1. PERFORMANCE OF PLANTED MAPLE IN WESTERN GUILAN PROVINCE, IRAN

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The success of planted Acer velutinum was investigated in western Guilan Province, Iran. This region had been reforested in 1985.The study was carried out in the autumn of 2003 using the full callipering method. The goal of this paper is to review the maple plantation, in order to present a background that is useful for an ecological evaluation of the maple plantations in Iranian forests. Some quantity and quality factors about bole and crown were evaluated. The resistance of maple to difficult conditions including irregular cutting, and fire and full sun make this species highly valuable for plantations. This study showed that, after a period of 21 years, maple is suitable for plantations on the Caspian Sea flat area and the slopes of the Alborz Mountains, and can financially compete with other endemic and exotic species.

INTRODUCTION

Iran is located in the North Temperate Zone between 25° to 40° latitude and 44° to 63° longitude, with a total area of approximately 1.65 Million km^2. Three decades ago, the total forest area of Iran was approximately 18 M ha (Amani 1996, Alizade 1997). Unfortunately, large areas of those forests have since been destroyed. The main native species of trees in Iranian forests are beech (Fagus orientalis, Lip sky), Hornbeam (*Carpinus betulus*) and oak (*Quercus castanefolia)*. These species make up 32.7, 31 and 8.4% of the total volume (Alizade1997). Traditionally, only small areas of exotic species have been grown. Maple (Acer velutinum, from the Aceraceae family) as an endemic species has been planted on a large scale on flat land and in the highlands of the Guilan Province (Abkenar 1991, 1999, 2002). Iran needs 9 M m^3 of timber for 70 M people and plantation forestry is the only solution for this problem. Hence a high priority is placed on expansion of the plantation area. The goal of this article is to review the plantation maple, in order to present a background that is useful for an ecological evaluation of growing maple plantations in Iran.

BOTANICAL CHARACTERISTICS OF MAPLE

Maple is a native to the plain and mountain areas of northern Iran. It has large leaves, similar to sycamore but larger, with some pubescence on the leaf veins on the underside of the leaf. The leaves are lobed, up to 15 cm long and across, with usually five coarsely toothed lobes, yellow-green above. The bark is grey-brown and smooth. The flowers are small and green and the fruit has large wings, up to 4 cm long, set at right angles. On the northern slopes of the Alborz Mountains, the maple group association includes Querco-Boxetum, Querco-Carpinetum, Carpino-Quercetum and Fagetum (Burschel and Hass 1987).

THE STUDY SITE

This study was conducted on a maple plantation in the western part of Guilan Province in northern Iran (Figure 1). This stand of 5.9 ha is located between 37° 18 latitude and 49° 18 longitudes. The pure stand of maple planted was planted on a 2 x 2m grid. The mean annual rainfall is 1557 mm, with most of the rainfall during August to May. June and July (34.6 °C) are the hottest months whereas January and February (6.4°C) are the coldest. The climate is humid and moderate (Alizade 1997). The topography of the study area is plain with a slope of about 5%. The topsoil has a loamy texture while the subsoil has a clay texture with a depth of 25 cm. The important characteristics of the soil in the study site are summarized in Table 1.

