

The Study of Caucasian Walnut (*Pterocarya frexinifolia* (Lam.) Spach.) in Forests of Mashelak (Noshahr, Iran)

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Abstract: Hyrcanian forests are located at green strip extending over the Northern Slopes of Alborz range of mountains and the Southern coasts of the Caspian Sea. In order to study Caucasian walnut in the Hyrcanian forests in Nowshahr, North of Iran, two sites were selected. Within Behsara site 8 and within Larochal site 23 circular plots with an area of 0.1 ha were established. Qualitative and quantitative characteristics were evaluated. Soil and climate condition were performed too. The results indicated that Caucasian walnut extends in special environmental conditions. This species is distributed in flat sites in the riversides. The results showed that Caucasian walnut grows in semi-deep to shallow soils with medium nutrient requirement. In the most sites, the soil texture is clay-silt and clay-sandy and pH varies between poor acidic to alkaline. The mean annual precipitation was 1300 mm and the mean annual temperature was 11°C. The mean density was 101 stem numbers per ha. The mean diameter at breast height was 49.7 cm and the mean crown diameter was 9 m and the mean total height was 28.9 m. In this study, 17% of the tree's trunks were non-cylindrical, 20% were bi-branch, 16% were without branches and 9% were non-symmetric crowns. The regeneration of Caucasian walnut is established every year. The others species in the study sites consist of *Carpinus betulus* L., *Alnus subcordata* C.A.M., *Quercus castanefolia* C.A.M., *Acer velutinum* Boiss and *Diospyrus lotus* L. The distribution of maple tree and alder tree is more frequent than others.

Key words: Caucasian walnut, ecological characteristics, quantitative characteristics, qualitative characteristics, Forests of Mashelak, Nowshahr, Iran

INTRODUCTION

The effects of environmental variables on plant communities have been the subject of many ecological studies in recent years e.g. (Bragazza *et al.*, 2005; Lyon and Gross, 2005; Pinto *et al.*, 2006; Ramirez *et al.*, 2007; Naqinezhad *et al.*, 2007). Research focusing on the relationship between Caucasian walnut and environmental variables such as soils and physiographic factors has become increasingly important in understanding the ecology of forest species.

The Hyrcanian (Caspian) district of Northern Iran possesses a closed-canopy deciduous forest, unlike the arid to semi-arid landscape throughout most of Iran.

The elevation range of this area is from below sea level up to 2700 m; this promotes to the development of different formations in these forests from resistant to cold up to sensitive to cold (Bobeck, 1951; Frey and Probst, 1986).

Hyrcanian forests are located at green strip extending over the Northern Slopes of Alborz range of mountains

and the Southern coasts of the Caspian Sea. This area ranges approximately, 800 km long and 110 km wide and has a total area of 1.8 million ha. Hyrcanian forests encompass various forest types including 80 woody species (trees and shrubs). They are suitable habitats for a variety of hardwood species such as beech, hornbeam, oak, maple, alder and Caucasian walnut (Sagheb-Talebi *et al.*, 2003).

Comparative studies on the ecology of forest communities in the Hyrcanian forests are scarce. Assadollahi (1980), Djazirei (1964, 1965), Dorostkar and Noirfalise (1976) and Hamzeh'ee (1994) presented some information about the soils of mainly upper mountain forests at the relation of some high mountain arboreal communities.

Caucasian walnut is found in the Southwestern Asia, Anatolia, Caucasian and North of Iran (2). *Pterocarya frexinifolia* (Lam.) Spach. is a fast-growing tree species naturally distributed throughout Western Black Sea Region of Turkey and is native to the Caucasus from Northern Iran to the Ukraine (Ansin, 1987).

Some areas like Mashelak forests, in the South of Nowshahr are suitable site for Caucasian walnut. Mashelak forests are located in the Hyrcanian forests with an area of about 1000 ha and an altitude of 300-1300 m above sea level. The ecological aspect of this area has not been investigated sufficiently before this study.

In this research, Caucasian walnut site conditions in Mashelak forests were studied.

MATERIALS AND METHODS

Study area: Behsara and Larochal forests are located in Mashelak forests in South of Nowshahr city in the North of Iran. The altitude varies from 400-700 m above sea level (Fig. 1).

