Pregermination Treatment and Germination Characteristics of Oriental Beech (*Fagus orientalis* Lipsky) in the Caspian Region

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Abstract – Oriental beech is one of the most important tree species in the Caspian region that regenerates naturally.

Seed pretreatment plays an important role in beech reforestation .For this reason the seeds of three different provenances; Gilan (Asalem), Nowshahr (Makarood), Gorgan (Cheshmeh gholgholy), across the Caspian region, were collected and after viability test (TTC) placed under cold stratification (for 8-19 weeks) to overcome dormancy. The results have shown that pregermination treatments had desirable effects on seed germination. There were significant variations between three origins and different treatment duration and germination characterstics. The Nowshahr and Gilan origins showed more similarity.

***Fagus orientalis* / pregermination treatment / Caspian region**

1 INTRODUCTION

Beech is the most valuable wood producing species in the Caspian forests covering 17.6 percent of the area and represent 30 percent of the standing volume (Resaneh *et al*. 2001). Its area extends about 700 km East-West in this region. The extreme eastern border of oriental beech forests is Ziârat valley near Gorgân town, on the southern coast of the Caspian Sea in Iran. These forests extend westwards as separated spots towards the Caucasus, Asia Minor and north of Greece, Bulgaria and Romania. Oriental beech is replaced by European beech (*F. sylvatica*) in the Central and West Balkans (Sabeti 1993; Bektas *et al.* 2000). In the Hyrcanian phytogeographical region, in Northern Iran, oriental beech forests cover the northern slopes of the Alborz Mountains, between 680 to2000 m above sea level and annual precipitation between 800 to 1800 mm, decreasing from West to East.

Beech seeds require cold stratification (prechilling) for prompt germination, and current practices with European beech (*Fagus sylvatica* L.) have combined stratification and storage into a coordinated procedure. The first step is to determine how much stratification is needed to overcome dormancy (Suszka – Zieta 1977). Termination of embryo dormancy is achieved by cold moist stratification or prechilling, *i.e.* subjecting hydrated nuts to

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temperatures between +2 and +5°C with or without medium (El-Antably 1976; Suszka – Muller – Bonnet-Masimbert 1996). The time period necessary to complete dormancy release is usually quite long, ranging from 5 to 8 weeks and in some cases even up to 12 weeks (Muller – Bonnet-Masimbert 1982). The level of primary dormancy in seeds is determined by several factors of genetic and non-genetic origin (Andersson – Milberg 1998). All of these factors may cause physiological variability which is matched with differences in seed morphology (size, weight, color *etc.*) or simply heterogeneity in degree of dormancy (Bewley – Black 1994). Therefore dormancy levels vary within the seed lot of many species among them *Fagus* spp.; a few nuts germinate without cold moist stratification or prechilling, but others in the same lot will not germinate until they are prechilled. In addition, during prechilling and dormancy release, the heterogeneity usually increases (Derkx – Joustra, 1997). On the other hand variation in dormancy level among populations is a well-known phenomenon (Frost – Cavers 1975; Miller *et al.* 1976; Paterson *et al.* 1976; Naylor – Abdalla 1982; Drennan – Bain 1987; Evans – Cabin 1995; Milberg *et al.* 1996; Schütz – Milberg 1997; Andersson *et al.* 1997).

Germination is one trait that has been found to greatly vary among populations (reviewed by Baskin - Baskin, 1998). Differences among provenances, particularly in germination, can be inflated by heterogeneous environmental conditions among sites at which seeds were collected (environmental maternal effects: Gutterman 1992; Lopez – Potts – Vaillancourt – Apiolaza 2003; Pico – Ouborg – van Groenendael 2003; Roach – Wulff 1987). Significant variation in germination ability of a species among seed samples of different sources have been reported also for several species of Central Himalaya. Causes of such variability might be generally attributed either to (a) genetic character of source population/plant (Witcombe – Whittington 1972; Bewley – Black 1994), or (b) impact of mother plant environment (Fenner 1991; Andersson – Milberg 1998; Bhatt et al. 2000). A survey on effects of different treatments of beech nuts showed that germination capacity increased with increasing duration of cold - moist stratification for nuts with and without endocarp (Soltani et. al. 2005). The provenance effect, as determined by broad sense heritability, was 80% for germination capacity and 42% for germination energy. Germination energy was significantly correlated with longitude and mean annual rainfall (Loha et al, 2006).

