Using Knobcone x Monterey Hybrid Pine (KMX) in Western Oregon

KMX is a hybrid pine with three needles per fascicle, scaly bark, and cones that remain closed and attached to the branches or stems for more than 10 years. Normally, only the intense heat of a forest fire will open up the cones and disperse the seeds (1x = actual size).

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The knobcone x Monterey hybrid pine, called KMX, is a cross between knobcone pine (Pinus attenuata) and Monterey pine (Pinus radiata). Monterey pine is native to only small areas of the southern California coast and offshore islands. It is noted for its fast juvenile growth and widespread use as a short-rotation softwood crop in mild climatic regions such as Australia and New Zealand. It does not tolerate cold climates.

Knobcone pine is found in mountains of southwestern Oregon and California on dry, rocky, or burned-over areas. Knobcone pine has a greater tolerance of frost and cold than Monterey pine.

The hybrid has some of the characteristics of both parents. It is a fast-growing, drought- and relatively frost-resistant tree that may have potential as a short-rotation timber crop in southwest Oregon.

This publication summarizes briefly the background and performance of the KMX hybrid in western Oregon. We'll discuss how KMX performance has varied in different locations and suggest management techniques, opportunities, and cautions. If you are interested in learning about what we do and do not know about KMX, this publication is for you.

We'll focus on using KMX as a timber-producing species. Because this hybrid has not existed for centuries like normal tree species, our knowledge of how it will perform in a variety of situations is incomplete. Scientists are still evaluating the wood quality, disease resistance, and growth characteristics of this interesting hybrid.

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**History of KMX Breeding**

The first KMX hybrid crosses were made in 1927 by the U.S. Forest Service (USFS) Institute of Forest Genetics at Placerville, California. They used California sources of knobcone and Monterey pine to see if the hybrid would be a viable tree. The hybrid was a vigorous tree with rapid growth and many characteristics intermediate between the parent species.

In the late 1950's and early 1960's, the U.S. Forest Service became interested in producing KMX for use on dry sites on the Siskiyou and Rogue River National Forests of interior southwestern Oregon. Their crosses used knobcone and Monterey pine to see if the hybrid would be a viable tree. The hybrid was a vigorous tree with rapid growth and many characteristics intermediate between the parent species.

The initial crosses by the Forest Service and Lee Hunt were controlled that is, the female cones were enclosed in pollen-proof containers, and the desired male pollen was introduced to fertilize the cones (see figure 1). Thus, wind-borne pollen from knobcone or other KMX trees was excluded, and the parents of these trees are known exactly. The offspring of such a cross are called the

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Some F2 individuals have strong Monterey traits, and they may not tolerate drought or frost as well as the F1 hybrids. Other individuals have strong knobcone traits, and they may have poor form and slower growth than the F1 hybrids. Unfortunately, there's no way to judge by looking at them what kind of a tree form F2 nursery seedlings will produce.

Performance in western Oregon

Results of Forest Service trials
Widespread planting of KMX, in formal or informal tests and for ornamental uses, started in the early 1960's. Many plantings are now available for evaluation (see figure 2). The Forest Service made more than 50 plantations in southwestern Oregon from 1963 to 1966. They planted KMX in burns and clearcuts. Some plantations covered several acres. The records provide the opportunity to see how KMX performs in a pure stand.

Initial survival of KMX in the 1963 SFS plantation trials was very good when compared to survival of native Douglas-fir or ponderosa pine. Long-term survival, growth, and susceptibility to disease varied by planting location.

On some warm, dry, south-facing aspects in southwestern Oregon, long-term survival and growth were very good. Depending on family, 80 or 90% of the trees survived, and leader growth averaged 2 to 4 feet per year over the first 10 years.

KMX planted on cool, moist coastal sites survived and, but soon became infected with fungi causing stem galls (see figure 3) and needle cast. Galls on the main stem caused deformity and weakening of the trunk, and, in some cases, multiple tops. Needle cast fungi reduced the amount of leaf needle area on the trees and resulted in decreased growth.