All the investigated areas have obvious homogeneity in geology and climate. Most precipitation occurs from early autumn to early spring. The climate is very humid with mild winters (August with the highest average maximum temperature of 0.1°C and February with the coolest month with an average minimum temperature of 2.6°C); a yearly average temperature of 11°C and a yearly precipitation of 1300 mm, were recorded (1972-2002) at the nearest meteorological stations in Noshahr city.

In order to determine characteristics of Caucasian walnut 31 circular plots with an area of 0.1 ha were selected (8 plots in Behsara and 23 plots in Larochal site). In the center of each plot a subplot with an area of 0.01 ha were selected.

In each plot altitude, slope gradient and side were recorded. Diameters at breast height (cm), diameter of crown (m), trunk height and total height (m) of all trees that have 12.5 cm DBH or larger were recorded, tree density and basal area were determined. The frequency of

woody seedling and sapling was recorded in each sub-sampling plot and grouped into three classes, i.e., up to 2.5, 2.5-7.5 and 7.5-12.5 cm.

In this study, stem bending, branch bearing and crown symmetry of Caucasian walnut trees were specified.

Moreover, 6 soil profiles were studied in the research areas (2 in Behsara and 4 in Larochal sites). Measured soil variables included physical and chemical properties. Soil texture (the proportions of sand, clay and silt) were determined by the hydrometer method (Bouyoucos, 1951); pH in a saturation extract was determined by pH meter and glass electrode within a suspension of 1:2.5 soil: water ratio (Anonymous, 1980); organic matter was estimated by the Walkley and Black's method (Nelson and Sommers, 1996); total carbon was estimated by the method of Allison and the proportion of CaCO₃ was measured by the Calsimeter method of Allison and Moode.

Organic nitrogen content was determined on a Kjeltac System Instrument (TECATOR) (Anonymous, 1990). Within each releve' an investigation well was drilled to determine the depth to the groundwater level. To omit the negative values of groundwater level in some releve's, 100 were added to all. Life form spectrum was assigned to all vascular plants per releve' according to the definitions of Raunkiaer (1934).

Data were analyzed by descriptive statistical methods in order to characterize the selected plots and the forest stands in the study areas. One way Analysis (ANOVA) was used to compare density, DBH, crown diameter, trunk height and total height between two sites. A comparison of height-diameter curves was developed for Caucasian walnut stands in the study areas. A χ^2 -test was established for the qualitative variables at each site.

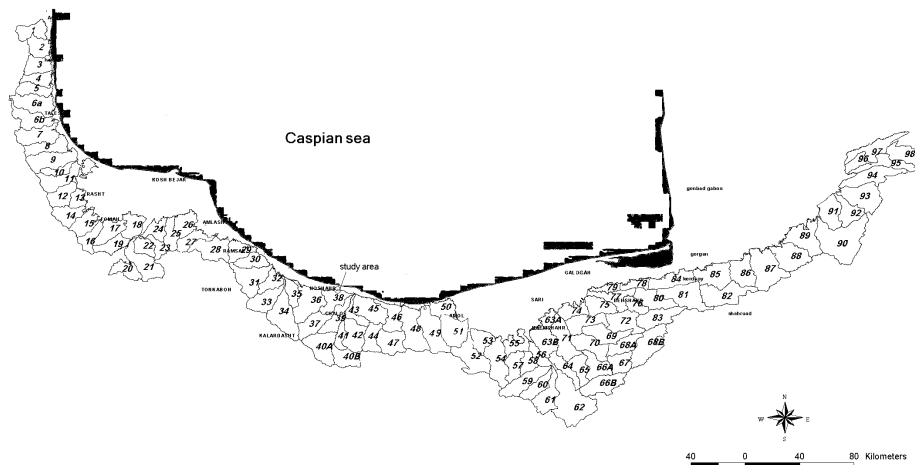


Fig. 1: The study area of Caucasian walnut in the North of Iran

RESULTS AND DISCUSSION

All plots were located on flat sites. In total 312 Caucasian walnut trees (67 in Behsara and 245 trees in Larochal sites) were measured in the study plots.

The mean density was 101 stem numbers per ha (84 in Behsara and 107 in Larochal sites). The mean diameter at breast height was 49.7 cm (39 in Behsara and 52.6 in Larochal sites). The mean crown diameter was 9 m, (9.6 in Behsara and 8.6 Larochal sites). The mean total height was 28.9 m (24.7 in Behsara and 30.1 in Larochal sites). The mean trunk height was 16.5 m, 14.6 in Behsara and 17.3 in Larochal sites (Table 1).

