



Study of *Carpinus betulus* Dieback Distribution Using Topographic Factors

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Abstract

The expanding phenomenon of dieback is caused by the reaction of trees against the harmful biotic and abiotic factors that lead to dying of shoots and branches of trees from upper crown to lower crown. This phenomenon spreads throughout the leaves and branches and all parts of the plant and may finally lead to the death of the plant. This study aimed to identify species dieback with especial attention to *Carpinus betulus* and the spread of dieback in this species using topography factors in series one of Shast Kalate Forest, north east of Iran in Golestan Province. In the study area, a statistical network with dimensions of 600×800 m was randomly and systematically designed (network of plots) and cluster sampling with six trees was applied in every plot. Topographical factors (altitude, slope direction and percentage) in each plot were taken. Analysing the data indicated that 28% of the total stands suffered from different degrees of dieback among which 22% belonged to the *Carpinus betulus* species. The percentage of dieback stands of this species in different classes of height had no meaningful difference, but it was located more in western aspect and gradients of less than 20%.

Keywords: Dieback, Topography, *Carpinus betulus*, Morphologic characteristics

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1. Introduction

Forests in the north of Iran are highly important because of their high diversity of fauna and flora. Valuable industrial species like beech, maple, and alder together with many wood and grass plantations multiply this importance. (Delfan *et al.*, 2004) Although technologically speaking, *Carpinus betulus* is not normally assumed a very precious species in the north but this assumption is not right as a study by Faezipour (1976) has showed the high value of this tree in many conversion industries (chemical and wood particles).

Carpinus species comprise 26 deciduous trees (and some bushes) native to the northern hemisphere. This species is abundant in central and southeastern Europe, Caucasia, North Anatolia, north of Iran (Golestan, Guilan and Mazandaran Provinces), and north of Sweden to the latitude 57° N. This species is limited to Caucasus and Hyrcanian forests in the northwest of Asia (Paul, B.H., 1974). Furthermore, the distribution of this species is seen at a height range of 400-1500 m from mean sea level. The species distribution falls in the humid cold, semiarid and Mediterranean climate according to De Martonne classification (Khaleghi *et al.*, 1998).

The dieback phenomenon is caused by harmful biotic and abiotic factors that lead to dying of shoots and branches of trees from upper crown to lower crown. The dying phenomenon spreads to all leaves, branches, and finally covers all the plant and kills it.

Shade tolerant trees die back more especially in places where they have little or no shelter. Although an extensive scale of dieback in one geographical region can affect only one species, it can sometimes affect several species. (Bruce, R., 2000)



Figure 1. The leaves and fruits of *Carpinus betulus* and dieback in crown

Dieback factors are assumed to be twofold:

1. Biotic factors that include human interaction, insects, fungi, and semi parasitic plants such as *Viscum album*.
2. Abiotic factors that include climate, soil, flood, earthquake, frost, fire, drought, wind, snow, topographic factors and so forth.

Fig. 2 schematically depicts the dieback phenomena.

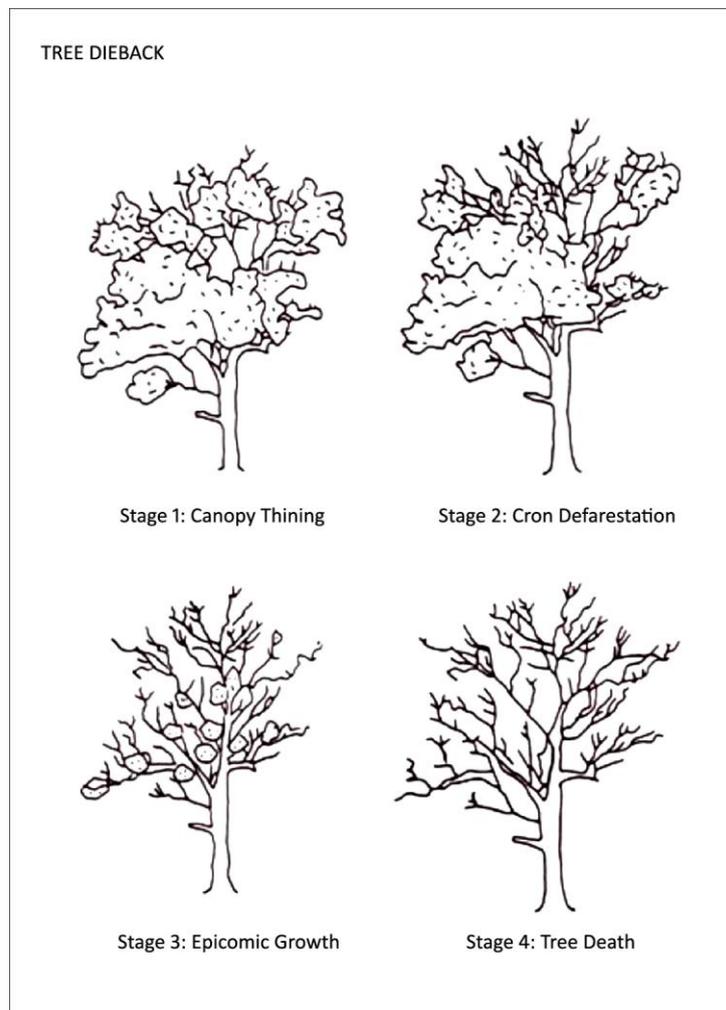


Figure 2. Tree Dieback stages

Studies about severity and distribution of dieback in Europe have showed that severity of dieback is directly related to altitude and tree age, and the most damage has been seen in trees over 45 years old. (Formard *et al.*, 1992). Robert *et al.* (2001) studied dieback in Hawaii and estimated 30% dieback there.