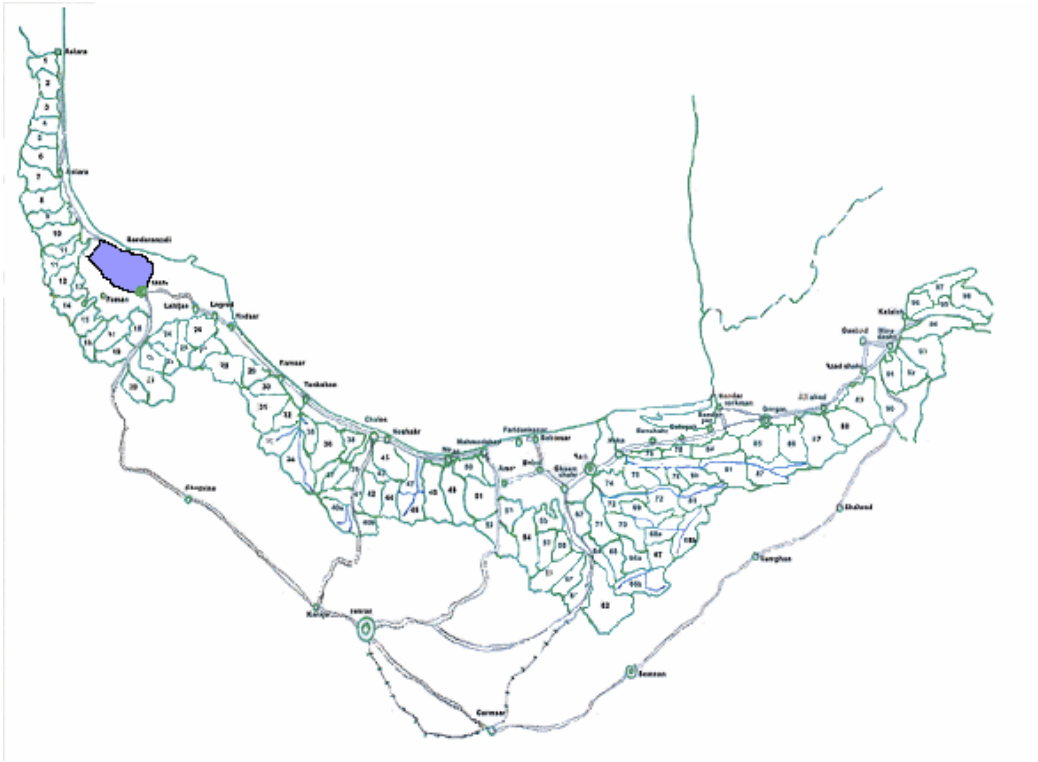

Figure 1. The situation of forests in northern Iran
Note: The study area is indicated in black.

Table 1. Important properties of the soil in the study area

Soil depth (cm)	Organic Carbon (%)	Soil acidity (pH)	Total N (%)	C/N	Texture
0-25	5.52	6.3	0.35	15.77	Loam
25-50	1.44	6.1	0.13	11.08	Clay
50-75	0.96	5.8	0.12	7.5	Clay
75-100	0.72	5.7	0.12	5.67	Clay

SAMPLING METHOD

Data for planted maple were collected in the winter of 2004 (for approximately 10 ha). Studies were carried out with tally inventory (100%) and analyzed with the volume formula:

V = G.H.F, where V = the volume of tree, G = the basal area, and F = the form factor (0.5).

The diameter, height, bottom bole warp, number of the secondary branches, health of crown and bole, crown symmetry, plumb line and situation of bole axial were measured on all trees. The situations of stand were tested with probability index and skew ness, and chi- squared tests were performed on diameter and height distributions and a ratio of height to diameter (H/D ratio) (as described by Zobeiry 1993, 2004).

RESULTS OF THE ANALYSIS

The planted maple trees were surveyed and diameter distribution in 5 cm classes was calculated. Descriptive statistics on tree diameters are presented in Table 2, and on height and volume in Table 3. The diameter distribution curve shows positive skew ness (Figure 4). The amount of skew ness become very high (b = 0.44), reflecting competition and lack of intermediate cutting. The height distribution curve have negative skew ness (b = -0.15).

Table 2. Descriptive statistics of stand diameter for a 21 year period

Mean of diameter (cm)	16.23
Median (cm)	15.5
Mode class (cm)	15
Variance (cm)	24.41
Standard deviation(cm)	4.94
CV (%)	30.43
Pierson index (skew ness)	0.44
Diameter increment (cm)	0.82
Age (year)	21

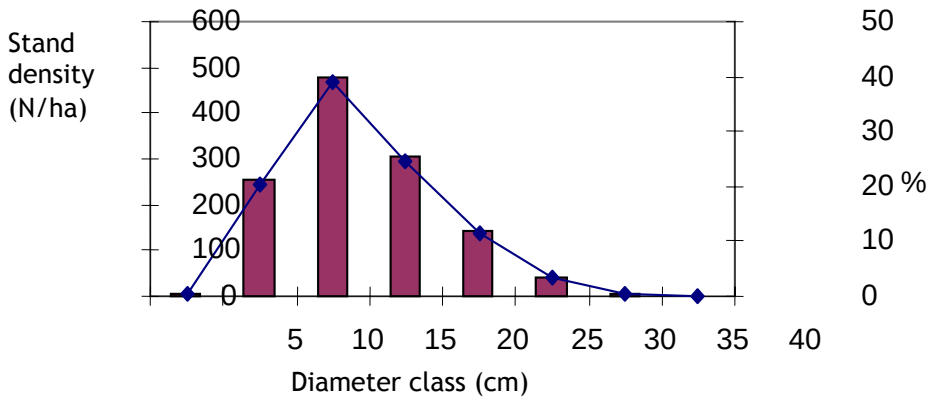

Fig 2. Diameter distribution in terms of number of trees per hectare

Table 3. Descriptive statistics of stand height and estimated timber volume

Mean of height (m)	15.76
Top height (m)	18.09
Height increment (m)	0.88
Volume (cubic meter/ha)	11.13

The nonlinear relationship between tree diameter (dbh) and height is illustrated in Figure 3, and is statistically significant at 1% level. The regression equation is:

$$H = 0.762905 + .0442053\ dbh - .000076\ dbh^2 \quad R^2\ 0.87573$$

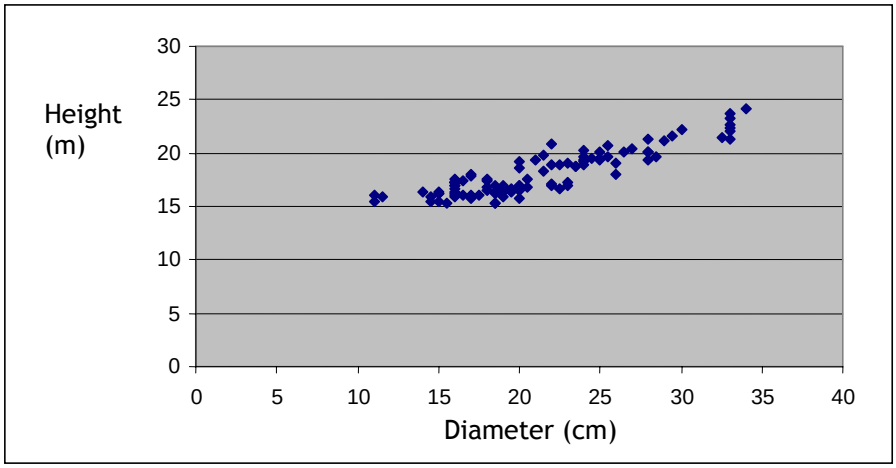

Figure 3. The relationship between tree diameter and height (m)

