Influence of physiographic factors on vegetative and morphological characters of Beech plus trees - A case study in Hyrcanian forest
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ABSTRACT
This study was done to improve our understanding on the influence some physiographic factors including aspect and altitude on quantitative characters of beech (Fagus orientalis Lipsky) plus trees. This research was conducted in Experimental Forest Station of Gorgan University that is located in a temperate forest of Golestan province in the north of Iran. In this research, two parcels at high altitudes (800 - 900m) and two parcels at lower altitudes (550 - 650m) with east and west aspects were selected as well. After selecting of plus trees in every parcels, the characteristics including tree total height, stem height without branch, crown length and radius, trees diameter, annual mean growth of diameter and bark thickness were measured. Greater amounts of annual diameter growth were detected in east direction which had a significant difference (P<0.05) with west direction. Results are indicating that the tree total height, stem height without branch, crown length to total height ratio and annual growth of diameter had significant differences (P<0.01) between two altitude classes and the most total height and stem height without branch were observed in high altitude class. Crown length to total height ratio and also annual growth of diameter were decreased with increasing of altitude. Analysis of variance showed that interaction effects had no significant differnces for all of studied characteristics. In total, our study supports that west slopes and upper altitudes have more appropriate conditions for growth of beech plus trees.

Keywords: Fagus orientalis Lipsky, altitude, aspect, quantitative characteristics.

1. Introduction
Natural regeneration of tree species can provide the economy and environmental aims in future. Usually, few trees of the same species have high quality with considering to economy condition. To elevating economic potential of trees species in afforestation programs, we need to do some activities such as simple selection of seed origin for control of pollination complicated process and also due to evaluation of genetic variance. Mass selection of superior phenotypes in the most widely used method of obtaining material for the initial stages of tree breeding programs (Zobel and Talbert, 1984). According to IUFRO definition, plus trees are phenotype judged but not proved by test to be usually superior in some quality and quantity, e.g. exceptional growth rate desirable growth habit, high wood density, exceptional apparent resistance to disease and insect attack or to other adverse environmental factors (Nieuwenhuis, 2000). Iranian Caspian forests cover about 1.9 million ha. These forests are also called Hyrcanian or Northern forests. They are located on the coast of the Caspian Sea and the northern slopes of the Alborz Mountain range from sea level to 2800 m altitude. These forests grow like a thin strip (800 km long and 20 - 70 km wide). These are the most valuable forests in Iran. Industrial harvesting occurs only in the Caspian forest.
These forests have been divided into 98 watersheds and each watershed has been divided into several districts (Lohmander and Mohammadi Limaei, 2008). The Hyrcanian forests are one of the last remnants of natural deciduous forests in the world (Saghebi Talebi, 2000).

Beech (*Fagus orientalis* Lipsky) is one of the most important elements of forests in the temperate broad-leaf forest biome and represents an outstanding example of the re-colonization and development of terrestrial ecosystems and communities after the last ice age, a process which is still ongoing (Mosadegh, 2000; Marvie Mohadjer, 2007). In Iran, pure and mixed beech forests are one of the most important, richest and most beautiful forests often lying on the northern slopes of Alborz mountain ranges adjacent to the Caspian Sea coasts. Natural dense sites are found at the altitudes of 1000m to 2100m. However some communities could be observed down to 600m altitude depending on the local and microclimatic conditions. The beech trees are found in small groups up to 500m a.s.l. while individuals have been reported from 110m up to 2650m. At low altitudes, they occur mixed with hornbeam (*Carpinus betulus* L.) (Marvie Mohadjer, 2007).

Many factors are effective on ecological sites of beech stands. The roles of physiographic factors are more important than others because plant cover is result of interaction between increment and environmental factors (Loffer, 2007). According to geology law, latitude and slope direction cause to limitation of plant distribution (Ganbari, 2008). Seyyed (1997) in study of beech stands located in Gorgan city (north of Iran) forests at 300 - 1400 m. a. s. l. found that ecological characteristics are effective on diameter at breast height, length of stem without branch, basal area, tree volume and quality. He pointed that the characters of total height branch number of trunk and tree value were improved with increasing of altitude. But, the other characters such as crown form, crown symmetry, trunk twisting were heritage and genetically and independent of site condition. Hasanzad Navroodi *et al.*, (2000) believe that altitude and slope direction are effective on volume of beech stands in Asalem region (north of Iran). Also, Hasanzad Navroodi *et al.*, (2004) found a negative relation between standing volume of beech stands and altitude in Asalem region. The role of physiographical factors on increment characters of beech forests in Middle East deciduous temperate zone such as Hyrcanian forests is not fully understood. So, finding of plus tree and their relations to physiographic factors are essential for genetic preserve and extending of these stands at future. The main objective of this study is to quantify the effects of slope and aspect parameters on vegetative and morphological characters of beech plus trees in an old - growth hardwood forest of Iran that is the first survey in these forests.