The mean density, DBH, crown diameter, total height and trunk height was significantly greater in the Larochal plots than in Behsara for all Caucasian walnut trees (ANOVA, values of p-value in Table 2).

The others species in the study sites consisted of *Carpinus betulus*, *Alnus subcordata*, *Quercus castanefolia*, *Acer velutinum* and *Diospyrus lotus*. Caucasian walnut had the highest mean density, while maple tree had the highest mean basal area per ha (Fig. 2).

The distribution of diameter all the trees and Caucasian walnut are shown in Fig. 3. Their frequency distribution was approximately normal.

Comparison of height-diameter curves were developed for Caucasian walnut stands in the study areas. Height-DBH relationships for the two sites resulted in similar patterns of curves (Fig. 4).

In this study, 17% of the tree's trunks were non-cylindrical, 20% were pitchfork, 16% were without branches and 9% were non-symmetric crowns (Table 3). Only the frequency of stem bending was significantly different in Larochal and Behsara sites (Table 4: likelihood ratio χ^2 -test, $p < 0.05$).

The regeneration of Caucasian walnut (seedlings and saplings) were the most frequent, although the abundance of tree seedlings and saplings belonging to the height class 2 (<1.3 m) for maple tree was more than others (Fig. 5).

Table 1: Quantitative charectistics of Caucasian walnut in the study sites

Site	Stem No. per ha	DBH (cm)	Crwon diameter (m)	Total height (m)	Trunk height (m)
Behsara (n = 67)	84±32	39.0±26.9	9.60±4.98	24.72±8.61	14.60±4.63
Larochal (n = 245)	107±53	52.6±22.9	8.56±3.24	30.05±7.37	17.26±4.94
Total (n = 312)	101±46	49.7±24.9	8.89±3.72	28.87±7.96	16.53±5.04

Table 2: ANOVA for quantitative charectistics of Caucasian walnut in the study sites

Factor (site)	Stem No. per ha	DBH (cm)	Crwon diameter (m)	Total height (m)	Trunk height
F	6.241	17.158	4.177	25.531	15.475
p-value	0.013	0.0010	0.042	0.0010	0.0010

Table 3: Qualitive charectistics of Caucasian walnut in the study sites

Site	Stem Bending	Bi-branch	Crown symmetry	Branch bearing	N
Behsara					
n	5	17	62	17	67
%	7	25	93	25	
Larochal					
n	48	46	221	33	245
%	20	19	90	13	
Total					
n	53	63	283	50	312
%	17	20	91	16	

Table 4: Chi-square test for qualitive charectistics of Caucasian walnut in the study sites

Factor (Site)	Stem bending	Bi-branch	Crown symmetry	Branch bearing
Chi-square	5.540	2.550	0.250	5.490
p-value	0.019	0.110	0.619	0.064