The volumes of testifier (selected) trees as obtained the V = G.H.F formula were analyzed and the relationship between diameter at dbh and volume was found to be significant at the 1% level.

$$V =. 0.96810 + 017569\ D - 001319\ D^{2},\ R2\ 0.99503$$

Stand normality was tested with chi-square test and probity index. The chi-square test showed the distribution was non-normal (α = 0.05%) and probability index showed this stand has skew ness and the Henry line breakdown in 10 cm classes.

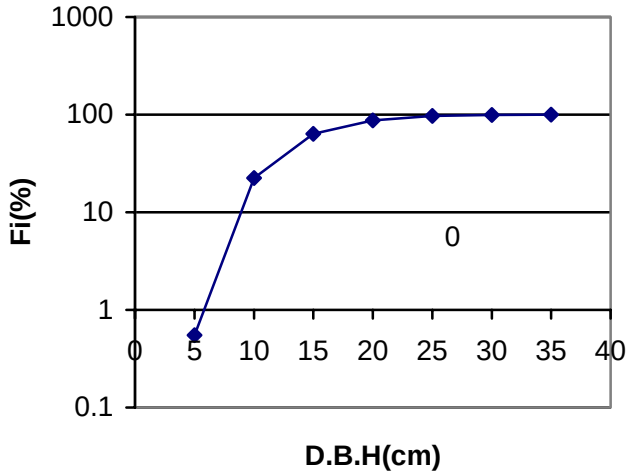

Figure 5. Cumulative relative frequency of tree diameter

The quality aspects were studied on testifier trees as indicated in Tables 4, 5.

Table 4. Bole and crown quality aspects in maple stand

Quality aspect	Relative frequency (% of trees)
Bole healthiness: illness	28.0
Spiral grain in bole	42.4
Live branch in bole	50.5
Dead branch in bole	19.7
Biaxial trees	26.0
Crown symmetric	64.6
Crown healthiness: safe crowns in stand	90.2

Table 5. Proportions of trees in various growth dominance groups

Growth dominance group	Proportion of trees (%)
Dominant	38.8
Co-dominant	43.9
Suppressed	17.3

Biaxial trees are common among maple trees (Amani1996, Hashem Nejad 2000). In this study, tree bole was measured vertically into four sections. The most biaxial maple trees were found in the second section.

The height to diameter (H/D) index of 91.7 indicates an unstable condition (Burschel and Hass 1987), where thinning may be dangerous. Bole and crown were tested between the situation of trees in story with chi-square test, and a significant difference was found (α = 0.01).

SUMMARY

There are a number of fast-growing tree species with potential for growing in plantations in Iran, including poplars, eucalypts, Alnus and Pinus species, which can be exploited under short-rotation forestry. Of the total forest area of Iran (earlier estimated at approximately 18 M ha), there are only about 1.8 M ha of commercial forest. Unfortunately, large areas of those forests have been destroyed through irregular cutting and grazing. There is a need, therefore, to expand production forestry which involves raising plantations of fast-growing species under short-rotation intensive culture, to supply about 9 M m3 of wood per year for the 70 M population, cf. the Iranian natural forest production of 1 M m3 (Abkenar and Khoshkebigary 2004). The resistance of maple against difficult conditions including irregular cutting and tolerance to light (maple trees can be tolerant to full sun light) and fire (regenerate after fire) make this species important for timber plantations. This study showed that, after 21 years, planted maple has the ability to grow successfully on the Caspian Sea flat area and slopes of the Alborz Mountains, and to withstand competition with other endemic and exotic species. Study results further showed that:

- Under the best conditions the mean annual increment in maple was 0.82 cm compared with 0.44 cm for beech trees (the main commercial trees in Iranian forest) (Siahipor 2001).
- the mean annual height increment in maple was 0.79 m which is competitive with that in planted exotic pine under the same conditions (maritime pine, 0.99 m) (Abkenar 2004)
- The mean annual volume increment in maple was 11.13 sylve compared with 4.82 cubic meters for beech trees under the best site conditions (Abkenar and Khoshkebigary 2004) and 2.6 cubic meters for maritime pine.
- These characteristics of maple trees prove its suitability in an agri-silvi production system. It is a suitable species for plantation growing in social forestry, agro-forestry and also in industrial plantations. Further testing of maple plantations in other areas in north of Iran thus appears to be warranted.

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