2 MATERIALS AND METHODS

2.1 Seed sources

Lots of oriental beechnuts, used in these experiments, were collected from 10 different mother trees (in each provenance) of three different provenances in the Caspian region: in Darya-Bon Nav Asalem(Gilan), Makarood (Nowshahr) and Cheshmeh Gholgholi (Golestan) at 900, 950 and 1000 m asl. during a two weeks period in November 2008. After collection, seeds were extracted from their capsules and its physical (%MC, 1000 seed weight) and physiological (viability, germination capacity) characteristics determined at the Caspian Forest Tree Seed Centre seed laboratory according to ISTA rules (ISTA, 2008). For breaking dormancy, 4 replicates of hundred seeds from each provenance were soaked in cold water for 48 hours, then mixed at 3–5 °C with medium (sterilized sand) for a maximum period of 24 weeks (Suszka 1975) and then germinated.

2.2 Data analysis

Germination characteristics such as GC (germination capacity), GR (germination rate), GS (germination speed), MDG (Mean Daily germination), PV (peak of velocity), GV (germination value) and GE (germination energy) (Willan 1985, Panwar and Bharadwaj 2005) were calculated as follows:

$GC = (G + VS)/TS \times 100$, $GR = n/N*100$ $GS = \sum (n/DSS)$

$MDG = FCG/T$ $PV = MCG/DSS$ $GV = PV*fMDG$

$GE = (\text{max germinated seed a day})$

where:

G = germinated seeds
VS = viable, nongeminated seeds at the end of period
TS = total seed per replicate
n = number of germinated seeds in each count
DSS = days from the start of the test
FCG = Final Cumulative germinated seed
T = total period of germination
MCG = Maximum of cumulative Germination
fMDG = final Mean Daily germination
N = number of tested seeds

Generalized linear model (GLM) or univariate variance analysis was performed to determine differences in GC and GS and one - way ANOVA for determining differences in PV, GV, and MDG between three provenances.

3 RESULTS

The results of lab analysis are shown in *Table 1.*

Table 1. The results of lab analysis

	Provenance	Physical characteristics		Physiological characteristics	
		% MC	1000 S.W.	% V.S.	% GC
1	Darya-Bon Nav Asalem (Gilan)	26/6	253/75	82	77
2	Makarood (Nowshahr)	27/7	293/62	89	89
3	Cheshmeh Gholgholi (Golestan)	18	244/16	98	84

The results of survey on the effects of cold stratification on beech nuts germination in contrast with control showed that this treatment can significantly promote germination process in all provenances. Germination characteristics of three different provenances show that

- GE in all provenances is significantly different.
- PV, GV, GS of Asalem and Makarood provenances are similar but different from Cheshmeh Gholgholi (Histograms No. 1, 2 and 4)
- MDG in Makarood and Cheshmeh Gholgholi are similar but significantly different from Asalem (Histogram No. 3)
- Treatment Duration (T.D) in Asalem and Makarood are similar but significantly different from Cheshmeh Gholgholi

Table 2. The results of treatment and germination characteristics

Provenance	% GE	PV	MDG	GV	GS	% Gr	(Week) T.D
Asalem	57	1.63	0.95	1.55	0.27	73	8–18
Makarood	71	1.69	1.14	1.90	0.25	88	8–19
Cheshmeh Gholgholi	66	3.09	1.2	3.17	0.41	81	10–19

4 DISCUSSION AND CONCLUSIONS

Germination energy may be significantly correlated with longitude and mean annual rainfall. (Loha et al. 2006). Variation in dormancy level among populations is a well-known phenomenon (Frost – Cavers, 1975; Miller et al. 1976; Paterson et al. 1976; Naylor and Abdalla 1982; Drennan – Bain 1987; Evans – Cabin 1995; Milberg et al. 1996b; Schütz – Milberg, 1997; Andersson et al. 1997). Necessary treatment duration was different in all provenances but more similar in western and central ones (Asalem – Makarood). Causes of such variability might be generally attributed either to (a) genetic characters of source population/plant (Witcombe – Whittington 1972; Bewley – Black 1994), or (b) impact of mother plant environment (Fenner 1991; Andersson – Milberg 1998; Bhatt et al. 2000).

As already described, cold stratification had significant effect on seed dormancy breaking in all three provenances of oriental beech (control had not any germination) as reported in European beech which require cold stratification (prechilling) for prompt germination, and current practices with European beech have combined stratification and storage into a coordinated procedure.(Suszka – Zieta 1977).

Germination characteristics of provenances Asalem and Makarood were similar but Cheshme gholgholi was different The difference may be caused both by provenance effect and longitudinal difference.

5 RECOMMENDATIONS

According to achievements of this study it seems that direct seeding of stored, pretreated seeds that are collected immediately after dispersal, can help to regenerate this species, because this way the seeds escape predation and the effect of rare mast years is minimised.

Regarding the importance and extended distribution of this species and missing experiences on this issue it seems that more research in this field should be done.

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