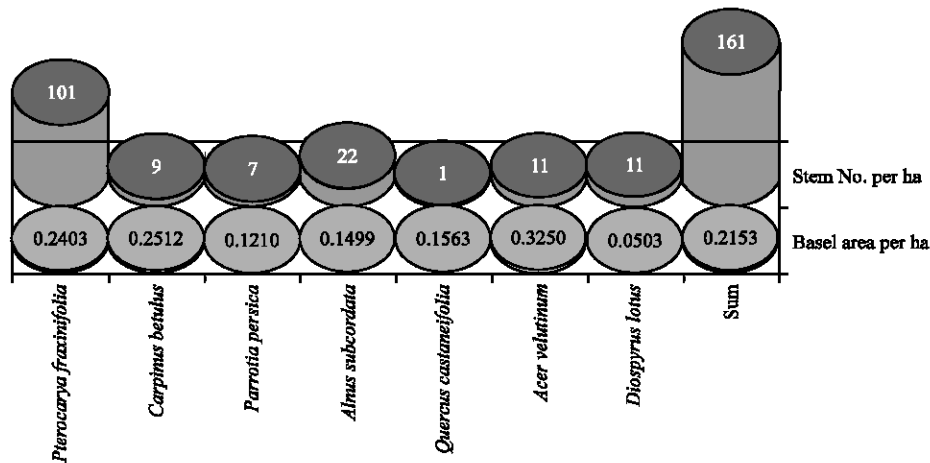


Fig. 2: Stem number and basal area per ha for all tree

Table 5: Physico-chemical properties of soil in Caucasian walnut study sites

Profile	Horizon	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture	B.S.P	EC DS/m	pH	Caco ₃ (%)	Organic (%)	Organic m carbon		Phosphor nitrogen (ppm)	Potassium (ppm)	C/N
												Total (%)				
Larochal 1	O	0-4	39	42	19	Loam	65	0.627	7.58	1.5	3.35	5.70	0.23	7.4	270	12
	A	4-14	20	55	25	Loam	40	0.381	7.68	1.7	0.47	0.80	0.039	3.8	185	12
	C	14-40	10	36	54	Sandy	32	0.501	7.85	0.0	0.07	0.12	0.006	2.5	265	12
Larochal 2	A	0-10	26	38	36	Loam	57	0.513	7.31	0.0	2.82	4.80	0.239	5.3	120	12
	C	10-16	21	50	29	Sandy loam	42	0.465	7.78	0.5	1.27	2.20	0.107	0.7	35	18
Larochal 3	A	0-10	25	35	40	Loam	53	0.573	7.65	0.0	2.91	5.00	0.247	6.1	185	12
Larochal 4	A	0-15	23	54	23	Loam	50	0.495	7.63	0.8	2.96	5.10	0.252	5.8	265	12
Behsara 5	A	0-31	42	48	10	Loam	103	0.486	6.26	0.0	3.69	6.36	0.301	5.3	195	13
	B	31-51	45	46	9	Clay loam	86	0.321	6.67	0.0	0.62	1.06	0.06	3.0	145	10
	C	>51	36	50	14	Clay loam	60	0.468	7.22	0.0	1.04	1.79	0.09	1.6	70	12
Behsara 6	A	0-45	32	48	20	Sandy clay loam	60	0.483	7.78	0.5	2.77	4.70	0.24	5.1	80	12

