

Study on Cone Formation Stage of Caucasian Fir (*Abies nordmanniana* ssp. *nordmanniana*)

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Abstract

Determination of the good seed year is important to obtain high quality and quantity seeds from stands. Also, pollination and fertilization need to be done without problems. Tree quality, health and good seed bearing capacity is related to climatic factors during flowering and seeding stage and related to site conditions. Healthy, high quality and enough number of seeds are required in order to have a successful natural regeneration. Observing the morphological characteristics of trees in the stand or as single trees is the fastest, easiest and cheapest way to characterize their health status.

In this study, a tree species, Caucasian fir, from the Karadeniz Technical University campus was observed. Phenological changes of the male and female flowers will be observed periodically and photos of these changes will be provided. During the early months observations will be weekly but on later periods observations will be bi-weekly. Caucasian fir's pollination, fertilization, cone formation, cone growth and seed fall will be determined based on observations and the study results.

Key Words: Fir taxa, cone formation stages, male and female flowers

Introduction

Forests cover one third of the lands on Earth and also form more than three fourths of total biological mass. Forests are also important to protect and preserve biological diversity and ecological values. Despite this, forests are being destroyed by overexploitation and soil misuse, damaging its structure. As a result of pollution and other abiotic factors such as insects, fungi, acid rains and other biotic factors due to changes in atmospheric chemistry, air quality and climate, some significant damages are being done on forests from time to time. These global problems are threats to all regions with different intensity, which also applies to Turkey (DPT, 2001).

Afforestation is an expensive and long-term investment. In order to secure these investments, genetically superior seeds should be used in suitable habitats. Turkey's forest areas are shrinking and still decreasing like the rest of the world. The rapid increase in population (2.5%) and decrease in forest areas will significantly increase the need for wood. Thus, we will need more forest areas and more afforestation to meet increasing wood material needs and to decrease air and water pollution levels. More afforestation means higher quality seeds. In order to maximize the profit in afforestations that requires high amount of money and labor,

high quality seed and seedlings along with intensive cultivation techniques should be used. Success of big afforestation investments depends on the quality of seedlings. Quality seedlings can increase the wood production up to 40% (Yahyaoğlu, 1997).

This study aims to determine the phenological properties of Caucasian fir (*Abies nordmanniana* ssp. *nordmanniana*) native to eastern Black Sea region and endemic to the region.

Importance of Determining the Phenological Properties

Determining the rich seed year correctly and a healthy pollination are necessary to produce desired quality and amount of products from stands. On the other hand, the success of natural regeneration treatments depends on the experience and knowledge of the forest practitioner. Rainfall, mist, dew, rime, snowfall, autumn and spring frosts, extreme temperatures, drought and other climatic factors are directly related to the quality, health and amount of tree seeds during rich seed years.

According to Saatcioglu (1976), mist, unusual rime and dew during flowering can cause losses to male and female flowers. Also, heavy rainfall during flowering can interrupt pollination and cause abortion. Atay

(1982) reported that cool summers and autumn frosts can delay the maturation of oak seeds or completely prevents them from maturing. On the other hand extreme temperature and dry summers can scorch beech masts.

In order to achieve success in naturally regenerated sites, the amount of seeds must be 10 times more than the planned seedlings. Therefore, healthy and high amount of seeds are required for a successful natural regeneration.

The easiest, fastest and cheapest way to examine the health of trees in stands or growing individually is to observe their visible features. If an environmental stress or any sort of disease affects a tree, it will react with visible responses. For example, if the pine processionary moth is present the needle number will decrease. Leaves/needles of a drought-affected tree can also fall off. The top of a diseased tree can partly or fully dry off. During strong winds, tree branches or stem can be damaged. Branch and leaf loss can affect tree growth and development. Diseased trees can harm the forests' ecological balance and damage all ecosystems. Forest trees that do not function well can affect the ecological balance and reduce the economic value of the forest.

Cone formation, development and natural seed fall is essential for the healthy seeds. Therefore all these factors were observed and photos were taken in this study carried out in the Kanuni campus of Karadeniz Technical University. The obtained materials were examined and shown in this study.

General Information on Caucasian fir

Natural distribution site of Caucasian fir

Caucasian fir forms the lower layer in mixed stands with beech and Scots pine located in eastern Turkey, starting from the eastern Black Sea region to Kızılırmak River and partly in other parts of the Black Sea region (Figure 1).

Its natural range goes up to 1,500-2,000 m altitudes in eastern Black Sea region. In Turkey it is found in eastern Black Sea forests located between Yeşilırmak Valley

and Turkey-Georgia border. It can be found in mixed forests with *Fagus orientalis*, *Pinus sylvestris*, etc. at 800-1,700 m altitude.

