate the characteristics measured of *F. orientalis* seedlings planted in two treatments, including cleaning *Sambucus* and leaving *Sambucus* (b) to introduce the applied recommendations for better management of beech seedling grown in such gap types.

MATERIALS AND METHODS

Study site: The field experiment was conducted in an uneven-aged oriental beech (*Fagus orientalis* Lipsky) stand located in Sangdeh (36° 58′ N, 53° 18′ E), a Caspian forest site region in Mazandaran province (Northern Iran). The physiographic characteristics of the site were presented with elevation of 1500 m a.s.l., north-facing with slope about 20%. The forest had an uneven-aged stand structure resembling a reverse-J diameter distribution curve with ~ 5 years since previous harvest. The stand had a basal area of 35 m^2 ha^{-1}, density of 450 stems ha^{-1} and a maximum tree diameter at 1.3 m (d.b.h.) of 150 cm. Oriental beech was the dominant tree species with 85% of standing volume (m^3 ha^{-1}). Additional tree species included hornbeam (*Carpinus betulus*), maple (*Acer velutinum*, *Acer laetum*), small-leaved lime (*Tilia cordata*), alder (*Alnus subcordata*) and to a small extent oak (*Quercus castaneifolia*), which with a top height of 30-35 m were accompanied with *F. orientalis*. The dominant ground vegetation was elder (*Sambucus ebulus*), bramble (*Rubus fructicosus*) and fern (*Pterilium aquilinum*).

Soil characteristics: Soil pH and Electrical Conductivity (EC) were measured by preparing a soil solution using distilled water (1 g in 20 mL) and calibrating the solution with an Elico-pH meter (Elico Company, Pradesh, India). Soil texture was estimated by the use of sieves of different meshes. Sieving separated different fractions (different size particles) from the sample and then the relative proportions of each fraction were calculated (Arakeri *et al*., 1967). Soil organic matter was determined as loss-on-ignition of oven-dried soil over 24 h in a muffle furnace at 550°C (Allen *et al*., 1976). To estimate organic carbon the chromic acid colorimetric method (Black *et al*., 1965) was used by preparing standard curves. Carbon value was estimated from the standard curve (Perur *et al*., 1972). Phosphorus level was estimated colorimetrically by the molybdenum blue method after extraction with Trough's reagent, potassium by the EDTA titration method (Allen *et al*., 1976) and nitrogen by the micro-Kjeldahl alkaline permanganate method (Perur *et al*., 1972). Table 1 shows physico-chemical properties of forest soil. Generally, soil moisture was mesic with forest brown type.

Climate characteristics: Based on the nearest meteorological station, located at 2 km from the study site, average annual precipitation is 800 mm. Average maximum temperature of the warmest and average minimum temperature of the coldest months is 22 and 4°C, respectively. According to Emberger (1932) classification, the pluviothermic index (Q_2) is 101, climate is humid with cold winters and dry summers (with xerotic index ≈ 50 days). Maximum air temperature in July and August was 34 and 35°C, respectively. Precipitation was 10 mm in July and 14 mm in August.

Experimental design: The experiment established in 2000 was a randomized design with eight plots of 2.5×2.5 m, in the center of a 200 m^2 gap size. In each plot, 36 beech seedlings were planted in a grid of 50×50 cm. Three years after plantation two treatments were replicated four times in the plots. In one treatment (within 4 plots) all *Sambucus* individuals were cut in mid-June. In other treatment the *Sambucus* individuals with a height taller than beech seedlings were left untreated. Light recording, carried out with a Lux-meter unit (Weston Illumination Meter), gave average values of 5 and 25% of full day light intensity, respectively in treated and untreated plots. The readings were taken during overcast and sunny weather in mid-summer, when tree canopy leaves were fully developed.

The number of the surviving seedlings and their shoot growth were measured in late November, two years after examination (cleaning treatment). Foliage discoloration degree or vitality quality of seedlings, based on the United Nations, Economic Commission for Europe and European Commission (UN/ECE) (1998) classification (Table 2), was noted in late August. Survival, height growth and collar diameter were examined by an independent sample t-test and a square-root transformation was made prior to t-test, where required. The categorical data of foliage discoloration were examined by Chi-square (χ^2) analysis (Anonymous, 1999). The significance level used was $p<0.05$, unless otherwise mentioned.

Table 1: Physico-chemical properties of the forest soil

Texture	Loam
pH	6.00
Organic matter (%)	6.43
EC (mS cm^{-1})	0.73
C (%)	3.70
N (%)	0.38
P (ppm)	6.30
K (ppm)	145.00
C/N	9.84

Table 2: Foliage discoloration degree of *Fagus orientalis* seedlings (according to United Nations, Economic Commission for Europe and European Commission, 1998)

Foliage discolored	Discoloration degree
Up to 10%	None
10-25%	Slight
25-60%	Moderate
>60%	Severe

RESULTS AND DISCUSSION

Analysis of data using t-test revealed that at the end of the third growing season survival rate was significantly different in plots cleaned from *Sambucus* and plots controlled (Table 3) whereas 46 and 71% of beech seedlings were survived respectively in above treatments (Table 4).

Analysis of data after square-root transformation and t-test exhibited that at the end of this period height growth of two treatments was prominently different (Table 3). In fact average height growth measured under *Sambucus* was 21 cm and for those cleaned from *Sambucus* was 12 cm (Table 4).