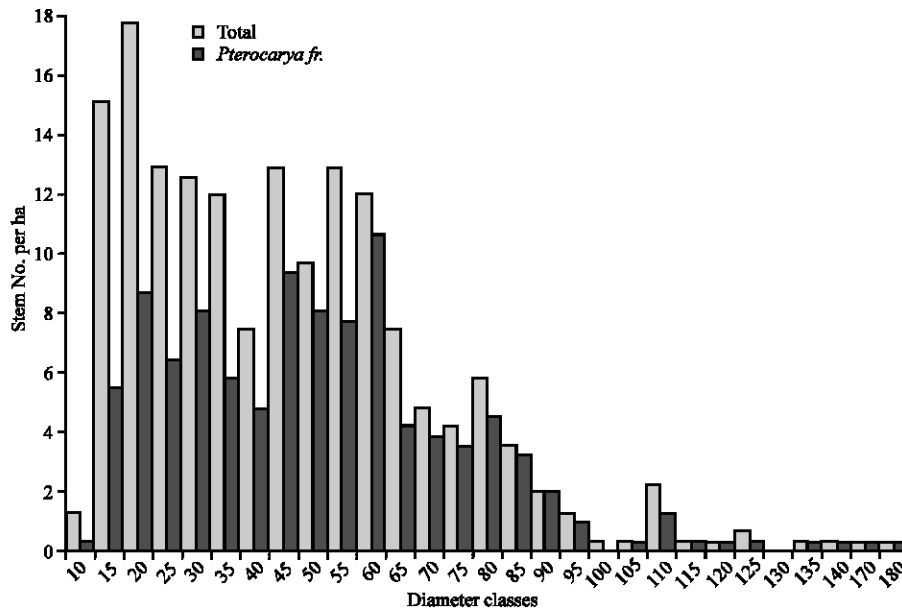


Fig. 3: Density for Caucasian walnut and total of trees

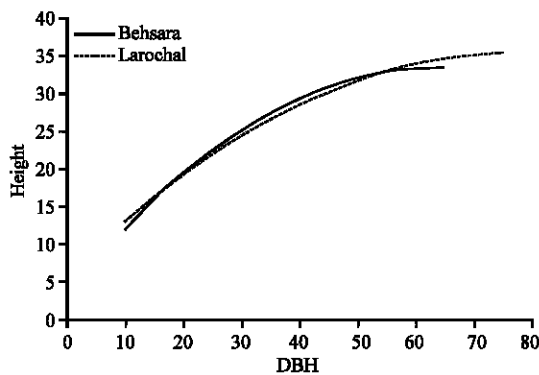


Fig. 4: Comparison of height-diameter for curves Caucasian walnut

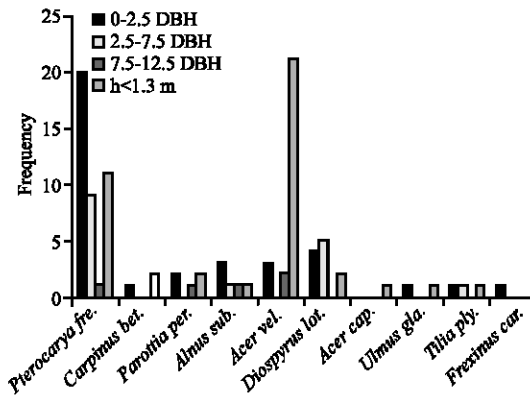


Fig. 5: Regeneration of trees in the study areas

Physico-chemical properties of soil in these two sites were shown in Table 5. The soils were Inceptisols and Entisols, loam, clay loam, loam sandy and sandy clay loam in texture and dark grey to brown dark grey in color and

were moderate in nutrient requirement. Soil pH values varied from 6.2-7.8. The soil was rich in nitrogen and calcium, poor in potassium and phosphorus. C/N ratio varied from 10-12 (Table 5).

Caucasian walnut is a light demanding tree in the Hyrcanian forests. The best growth is in flat sites, slopes with low gradient, an altitude of 400-700 m above sea level and near river banks on semi-deep and moist soils. Climatic conditions associated with the species' distribution are generally mild winters and summers and a very humid moisture regime. Studies of Caucasian walnut in those areas indicate that stands, in which Caucasian walnut are predominant were generally confined to sandy loams, loams, or silt loams. Most soils were classified as Inceptisols, Entisols. Another study of Caucasian The study in Vaz experimental forest in the Hyrcanian forest show that Caucasian walnut often grows on clay-deep soils, Northern slopes of 5-10% gradient, altitude of 500-1000 m. A.S.L. and river banks and valley sides with low gradient slope (Ebrahimi *et al.*, 2005). Soil pH values varied from 6.2-7.8 in the study plots. In Vaz forests, Soil pH values varied from 5.8-7.9 (Ebrahimi *et al.*, 2005).

Although, CaCO₃ is correlated with acidity in Hyrcanian forests (Assadollahi, 1980; Djazirei, 1964, 1965; Hamzeh'ee, 1994), it can also be considered as an element of soil texture and thus a gradient from organic texture to mineral texture can be accompanied by accumulation of CaCO₃ especially in the upper surface soil (Rastin, 1983). The accumulation of CaCO₃ in Caucasian walnut soils in the direction from the upper stratum to the lower stratum affects directly vegetation types. High values of pH are strongly correlated with the amount of CaCO₃ (the higher proportion of CaCO₃, the higher pH value). The C/N ratio shows a negative correlation with acidity and is categorized as an acidity-related variable in our studied environmental variables (the lower pH value, the greater C/N ratio). Acidic situation in Larochal is responsible for decrease in soil mineralization and then increase the C/N ratio especially in the lower soil depth. Although, a low C/N ratio has been recorded in an acidic Hyrcanian forest soil (Ejtehadi *et al.*, 2004), we found that C/N ratios were decreased with an increase in soil pH, being consistent with findings by Schuster and Diekmann (2005).

Caucasian walnut grows in mixture with other species and seldom forms pure stands. It is also found in the following forest types in the study plots: pure stands of Caucasian walnut, Caucasian walnut-maple tree, Caucasian walnut-alder, alder-Caucasian walnut and maple tree-Caucasian walnut. Caucasian walnut trees grow in the study sites with *Carpinus betulus* L., *Alnus subcordata* C.A.M., *Quercus castanefolia* C.A.M., *Acer velutinum* Boiss and *Diospyrus lotus* L. In "Vaz" forests, Caucasian Caucasian walnut grows with *Carpinus betulus* L., *Alnus subcordata* C.A.M., *Alnus glutinosa*

Gaetn, *Acer velutinum* Boiss, *Populus caspica* Bornm, *Fraxinus excelsior* L. and *Juglans rigia* L. (Ebrahimi *et al.*, 2005).

In the study areas, the qualitative characteristics of Caucasian walnut (stem form, crown symmetry) were favorable, but in Vaz sites those were not (Ebrahimi *et al.*, 2005).

The regeneration of Caucasian walnut in the study areas and Vaz sites were not suitable and were generally asexual (root sucker) (Ebrahimi *et al.*, 2005).

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