Other failures resulted from planting KMX in frost pockets, on soils with poor nutrient balance, or in treeless meadows inhabited by gophers. Severe competitive situations was often the problem in some cases. Indeed, success in establishing conventional species such as Douglas-fir or ponderosa pine was often limited during the same time period. These experiences demonstrated that KMX could not be used as a cure-all tree for tough-to-manage sites.

Of the 50 test plantations, only a few have survived the rigors of

Figure 2.—A successful 20-year-old plantation of KMX in an unrehabilitated clearcut in southwest Oregon. The whole area was planted twice with Douglas-fir before KMX was introduced.
climate and attack from fungi. No published results are available from the USFS plantings. As a result of their evaluations, USFS geneticists and pathologists have officially terminated the breeding project.

They feel the hybrid has little promise as a timber tree because of its poor resistance to pathogens in some locations. Research in tree genetics has turned to the far more critical work of improving major species like Douglas-fir.

Results of other plantings

In some locations, USFS Geneticists have officially terminated the breeding project. They feel the hybrid has little promise as a timber tree because of its poor resistance to pathogens in some locations. Research in tree genetics has turned to the far more critical work of improving major species like Douglas-fir.

What makes KMX attractive to woodland owners is the excellent performance it has shown in some plantings in comparison to native tree species on the same site. Industrial owners occasionally have interplanted KMX with Douglas-fir and ponderosa pine on hot, dry southern slopes. This provides the opportunity to compare the performance of KMX with other species (Table 1). In the example, average survival of KMX was nearly double that of ponderosa pine and triple that of Douglas-fir planted on the same site. Improvements in nursery stock and planting techniques have increased survival rates of Douglas-fir and ponderosa pine planted on such sites, but much of the volume growth superiority of KMX remains.

A 20-year-old clump of KMX F1 generation near Winston, Oregon gives some indication of the potential growth of KMX on appropriate sites. The following data were taken from only 33 trees planted at a 17 x 17 foot spacing.

- Diameter at breast height (inches)
  - Average: 12.7
  - Range: 7.4 to 15.8
- Height (ft)
  - Average: 62.6
  - Range: 46 to 70
- Volume/tree (bd ft to 6-inch top)
  - Average: 92

Estimating volume per acre from this data could be misleading because it’s impossible to tell how much this clump of trees is drawing water and nutrients from surrounding open areas. The growth is, however, far superior to Douglas-fir planted on the same site. It would be misleading to extrapolate from these examples to a larger scale of operation.

A cold snap in December 1972 showed that KMX bred with knobcone from the north end of its range survived much longer than those bred from California knobcone. Temperatures during that period remained below freezing for 2 weeks and reached a low of 5°F in the Willamette Valley.

In coastal Oregon locations, temperatures reached the low teens. Trees from the Placerville crosses planted near Corvallis were killed. Trees from the USFS and Lee Hunt’s work survived well in southwestern Oregon and in the Portland area.

In the Willamette Valley trial, KMX is more tolerant of a high percentage of disease and insect problems. Western gall rust commonly infects ponderosa pine. In 9 years, KMX planted on a wet site east of Brownsville, Oregon, grew to twice the height and four times the diameter of ponderosa pine planted at the same time. Douglas-fir do not survive on such sites.

Unfortunately, no systematic trials of KMX on droughty sites have been conducted. The information given here was gleaned from field visits to many of the available planting sites. No estimates of total area planted to KMX are available.

Insect and disease problems

The KMX hybrid is susceptible to several disease and insect problems. Western gall rust commonly infects KMX, producing galls on the branches.
(figure 3) and occasionally on the main stem. Heavy infection on the trunk will create a weak spot that can increase wind or snow breakage.

Needle-cast diseases, such as red band needle blight, also are common on KMX and lead to the loss of the older age classes of needles. This can cause a loss of diameter or height growth, and repeated infections could lead to mortality.

The pine tip weevil has been observed to damage KMX trees planted in Medford. It is not known if this insect will be a serious problem in large-scale plantations.

