Christmas Tree Genetics

Fir Species of the World

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Introduction

During the past 30 years, Christmas tree growers in the mountains of North Carolina have capitalized on their close proximity to the native range of Fraser fir. As a result of their efforts, Fraser fir is now widely accepted as the premier Christmas tree species in much of the United States. While it is anticipated that Fraser fir will continue to play a prominent role in the Christmas tree market, the future is never certain. Complete dependency of the North Carolina Christmas tree industry on Fraser fir may not be an optimal strategy. Reasons to consider other fir species include:

- Historically, the tastes of Christmas tree customers have undergone dramatic changes. Thus, it is likely that growers of other fir species will develop market niches and increase their market shares.
- Fraser fir has many pests. Natural stands of Fraser fir are threatened by infestations of the balsam woolly adelgid while Christmas tree plantations planted below the species' natural range are increasingly plagued with *Phytophthora* root rot and other disease and insect pests.
- Some firs are better adapted than Fraser fir to frost pockets (via later bud break) or other special types of sites.
- Unforeseen new pest or other biological problems may develop in the future.

Thus, it is prudent that research addresses the advantages and disadvantages of other fir species and that North Carolina Christmas tree growers gain awareness of these species. Knowledge and the use of other fir species may provide the flexibility to effectively address some of the challenges to North Carolina's Christmas tree industry.

Taxonomy

All true fir species are classified in the genus, *Abies*. It should be noted that Douglas-fir, a common Christmas tree species in the Northwest U.S., is not a true fir but classified in another genus, *Psuedotsuga*. Similarly, Chinese fir, occasionally planted as an ornamental in the U.S. is not a true fir but classified in the *Cunninghamia* genus.

Approximately 40 to 50 species of *Abies* exist. In many cases morphologically distinct species occur along with intermediate forms. Some taxonomists consider the intermediate form as a variety of one of the distinct species while others consider the intermediate form a hybrid of the two distinct species or even as a third species. Thus, the number of true fir species varies from author to author and the scientific nomenclature for some species is confusing.

According to the classification of Dr. Gerd Krüssman presented in the *Manual of Cultivated Conifers* (Krüssman 1995), the *Abies* genus is divided into two subgenera: *Pseudotorreya* and *Sapinus*. Only one species, bristlecone fir (*Abies bracteata*), a sharp-needled fir native to California, is classified in the first subgenus. Forty-seven species are classified in *Sapinus* which is itself sub-divided into seven sections. Some of these seven sections are further subdivided into series. In the Küssman classification, Fraser fir (*Abies fraseri*) is classified in the *Lasicocarpae* series of the *Balsameae* section along with its close relatives, balsam fir (*Abies balsamea*) and subapline fir (*Abies lasiocarpa*).

Botanical Characteristics

Fir species are generally large, evergreen, conical-shaped trees with radially arranged branches. Following are some distinguishing features of true firs (Harlow and Harrar 1969):

- The needles are spirally arranged, flattened in cross section,

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grooved above with numerous row of stomata below, leave a circular scar when removed from the tree and usually exude a balsamic, turpentine-like or citrus-like odor when bruised.

• The female cones are erect in the upper crown of the tree, mature in one year with deciduous scales and bracts and persistent cone axes and often exude fragrant resins.

• The male strobili occur in the same trees as the female cones and are borne solitarily on the underside of the lower crown branches in the needle axils.

•Young stems bear fragrant resin blisters, buds are rounded often covered with resin, wax and curved needles.

Distribution

Fir species are native only to the Northern Hemisphere where they are widespread particularly in the temperate and frigid regions and at elevations from sea-level to over 15,000 feet (Liu 1971).

In the Eastern Hemisphere, firs range in latitude from approximately 23°N to 67°N and in longitude from 5°W to 160°E. In the Western Hemisphere, they range in latitude from approximately 14°N to 64°N and in longitude from 43°W to 145°W (Liu 1971). As a reference, the relatively limited distribution of Fraser fir is roughly between 35°N and 37°N latitude and 81°W and 84°W longitude.

Uses

Forestry Although there are some notable exceptions, the firs as a group are not commercially important in the production of wood and pulp products, particularly in comparison to other conifers such as the spruces (*Picea* spp.) and pines (*Pinus* spp.). In the U.S., concolor, grand, subalpine and noble fir in the West and balsam fir in the East are used as commercial forest species. In Europe, European silver, Spanish, Moroccan, Algerian, Cilician, Greek and Nordmann fir are used by the forest industry while West Himalayan, momi, nikko and Siberian are used for forest production in Asia. The oleoresin of firs are sometimes commercially used for medicinal purposes, as a medium for permanently mounting microscope slides and for cementing components of optical systems (Burns and Honkala 1990, Harlow and Harrar 1969, van Gelderen and Smith 1995).

Horticulture While firs are beautiful trees in their natural habitat, their role as ornamentals is not prominent. Uncultivated specimen are too large for small gardens but can be used effectively in landscape gardening, in groupings near large buildings and as screens. Ornamental firs are mostly found in arboreta and large parks. Prostrate, compact, pendulous and blue-foliage cultivars (over 150 total) have been developed that can add novel and beautiful textures, colors and shapes to small residential landscapes (van Gelderen and Smith 1995).