Table 3: Statistical analysis for the characteristics measured of *Fagus orientalis* seedlings in areas controlled and cleaned from *Sambucus ebulus*

Variable	df	t-value	χ^2-value	p-value
Survival	6	4.48		0.025*
Height growth	6	12.65		0.037*
Collar diameter growth	6	1.24		0.125^{ns}
Vitality quality	3		10.20	0.032*

*: Significant; ns: Non-significant; df: Degree of freedom

Table 4: Characteristics measured of 3-year-old *Fagus orientalis* seedlings in areas controlled and cleaned from *Sambucus ebulus*

Variable	Untreated area	Cleaned area
Survival (%)	90.0a	80.0b
Height growth (cm)	21.0a	12.0b
Collar diameter growth (mm)	3.7a	4.1a

Different letter(s) in row are significantly different (p<0.05%)

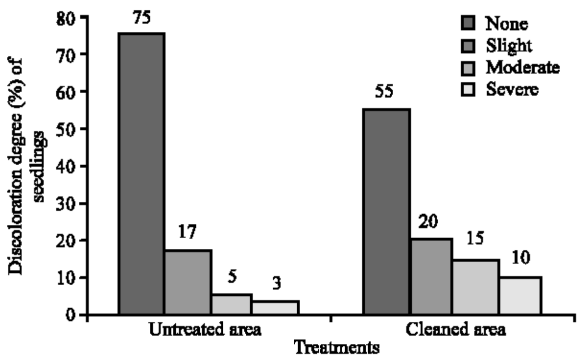

Fig. 1: Percentage of foliage discoloration of *Fagus orientalis* seedlings in areas controlled and cleaned form *Sambucus ebulus*

Collar diameter growth did not substantially differ in *Sambucus* cut area and untreated area (Table 3) whereas during the period it accounted 3.7 and 4.1 mm, respectively in above areas (Table 4).

Vitality quality of beech seedlings differed statistically between treatments (Table 3). In other words, influence of *Sambucus* on vitality quality was significant. Figure 1 also illustrates that in absence of *Sambucus* 75% of beech seedlings are none discolored, 17% slight discolored, 5% moderate discolored and 3% severe discolored. High-quality beech seedlings are more abundant in untreated area but frequency of low-quality beech seedlings is greater in cleaned area. In total more than 75% of seedlings in both treatments are none to slight discolored.

The results of this experiment displayed that collar diameter growth of beech seedling did not differ between both treatments in three years after plantation but survival and height increment were greater where the *Sambucus* was removed. Likewise, vitality quality was better in plots controlled than in removed from *Sambucus*, as well. Indeed, outstanding survival and height growth rates and good vitality quality of beech seedlings grown under *Sambucus* reveal that beech seedlings can well establish and grow in shade and competition produced by *Sambucus*. Numeral reports have been published about survival and establishment of beech seedlings in shelter of shrub and herbal vegetation as well as on thick leaf litter layer (Brown, 1960). In reality, for good establishment, seedling root should penetrate in mineral soil (Savill, 1991; Tabari, 1999). Better conditions can be achieved by soil scarification together with ground flora removal, or that scarification is made deeper and probably both these methods be applied prior to seed fall (Becker *et al*., 1978). Nonetheless Baumgarten (1996) believes shoot increment, survival and vigor of beech seedling, like *Picea abies* and *Douglas-fir*, will not more suited if ground vegetation is eliminated. For beech seedlings, competition with grass is an essential problem (Savill, 1991; Coll *et al*., 2003, 2004; Sean *et al*., 2005). This is while that Helliwell (1982) claims that in open field, like many late-successional species, beech seedling compete stronger than other hardwoods with grass and other herbaceous species. Contrary to beech, European oaks (*Quercus robur*, *Q. petraea*) are not emulated by extensive *Holcus mollis*, *Deschampsia fleuxusa* (Jones, 1959). It has been also referred that *P. abies* current-year shoot length, shoot and root biomass, seedling nutrient concentration and mycorrhizal colonization are increased by reduced belowground competition of *Vaccinium myrtillus*. Likewise reduced aboveground competition affected *P. abies* seedling root biomass positively whereas seedling survival, shoot length and shoot/root ratio were negatively affected. Generally suppressed growth of *P. abies seedlings* in *V. myrtillus* sites of Northern boreal forests was caused mainly by belowground resource competition (Jäderlund *et al*., 1997).

In this study, generally it may be suggested that the results falsified that competitiveness hypothesis. We expected the beech seedlings would perform higher survival and growth rates following *Sambucus* elimination. Instead, these characteristics response of the treated seedling decreased. Similarly, Kuusela (1990) and Jaderlund *et al*. (1997) declare that competitiveness of bilberry (*Vaccinium myrtillus* L.) contributes to a reduction in conifer seedling growth. By contrast Chrimes *et al*. (2004, on Norway spruce) showed that saplings reacted with a decrease in height increment compared with the control during the first and second year after cutting bilberry. Even-though this term was similar in both treatments the following three years.

From this experiment it can be deduced that in third year after plantation, with liberating shade-bearing beech seedlings from *Sambucus* not only do not promote survival and growth but also augments costs for plantation maintenance. To this reason in such gap sizes in order to better treating beech plantations it is recommended that cleaning *Sambucus* to be avoided in early years.

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