Occurrence and severity of these problems are related to topographic location, climatic variation, and local inoculation potential. High relative humidity favors disease spread by airborne spores. Therefore, planting KMX in topographic depressions, near streams, or in areas of impeded air drainage increases the probability of serious infection.

Potential problems caused by disease are a major concern in the long-term use of KMX in timber production. Western gall rust and needle rusts devastated most of the USFS plantations in Oregon. Most KMX trials in California were also infected by these diseases.

Many pathologists believe the inoculum that causes these diseases to spread will build up if KMX is widely planted. Unfortunately, such problems may not appear until the plantation is 10 to 15 years old. Planting KMX on exposed south aspects may mitigate the problem, but as stands develop, favorable conditions for spread of disease may develop, given the canopy. A very long-term test will settle this question.

### Wood characteristics and potential markets

Tests of the characteristics of KMX showed that it produces high quality pulp and is suitable for studs and dimension lumber. In limited testing, it was second only to western hemlock in pulping characteristics. Tests of the wood showed that it is similar to the other western pines in its strength characteristics (see table 2).

<table>
<thead>
<tr>
<th>Table 2.—Moduli of rupture (MOR) and elasticity (MOE) for Western tree species (larger numbers mean stronger wood)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOR (PSI)</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>KMX hybrid pine</td>
</tr>
<tr>
<td>Lodgepole pine</td>
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<tr>
<td>Ponderosa pine</td>
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<tr>
<td>Sugar pine</td>
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<tr>
<td>Grand fir</td>
</tr>
<tr>
<td>Western hemlock</td>
</tr>
<tr>
<td>Sitka spruce</td>
</tr>
<tr>
<td>Coastal Douglas-fir</td>
</tr>
<tr>
<td>Interior Douglas-fir</td>
</tr>
<tr>
<td>Australian-grown Monterey pine</td>
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</tbody>
</table>

* Modulus of rupture (MOR) measures the breaking strength of wood while bending.

Juvenile wood from a 20-year-old tree was lacking in compression and bending strength and, therefore, not suitable for stress-tested lumber. It was suitable for studs.

Trees grown in a stand with proper spacing should have strength characteristics suitable for veneer or stress-tested lumber. It is more suitable than the more rigorous use. The wood produced by trees in similar growing conditions is similar to that of ponderosa and other pines grown in the southern States. These species have been managed at high quality levels.

In New Zealand and Australia, Monterey pine—the timber species most like KMX—is used for paper, and it's thinned and thinned for high quality lumber and plywood. There's no reason to expect that KMX would not be suitable for use in fiber or strand boards.

Since little KMX has grown to harvest size, market conditions are difficult to predict. Markets for KMX planted now and grown to 25 or 30 years of age are unknown.

### Does KMX have a future in Oregon?

Because KMX is a hybrid and one of the parents is from a much milder climate in California, it's considered an "exotic" or introduced species. Although many exotics have been introduced to Oregon, none have performed as well as native northwestern conifers. However, many of our preferred ornamentals are exotics.

Because KMX is a synthetic hybrid, it does not have the long history of adaptive evolution in the wild (therefore) may have less tolerance of climatic extremes that occur only periodically. It's also uncertain how KMX will withstand infection by disease or attack by insects.

KMX stands planted in a few locations have withstood many environmental rigors and disease problems and have grown very well for 20 years. These few successes were accompanied by many failures. Further use of KMX must, therefore, balance the risk of a severe climatic event or disease outbreak in KMX against the potential for greater production on marginally productive land.

The best place to try KMX as a timber producer is in the interior valleys of southwestern Oregon (below 2,500 feet), on dry, exposed south aspects. On such sites, limited short-term trials of the KMX have shown it will survive and grow substantially better than either Douglas-fir or ponderosa pine. On such sites, it has grown to small saw log dimensions in 20 to 25 years.

KMX is not a good choice for planting as a timber producer on better sites in western Oregon. On such sites, Douglas-fir performs...
high quality wood with few of the uncertainties of KMX. Don’t plant KMX in topographic depressions where frost, high humidity, or snow might cause problems. Don’t plant it above 2,500 feet or east of the Cascade Crest.