2. Materials and Method

2.1 Site characteristics

The study area is located at the Experimental Forest Station of Gorgan University (Shastkolate forest) in the North - East of the Hyrcanian forest, Iran (36°45’ N and 41°54’E). Location of study area presented in Figure 1. Near the study stand (at Gorgan city) mean annual precipitation is about 650 ± 144 mm and the mean monthly temperature is highest in May (27.9°C) and lowest in November (8.7°C). This forest site is covered by different forest community such as *Zelkova - Quercetum, Parrotio - Carpinetum, Fageto - Carpinetum* and *Fagetum* (Habashi *et al.*, 2007). For present research, four different parcels (numbers 21, 24, 27 and 32) covered by beech (*Fagus orientalis* Lipsky) type were selected that those are located in district one of Shastkolate forest. Two parcels (numbers 27 and 32) are located at 800 - 900 m. a. s. l. with west aspect direction and two parcel (numbers 21 and 24) at 550 -
650 m. a. s. l. with east aspect direction. It is mentionable that selected areas had same slope percent. There were no signs of human or major natural disturbance. Canopy height was typically about 30 m and Canopy cover is about 55 - 100%.

2.2 Selection of plus trees and characters record

After field trip on located parcels, beech candidate plus trees were selected by comparison tree method and then graded on basis of morphological characteristics such as cylindrical trunk, trunk straightness, lack of pest and disease affects, twisting bole, undulating bole and crown symmetry (Zoghi, 2010). In every parcel the candidate tree with higher point selected as beech plus tree. Thirteen, ten, thirteen and ten plus trees marked in parcels 21, 24, 32 and 27, respectively. In the step level, some of quantitative and qualitative characters (including total height, stem height without branch, crown length, crown radius in four main directions to access crown symmetry and tree diameter in four main direction to access diameter symmetry) for marked plus tree in every parcel were measured and recorded. For considering of diameter growth and bark thickness, an increment core of ten last years was taken by increment borer to northern aspect and in diameter at breast height.

2.3 Statistical analyses

Normality of the variables was checked by Kolmogrov - Smirnov test and Levene test was used to examine the equality of the variances. Differences between aspects and altitudes in studied characters were tested with two - way analysis (ANOVA) using GLM procedure, with aspects (east and west) and altitudes (550 - 650m and 800 - 900m) as independent factor. Interactions between independent factors were tested also. Significant differences among treatment averages for different parameters were tested at P≤ 0.05. SPSS v. 11.5 software was used for all the statistical analysis.

3. Results

3.1 Aspect effect
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Considering of data analysis indicated that aspect effect is not significant on studied characteristics except diameter growth. Mean of diameter growth was significantly (P<0.05) higher at east direction in comparison to west direction (Table 1 and Figure 2).

**Table 1:** Two - way ANOVA for increment characteristics in relation to physiographic parameters

<table>
<thead>
<tr>
<th>Statistical / increment characteristics</th>
<th>Aspect</th>
<th>Altitude</th>
<th>Aspect × Altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean squares</td>
<td>F</td>
<td>Mean squares</td>
</tr>
<tr>
<td>Total height (m)</td>
<td>7.406</td>
<td>0.35**</td>
<td>181.868</td>
</tr>
<tr>
<td>Stem height without branch (m)</td>
<td>7.391</td>
<td>0.61**</td>
<td>356.587</td>
</tr>
<tr>
<td>Crown length (m)</td>
<td>29.594</td>
<td>1.75**</td>
<td>31.748</td>
</tr>
<tr>
<td>Crown length to total height ratio</td>
<td>0.014</td>
<td>0.95 ns</td>
<td>0.105</td>
</tr>
<tr>
<td>Crown symmetry</td>
<td>0.001</td>
<td>0.03 ns</td>
<td>0.234</td>
</tr>
<tr>
<td>Diameter symmetry</td>
<td>0.000</td>
<td>0.13 ns</td>
<td>0.001</td>
</tr>
<tr>
<td>Annual mean growth of diameter (mm)</td>
<td>3.581</td>
<td>3.34*</td>
<td>14.738</td>
</tr>
<tr>
<td>Bark thickness (mm)</td>
<td>13.546</td>
<td>2.90 ns</td>
<td>3.390</td>
</tr>
</tbody>
</table>

**Different is significant at the 0.01 level. *Different is significant at the 0.05 level. (ns): Non significant differences (P > 0.05).**

**Figure 2:** Mean of increment characteristics in relation to aspect
3. 2 Altitude effect

Data analyses indicated that increment characteristics including total height, stem height without branch, crown length; crown length to total height ratio and mean of annual diameter growth had significant differences between two altitude classes. Total height and stem height without branch significantly (P<0.01) increased with increasing altitude from 550 - 650m class to 800 - 900m range (Table 1 and Figure 3). Greater amounts of crown length to total height ratio and annual mean growth of diameter characters were found in 550 - 650m altitude range, significantly (P<0.01) (Table 1 and Figure 3). Furthermore, interactions between independent factors were not significant on none of studied increment characteristics (Table 1).