Dubicki (1994) found that dieback was more severe in higher places than lowland in western mountains of Poland. Not many studies have been conducted on severity and distribution of dieback in Iran. Gholamali Jalali studied the causes of dieback in beech tree in forests of Sari in 1996. This study aimed to recognize causes of dieback, and found four causes: human factor 60%, climate 21%, insects and fungi 4%, and unknown factors 15% (Jalali, 1996).

Mohammadnejad (1998) studied damage distribution (crown breakage, dieback, uprooting, and steam breakage) in *Carpinus betulus* of Jamaledin kola series of Mazandaran paper and wood forests. The results showed that 6.68% of stands were damaged, and the most damage was seen in higher altitudes and southwest direction.

Canopy dieback and mortality would be more extensive in soils with stronger soil horizon development and potentially less favourable soil hydrological condition (Hamerlynck *et al.*, 2002). It is not clear that crown dieback always results in mortality, as black ash uses branch abscission to recover from stress (Kozłowski, 1991; Pallardy, 2008). This study aims to investigate the distribution of dieback in *Carpinus betulus* trees in relation with topographic factors in series one of Shast Kalate forest in order to use it in efficient management of this forest in the future.

2. Materials and Methods

Study area: District one of Shast Kalate's forest is located in the watershed 85 in preliminary comprehensive classification plan of Northern forests. It is located in the southwest of Gorgan with an area of 1714 hectares. It borders farms to the north, Chomagh Darreh and Pashmalobon to the east, forest road of about 1 km to the west between Shast Kalate River and Pashmalobon.

The educational-experimental forest of Shast Kalate has moderate temperature and temperate climate with little annual change, high humidity, strong sea and local winds and around 600 mm of precipitation distributed year-round. Climatic statistics of Gorgan meteorological centre shows that mean annual precipitation in Gorgan is 649 mm. Frost days may last from November to March, but is not harsh and does not limit plant growth in winter.

Natural stands: Stands of this forest are generally comprised of mixed broad leaved trees. The dominant tree species in the altitudes of lower than 500-700 meters above sea level are Hornbeam (*Carpinus betulus*) and ironwood tree (*Parotia persica*), and above this altitude, beech (*Fagus orientalis*) is dominant as the main species. These species are mostly seen with other non-dominant species as mixed stands.

Field data: In the studied area, a statistical network of plots with dimensions of 600×800 m was randomly and systematically designed and cluster sampling with six trees was applied (in every plot). The centre of the network was the main plot and 4 minor plots with a distance of 25 meters from the main plot were chosen in 4 main geographic directions (north, east, south, and west). In each minor plot, 6 trees near the centre with diameter of more than 12.5 cm were randomly selected as sample trees. As a result, in each plot (with 4 minor plots) 24 trees were measured. The measuring comprised of species, diameter at breast height, tree height, crown height and diameter, altitude above sea level, slope direction and percentage, and dieback amount with 4 stages (Fig. 2). Chi square test was used to analyse the data and detect any relationship between dieback and the topographic factors.

3. Results

The results of statistical comparison of *Carpinus betulus* species in District one of Shast Kalate Forest showed no significant difference in altitude categories as shown in Tab. 1 and Fig. 3.

Table 1. Chi square test for dieback percentage of *Carpinus betulus* in different altitude categories

Percentage of dieback in <i>Carpinus betulus</i>		Chi square
9.787		Degrees of freedom
6		0.134
Meaningful level		

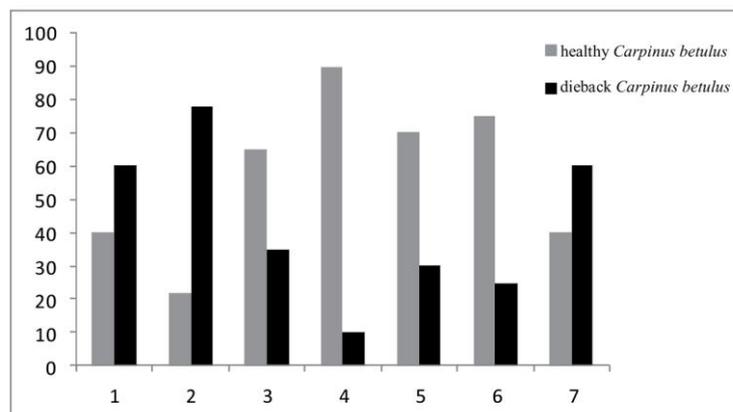


Figure 3. Percentage of dieback and healthy *Carpinus betulus* in different altitude categories

X: altitude categories (levels)

Y: Percentage of dieback and healthy trees

series 1: healthy *Carpinus betulus*

series 2: dieback *Carpinus betulus*

In Fig. 3, level 1 refers to the altitude 200-300 m, level 2 to 300-400 m, level 3 to 400-500 m, level 4 to 500-600 m, level 5 to 600-700 m, level 6 to 700-800 m, and level 7 to the altitude 800-900 m.