Other possible uses include:
• in agroforestry, as a short-rotation tree crop combined with forage production (see EC 1114);
• as a “nurse tree” to provide shade for more tolerant trees like Douglas-fir on dry sites (after the more desired species have become established, you could remove the KMX, perhaps as a first commercial thinning);
• as a fast-growing ornamental; or
• as a Christmas tree.

Management characteristics and opportunities

When you examine management regimes we propose here for KMX, you’ll have to consider them speculative until more information becomes available on its performance in stands. The recommendations in the next six sections are based on the assumption that KMX is similar to Monterey pine in its management characteristics.

KMX does not grow well in shaded conditions, and it is particularly sensitive to competition from adjacent trees. It should be maintained at a wide spacing compared to more shade-tolerant trees like Douglas-fir.

Selecting a seed source

Results of existing trials indicate that there is a great deal of variation in tree form and in disease and frost resistance in KMX, depending on the location and genetic makeup of the parents. Some families tend to develop very small side branches; others are extremely coarse. Some tend to have more cones on the main trunk or are much more likely to form multiple tops than others.

All this means that Pacific Northwest tree nursery operators and tree breeders have a heavy responsibility to select seed from the best individuals within seed orchards or plantations. It also means that a careful breeding program could improve the quality and capabilities of this hybrid for future use in Oregon.

Finally, it means that you must be careful to buy trees with appropriate frost tolerance and form characteristics for your intended use. Find out if you are getting F1 or F2 generation seedlings. F1 generation seedlings are more uniform in form and growth characteristics, but are generally not available because they require the laborious process of controlled pollination.

It’s important to ask whom the parents of the KMX hybrid seedlings were located in order to know that you’re selecting the proper KMX source for your area. This is analogous to selecting the proper seed source of Douglas-fir or ponderosa pine when ordering seedlings from the nursery.

KMX hybrids that have a knobcone parent from the northern range of knobcone pine (such as Toketee on the north Umpqua River or the Siskiyou Mountains) are best for planting in Oregon because they’re more frost hardy. Avoid trees from California sources.

Planting

Survival of planted stock is normally high, assuming good site preparation and planting conditions, so dense planting is not justified on the basis of expected mortality. If you plant trees at conventional densities of 300 to 400 trees per acre, anticipate early precommercial thinning. Planting excess trees would, however, allow for selection of better trees during precommercial thinning.

Animal damage

Deer and elk do not prefer KMX and will browse Douglas-fir before they will browse KMX. Bucks and bulls, however, will use the tree for rubbing their antlers. Porcupines will girdle KMX but seem to like ponderosa pine better.

Gopher damage may be a problem where KMX is planted in meadows with high populations of the rodents. Overall, KMX appears to have fewer animal damage problems than the native species in southwest Oregon.

Precommercial thinning

Figure 4 shows KMX trees in dense stands (8 x 8 foot spacing). At age 20, they grew much slower in diameter (8 to 12 rings per inch) than widely planted trees. Thus, it’s...
clear that wider spacing will be necessary if trees are to reach saw log size in 25 or 30 years.

Precommercial thinning should take place after the lower branches have died, unless pruning is anticipated. Two hundred well-spaced trees per acre (about 14 x 14 feet) should provide a commercial thinning of 8- to 10-inch material at 18 to 20 years. (For more information about precommercial thinning, see EC 1189.)

KMX, like other trees, is more resistant to wind damage when it's allowed to develop in a well spaced plantation. Trees with live crowns less than 30% of their total height appear to be susceptible to snow breakage when heavy wet snows occur. Open-grown trees may be damaged when heavy snows pull some of the limbs from the trunk.

Problems with wind and snow breakage can be expected above 3,000 feet, especially if stands are not thinned to a wide spacing. The best insurance against wind and snow break problems is to maintain the stand with adequate spacing and to use KMX only on recommended sites (that is, south aspects below 2,500 feet elevation).

Pruning
The hybrid produces heavy and abundant limbs (see figure 5), especially when grown at low densities. These limbs are extremely tough and limber—they tend to remain on the tree even if they're dead (figure 4). Therefore, if you want high quality wood in open plantations, pruning is necessary.