Caucasian fir can be found not only on seaside slopes but also on land slopes, such as on Kelkit Valley, between Koyunhisar and Şebinkarahisar, and on higher altitudes alongside Scots pine. At the same time, this fir taxon cannot form pure stands; in mixed stands it always exists as secondary species.

Ecology of Caucasian Fir

Firs are typical shade-tolerant trees. They can live under shadow for 60–80 years. This species thrive in humid areas and is resistant to freezing under shelter. Its humidity requirements are higher than of oriental beech. They avoid still water and grow best in deep, humid, clay, clay-loam and loamy soils. This species also thrive on high-aerated soils (Ürgenç, 1998).

Botanical characteristics of Caucasian fir

Compared to silver fir (*Abies alba*), the bud burst period in spring is a few weeks later so they are less affected by spring frosts. Caucasian fir does not require specific soil types. In France and some other European countries, Caucasian fir is used as forest tree because of these features, but grows slower in youth in comparison to silver fir. There are many different types and varieties used in landscaping.

The average cone (of cylindrical shape) length is 15-18 cm and the average diameter is 5 cm. Cones get narrower to tip, reddish brown when matured. The cone scales are 3-4 cm wide, deltoid-shaped and the outer scale is visible from outside. There is much resin on cone surface.

Buds are egg-shaped, resin-free and are found on the tip of lateral shoots. There are four buds on the tip of a lateral shoot. Their placement is two or three at the same level and one beneath them. It has fewer branches than *Abies nordmanniana* subsp. *equi-trojani*. Young shoots are grey, mostly short and covered with either dense black hair or with few black hairs.

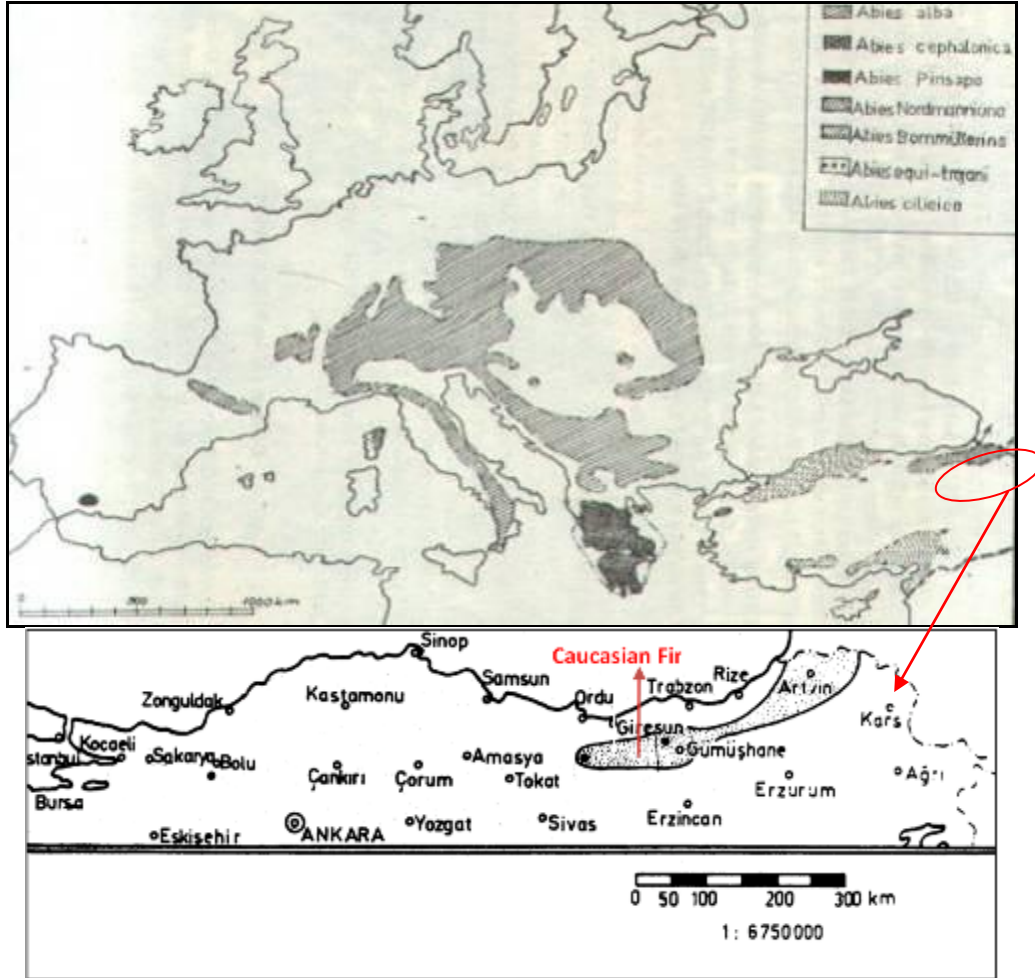


Figure 1. Natural range of Caucasian fir

Material and Method

The study was carried out on Caucasian fir trees located in the Kanuni campus of Karadeniz Technical University (Trabzon). Changes in the phenology of male and female flowers were observed periodically and photos of these changes were taken. During the earlier phase, field trips and observation of trees were weekly but trips and observations were bi-weekly during later months.