Statistical comparison of dieback percentage of *Carpinus betulus* stands in different altitude levels and slope directions showed a significant difference in that number of *Carpinus betulus* in level 1-3 (altitude 400-500 and west direction) and level 1-6 (altitude 700-800 and west direction) had the highest dieback percentage. Chi square table of dieback percentage of dieback and healthy *Carpinus betulus* in different altitude levels and slope directions are shown in Tab. 2 and Fig. 4.

Table 2. Chi square test for dieback percentage of *Carpinus betulus* in different altitude categories and slope direction

Dieback percentage of <i>Carpinus betulus</i> species	
Chi square	33.723
Degrees of freedom	12
Meaningful level	0.001

Comparison of the number of diebacks in stands of *Carpinus betulus* using chi square showed a significant difference in altitude level and slope percentages. Level 1-1-3 (altitude 400-500 m, west direction, slope more than 20 percent), and level 1-1-6 (altitude 700-800 m, west direction and slope percentage less than 20 percent) had the most dieback percentage while level 1-2-5 (altitude 600-700 m, eastern direction, and less than 20 percent slope, and level 1-2-6 (altitude 700-800 m, east slope direction and slope less than 20 percent) had the lowest percentage of dieback in *Carpinus betulus*.

Chi square test of the difference in dieback percentage in *Carpinus betulus* in different altitude levels, slope direction and percentage is shown in Tab. 3.

Table 3. Chi square test for dieback percentage of *Carpinus betulus* in different altitude categories, aspect and slope

Dieback percentage of <i>carpinus betulus</i> species	
Chi square	36.877
Degrees of freedom	18
Meaningful freedom	0.005

In general, observations and data analysis of dieback percentage of different species in series one of Shast Kalate Forest showed a significant difference between species regarding dieback trees. *Carpinus betulus* and beech ranked first and second with dieback percentage of 22.73% and 2.87%, respectively. All

species including maple, alder, *Diospyros lotus*, and acorn had dieback except *Parrotia persica*, and hackberry.

The relationship between dieback percentage of *Carpinus betulus* and morphologic characteristics of diameter at breast height, tree height, crown length, crown cross section, and topographic factors of altitude above sea level, slope direction and percentage, and the amount of light under the crown in four main directions was studied using Pearson correlation coefficient. The results showed mean percentage of dieback in *Carpinus betulus* crown was negatively associated with crown length, and positively associated with north light. There was also a positive association between dieback percentages of crown with four geographical directions.

4. Discussion and Conclusion

The results of this study about dieback phenomenon in series one of Shast Kalateh Forest showed that 28 percent of all stands in this series of different species had different degrees of crown dieback from 25% to 100% in all altitudes.

Studying the effect of aspect and slope percentage showed that most dieback affected trees were in directions of less than 20% in that most of the dieback trees can be seen at lower altitudes with slope percentages of more than 20%, and in higher altitudes with slope percentages of less than 20%. The amount of dieback at different altitude levels did not show a significant difference, but higher altitudes had more dieback. Most of the dieback affected stands were seen at altitude levels of 400-500 m, 600-700 m, and 700-800 m with west direction and slope percentage of less than 20%. The study of distribution of dieback in stands of *Carpinus betulus* in series one of Shast Kalate Forest showed the similarity of percentage and number of stands in hectare at different altitudes above the sea level.

The amount of crown dieback in *Carpinus betulus* all over the forest did not show a relationship with this factor, and can only be seen in trees with less crown length and more light. Furthermore, the highest percentage of dieback affected stands of *Carpinus betulus* was seen in altitude levels of 400-500 m, 600-70 m, and 700-800 m with western direction and slope percentage of less than 20%. However, with regard to the number of trees in each hectare, there was no difference between the levels. Studying the relationship between crown dieback and morphologic and topographic factors showed that dieback of *Carpinus betulus* stands was related to the altitude above sea level in western direction and slope percentage of less than 20%. Parameters like crown length, mean absorbed light of crown, and tree height are related with dieback of *Carpinus betulus* stands, but other factors did not influence dieback. Comparison of dieback affected trees showed that *Carpinus betulus*, beech and maple had the highest percentage of dieback, and *Parotia persica* and *Celtis sp.* species did not have any dieback, which shows the ability of these species to withstand adverse environmental factors.

Studying biotic factors effective in dieback of trees like fungal diseases and semi parasitic plants like *Viscum album* have priority in the study area. Studying severity and distribution of dieback affected trees in other forests of North of Iran and estimating its economic consequences are also important research issues. Paying attention to combination of cultivation species in a way that *Carpinus betulus* does not make up more than 20-30 percent is a suggestion that warrants further research.

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