Pruning can take place as soon as adequate crown has developed or when lower limbs die. Pruning should leave the upper 30 to 50% of the tree bole with live branches. Because markets and values are unknown, we can't predict that the cost of pruning will be justified. Pruning on native tree species hasn't proven to be economically justified when labor costs are taken into account.

Commercial thinning
Crop tree spacing, based on trials on Monterey pine in New Zealand, should be about 100 trees per acre, which is equivalent to an average spacing of 21 feet. Depending on

Figure 5.—KMX naturally holds limbs, both living and dead, for a long period. Pruning as shown here may be necessary to produce high quality wood.

initial spacing, commercial thinning could take place at age 20 to 25 years.

Summary
Because KMX is relatively new, there are many unknowns surrounding its use as a timber crop. We don't know if it will survive extreme cold snap conditions. We don't know how well it will survive disease problems over the long run when it's planted in large stands or over large areas. Table 3 summarizes important KMX characteristics.

Results of early trials indicate KMX may have potential for planting on south aspects below 2,500 feet in southwestern Oregon on forest-producing sites. Soils with nutrient imbalances, such as those on serpentine, peridotite, or gabbro parent rock, are not likely to produce good growth of any tree species.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing survival</td>
<td>High, even with moderately intensive site preparation and vegetation management.</td>
<td>Long-term growth potential is unknown.</td>
</tr>
<tr>
<td>Juvenile growth</td>
<td>Rapid, even on droughty or flooded sites.</td>
<td>Does not tolerate: 1. Frost, especially early in fall 2. Diseases (western gall rust, needle blights)</td>
</tr>
<tr>
<td>Tolerance</td>
<td>Tolerates drought and winter flooding.</td>
<td>Poor form (depending on genetics): F2's may have bushy form; tends to form large limbs; cones retained on bole; limbs retained indefinitely.</td>
</tr>
<tr>
<td>Wood quality</td>
<td>Good for pulp, fiber boards, studs.</td>
<td>Poor for stress tested lumber.</td>
</tr>
</tbody>
</table>
You could plant KMX on ridges and side slopes that are convex. From a disease standpoint, don't plant it in moist areas or valley bottom areas where frequent high humidity helps spread disease transmitted by spores.

On the other hand, it can grow where winter and spring flooding occur (for example, on ash bottom lands), but it may suffer from diseases when planted there. Animal damage problems are generally less severe on KMX than on native trees in southwest Oregon.

Survival of KMX planted on areas with good site preparation and proper handling and planting should be excellent. Early growth is exceptional when compared to Douglas-fir or ponderosa pine on dry sites.

KMX is sensitive to crowding. We have only tentative density targets for planting (300 t/A), precommercially thinning (200 t/A), and commercially thinning to a 100-t/A crop tree spacing. Branches are retained indefinitely along with cones, so you must practice pruning if high quality wood is your objective.

For further reading

In July 1992 the OSU Extension Service publications warehouse was destroyed by fire. We are replacing supplies. The publications listed below may be available in the office of the OSU Extension Service that serves your county. Check with that office for current prices. You also may call Agricultural Communications at Oregon State University, (503) 737-2513, to learn the availability and current price of the publications.


Oester, Paul T., and William H. Enmiingham, Using Precommercial Thinning to Enhance Woodland Productivity, Oregon State University Extension Service Circular 1189 (Corvallis, 1987). $1.00

The Woodland Workbook is a collection of publications prepared by the Oregon State University Extension Service specifically for owners and managers of private, nonindustrial woodlands. The Workbook is organized into 11 sections, containing information of long-range and day-to-day value for anyone interested in wise management, conservation, and use of woodland properties. It's available in a three-ring binder with tabbed dividers for each section.

For information about how to order, and for a current list of titles and prices, write Agricultural Communications, Publications Orders, Administrative Services Bldg. 422, Oregon State University, Corvallis 97331-2119, or inquire at the office of the OSU Extension Service that serves your county.

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