Photos of Caucasian fir flowers were taken in 03.03. 2010 after formation of male and female flowers. Pollination, efflorescence and seed fall were observed periodically. The study ended up at the beginning of seed fall.



Figure 2. Observed Caucasian fir (KTU Kanuni campus)

Results and Discussion

Caucasian fir Observation Results

Below the cycle based on observations on Caucasian fir and climate data is shown.



1- Male flowers are not active yet, beginning of vegetation period (March 3rd, 2010). Min. Temp.: 8.0°C, Max. Temp: 11.0 °C, Average temp.: 9.3°C



2- Male flowers become active at the beginning of vegetation period (April 7th, 2010). Min. Temp.: 9.0°C, Max. Temp: 13.0°C, Average temp.: 11.3°C



3- Male flowers of fir close to burst. Pollination continues (April 14th, 2010). Min. Temp.: 18°C, Max. Temp: 17°C, Average temp.: 14.6°C



4- Male flowers matured. Pollens are ready to spill (April 29th, 2010). Min. Temp.: 11.2 °C, Max. Temp: 14.3 °C, Average temp.: 12.2°C



5- Female flowers were formed 2-3 days ago and they continue to grow. Male flowers close to cease their activity (May 7th, 2010) Min. Temp.: 12 °C, Max. Temp: 18.3 °C, Average temp.: 15.5°C



6- Female flowers during growing season. Vegetative buds are still active (May 12th, 2010) Min. Temp.: 12.8°C, Max. Temp.: 18.6 °C, Average Temp.: 16.4°C



10- Cones started to mature. Resin is visible (July 1st, 2010) Min. Temp.: 20°C, Max. Temp: 26.1°C, Average temp.: 24.1°C



7- Female flowers continue to grow. Cone diameter around 7-8 cm (June 4th, 2010) Min. Temp.: 19.2°C, Max. Temp: 22.1°C, Average Temp.: 20.6°C



11- As maturation continues cones keeps leaning on branches (July 30th, 2010) Min. Temp.: 25°C, Max. Temp: 28.4°C, Average Temp.: 27.1°C



8- Male flower activities stopped (June 17th, 2010) Min. Temp.: 20.5°C, Max. Temp: 26.5°C, Average Temp.: 23.6°C



12- Cone formation almost halting. Cone diameter approximately 10-11 cm (August 6th, 2010) Min. Temp.: 25.9°C, Max. Temp: 31.3°C, Average Temp.: 28.5°C



9- Cone diameter approximately 9-10 cm. Bending started due to weight. Growth continues (June 17th, 2010) Min. Temp.: 20.5°C, Max. Temp: 26.5°C, Average Temp.: 23.6°C



13- Tip of cones completed approaching the end of maturation. Cones became heavier, approximately 15-17 cm long and lean on branches (September 2nd, 2010) Min. Temp.: 21.2°C, Max. Temp: 27.8°C, Average Temp.: 23°C



14- Matured cones started to turn brown (October 1st, 2010) Min. Temp.: 14.7°C, Max. Temp: 21.9°C, Average Temp.: 19.6°C



15- Matured fir cones started to spill (November 4th, 2010) Min. Temp.: 8.0°C, Max. Temp: 18.0°C, Average Temp.: 13.1°C



16- Cones are approximately 12 cm long and with the end of maturation they have started to spill (December 3rd, 2010) Min. Temp.: 15.4°C, Max. Temp: 23.2°C, Average Temp.: 17.5°C

Conclusion

In this study, cone formation and development stages in Caucasian fir were studied. Formation and development stages of Caucasian fir cones were completed in one vegetation period.

Caucasian fir studies started in March. First male flowers were observed in April due to increasing temperature. At first, male flowers are light red, white bottom, and when mature they turn into purplish-brown. It was

observed that the date of female flower formation by activation of pollens is May 12th. Female flowers are cone-shaped and 2-3 cm long. They are located on the shoots of branches, vertical, near the tree top. They are green and 2.5–3 cm long. Pollination occurred as described in the literature. In June, male flowers, after completing their parts in pollination, started to fall off. During the vegetation period the green color of cones slowly darkened. Cones, matured and spilled, are 15-17 cm long, 5-6 cm diameter, cylinder-shaped and stand vertical. They develop fast between July and September. It was observed that the color of matured fir cone is brown. Carpels were opened in October 15th. Cones spilled seeds in late November-early December.

There was 15-20 days difference between maturing period of trees in our study and the literature on maturing period of fir. The reason for this difference can be that they grow in the K.T.U University Kanuni campus not under forest and different climatic conditions.

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