Figure 3: Mean of increment characteristics in relation to altitude

4. Discussion

Considering of effective factors on distribution of species and also quantitative and qualitative characteristics is a way for right recognition and better management of forest ecosystems. Statistical analysis showed that the effect of slop direction on mean of diameter growth had significant differences and a greater amount of growth was found at west direction. Topography direction is introduced as an index for measuring irradiance because of the effect on evaporation, transpiration and environment temperature (Pierce et al., 2005). Slop direction has a lot of effect on water available for plant growth and fallowing site...
fertilizing. This physiographic factor also is very effective on ecosystem receivable light. This effect is more obvious on middle and high altitudes because light angle are reduced in winter. The slopes in front of sunlight have more heat and the potential of biomass production are more in this position also (Amanda et al., 2005; Ajbilou et al., 2006). With considering to, east directions receive more light thus the diameter increment is more occurred in this direction (Ghazanfari et al., 2003) that is observed in current research also. Amanda et al., (2005) findings showed that the effects of east and west slop direction on morphological characteristics are the same. In our research east and west slop direction only were effective on diameter growth and have no significant effect on the other studied characteristics. Any way, site aspect analysis is using as common for determine of quantitative and qualitative indices (Badano, 2005; Ajbilou et al., 2006; Corney et al., 2006).

Statistical analysis of altitude factor indicated that higher values of total height, stem height without branch and minimum of crown length to total height ratio were observed at 800 - 900m altitude class but the best of diameter growth was found at 550 - 650m altitude range. Site topography, especially altitude ranges have important influence on quantitative and qualitative characteristics of trees (Shabanian, 1996; Fallah Chay and Marvie Mohadjer, 2005). With increasing of altitude range, the mean of temperature, evaporation and transpiration are reduced, whereas the humidity will be increased (Magurran, 2004). Marvie Mohadjer (1984) pointed that altitude is influenced on ecological potential of forest ecosystems in north of Iran regarding to mountainous condition of these forests. The results of Seyyed (1997) research showed that diameter breast height, length of stem without branch and tree quality is increased with increasing of altitude class that is confirming of our study results. Hasanzad Navroodi et al., (2004) also concluded that altitude factor is effective on quantitative and qualitative characteristics of forest stands. Results of present research indicating that beech trees have more appropriate condition in higher altitudes than in lower pay attention to studied increment characters. But, we find greater amounts of diameter increment in lower altitude which it can be related to start of weather heating from lowland to uplands (Mirbadin and Dastmalchi, 2001). Moshtagh Kahnamoie et al., (2004) studied the relation between annual diameter increment of beech trees and environment factors in Hycranian forests of Iran. Their research believed that altitude factor is effective on annual diameter increment and this character was decreased with increasing of altitude range that can be similar to our finding also.

In total, our results claim that regarding to studied increment characters of beech plus trees in different parcels of study area, the parcel 32 have better position for beech trees. So, this parcel with west aspect and 800 - 900m altitude range provide more suitable condition than other parcels. Marvie Mohadjer (2004) expressed that north and west aspects provide suitable condition for beech trees because of more water reserves. He said Fagus oreintalis Lipsky grows between 500 - 2200 m. a. s. l. and the best of sites for beech have located at 1000 - 1500 m. a. s. l. Also, Seyyed (1997) resulted that the best sites of Iranian beech located at 900 m. a. s. l. pay attention to quantitative and qualitative characteristics. Importance of quantitative traits like total height and diameter at breast height in wood production is well understood. However, the value of improving wood through improvement of tree form is very often overlooked though characteristics like stem form, branching habit, wood structure and tolerance to disease are usually highly inherited (Longman, 1993). Total height, stem height without branch and diameter growth of beech trees are very important traits for determination of economy value for beech tree which plus trees have it more than none plus trees (Zoghi, 2010). The plus trees are due to increase of production with desirable quality. Regarding to parcel 32 has an altitude range about 900m, we can say this altitude limitation is

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suitable for beech plus trees and it could cause to influence on increment characteristics specially length stem without branch which it is one important factor on produce desirable wood.

5. Conclusion

Our study supports that west slopes and upper altitudes have more appropriate conditions for growth of beech plus trees. Because of the desirable reduction of *Fagus orientalis* Lipsky trees by harvesting, presentation of places as genetic reserves, finding beech plus trees in other site of Iran to help to natural regeneration are recommended. It is necessary to do progeny test to introduce of beech elite trees, also.

6. References

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