Christmas Tree Production Firs are ideally suited for use as Christmas trees due to their natural conical shape, pleasant color and aroma, good needle retention after harvest, and strong branches for holding ornaments. Table 1 lists currently used domestic and promising exotic fir species for Christmas tree production in the U.S. At the present, there appears to be national interest in experimenting with exotic fir species, especially in the Northeast, the Great Lakes Region and the Pacific Northwest.

While the interest in exotic fir species is rational, our knowledge of their performance is incomplete. Growers who are geographically widely dispersed usually (wisely) plant only limited numbers of exotics. Generally, seed from one or a few easily collected sources are available on the market. Worse, market seed is often unidentified and in some cases, misidentified, as to its origin.

To strengthen our knowledge about exotic fir species, rigorous and extensive geographic variation (provenance) studies need to be established for the most promising species. Many of these fir species have large ranges covering wide latitudes and elevations. Such a range results in much within species variation for both growth and adaptive traits (such as time of bud break). Tested seed sources should cover the entire geographic and elevational range of each species. Properly randomized and replicated tests need to be established on a variety of representative planting sites. Survival, growth and quality traits need to be assessed from test establishment through harvest. Only with such punctilious testing can we gain a comprehensive understanding of what to expect from various exotic species and their seed sources. In lieu of such exhaustive testing, growers need to be aware that their experiences and those of others may not provide the whole story on a particular species. Better and poorer seed sources are almost certain to exist that may completely alter the perceived value of a species as a Christmas tree.

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Species	*Comments*
	Domestic Fir Species
Balsam Fir	Large natural range; longest used fir species for Christmas trees in the U.S. Adaptable to many sites. Many seed sources are available. Canaan fir is a geographic source of a variety (var. *phanerolepis*) of balsam fir which can be quite variable in appearance. Canaan fir breaks bud later and appears better suited to poorly drained soils than either balsam or Fraser fir.
Concolor Fir	Large geographic range from Oregon to northern Mexico. Long slightly curving, blue to silver-green foliage; excellent shape and post-harvest needle retention.
Fraser Fir	Premier Christmas tree species in much of the United States.
Grand Fir	Shiny green foliage with fragrant, long 2-ranked needles. Susceptible to late frost damage. Sometimes suffers from current season needle necrosis and relatively poor post-harvest needle retention.
Noble Fir	Popular, widely-grown western fir species. Deep green to bluish green foliage. Lack of cold hardiness and poor growth outside of native range have been reported.
Pacific Silver Fir	Long dark-green needles that lie close to the branch; dense foliage.
Subalpine Fir	Soft dense pale bluish-green foliage. Susceptible to early spring frost damage. Arizona corkbark fir is a variety (var. *arizonica*) of subalpine fir which is dense and well-shaped with soft cream-colored cork-like bark.
	Promising Exotic Fir Species
European Silver Fir	Large range throughout the mountains of central and southern Europe; large variation among seed sources. Tolerant of balsam wooly adelgid.
Korean Fir	Similar in appearance to Fraser fir with lighter foliage and reddish buds. Some growers have had success with this species in the NC mountains.
Nikko Fir	Japanese fir; needles are rather stiff and slightly sharp, breaks bud late.
Nordmann Fir	Native to the Caucasus Mountains; dark green foliage with excellent needle retention; Abrolauria considered best seed source.
Turkish Fir	Closely related to Greek and Nordmann fir. Tolerant of dry sites.

Table 1. List of currently used domestic and promising exotic fir species for Christmas tree production in the U.S.

Current Research Efforts

Due to the high priority of genetically improving Fraser fir, exhaustive provenance testing of exotic species is not currently underway at N.C. State University. However, an investigation into several exotic species emphasizing their resistance to *Phytophthora* root rot has been initiated. Currently, about 800 seedlings of the following 5 species are being grown at the Horticultural Field Laboratory near campus: balsam (Canaan), Fraser, Korean, Nordmann and Turkish fir. A greenhouse screening of these species via artificial inoculations has revealed that Turkish fir is relatively resistant, Korean and Nordmann fir are intermediate and Fraser and Canaan fir are susceptible to *Phytophthora cinnamomi* (Benson et al. 1998). In spring 1998, these greenhouse seedlings will be transplanted into outdoor beds at the Upper Mountain Research Station in Laurel Springs. After one year, they will be out-planted into a series of species trials primarily on sites highly infested with *Phytophthora*. Some seedlings will be retained for use as rootstock for Fraser fir scion and also eventually be out-planted onto sites highly infested with *Phytophthora*. If any of these species show promising *Phytophthora* resistance in these tests, more exhaustive geographic testing may be initiated.

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Conclusion

The future is unpredictable. Biological problems are constantly arising and markets are constantly changing. Knowledge about other firs species may provide the flexibility to effectively address some current and future challenges to the North Carolina Christmas tree industry.

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