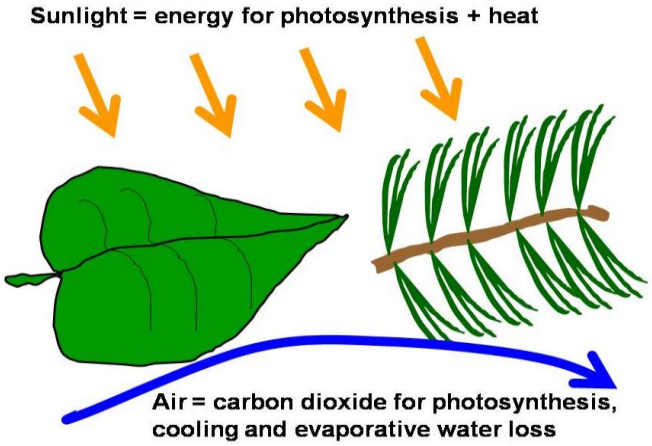
MONTANA STATE UNIVERSITY EXTENSION SERVICE

# Trees and Shelterbelts

*Dr. Peter Kolb, Montana State University Forestry Specialist*
*32 Campus Drive, Missoula, MT 59812. Tel. (406)243-4705*
*e-mail: peter.kolb@cfc.umt.edu*

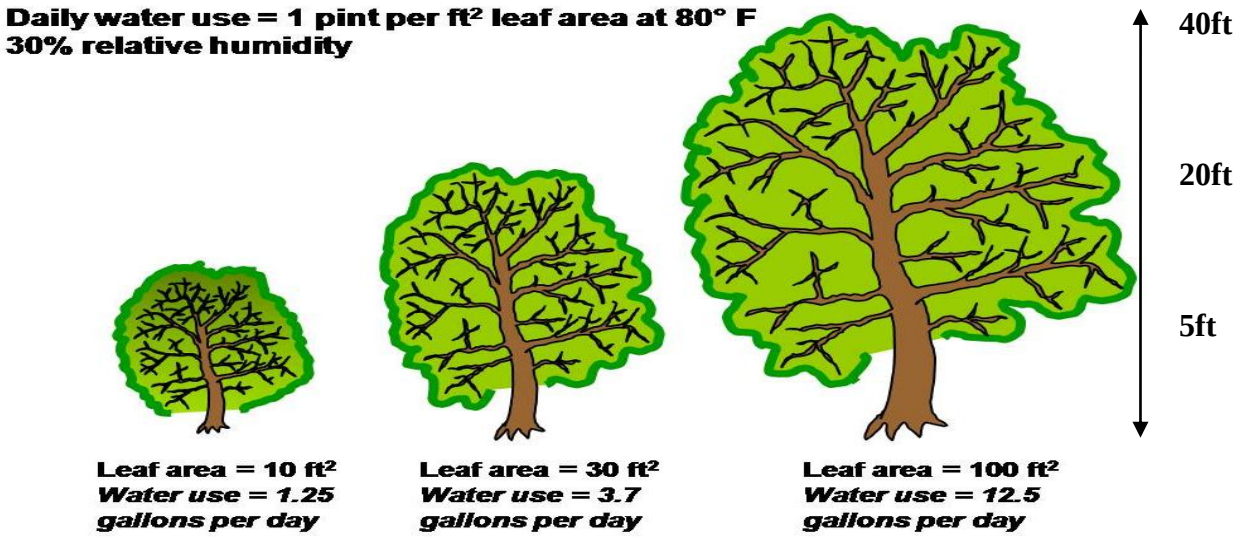
## Keeping shrubs and trees healthy and alive

All plants function in basically the same way. Leaves or needles are structures designed to capture the sunlight as the energy source for converting absorbed atmospheric carbon-dioxide and soil water into sugar – the basic building block for life. In order to absorb the needed carbon-dioxide leaves and needles have tiny pores on their surface called *stomates*. Although stomates are essential for letting $CO_2$ in, they also let water out especially when the air is dry and windy. The suction of water out of a leaf multiplies with every increase in wind or air temperature. For example, at 80°F and 30% relative humidity the water suction on a leaf exceeds 200 lbs per square inch! (Your vacuum operates at around 40lbs per square inch suction).

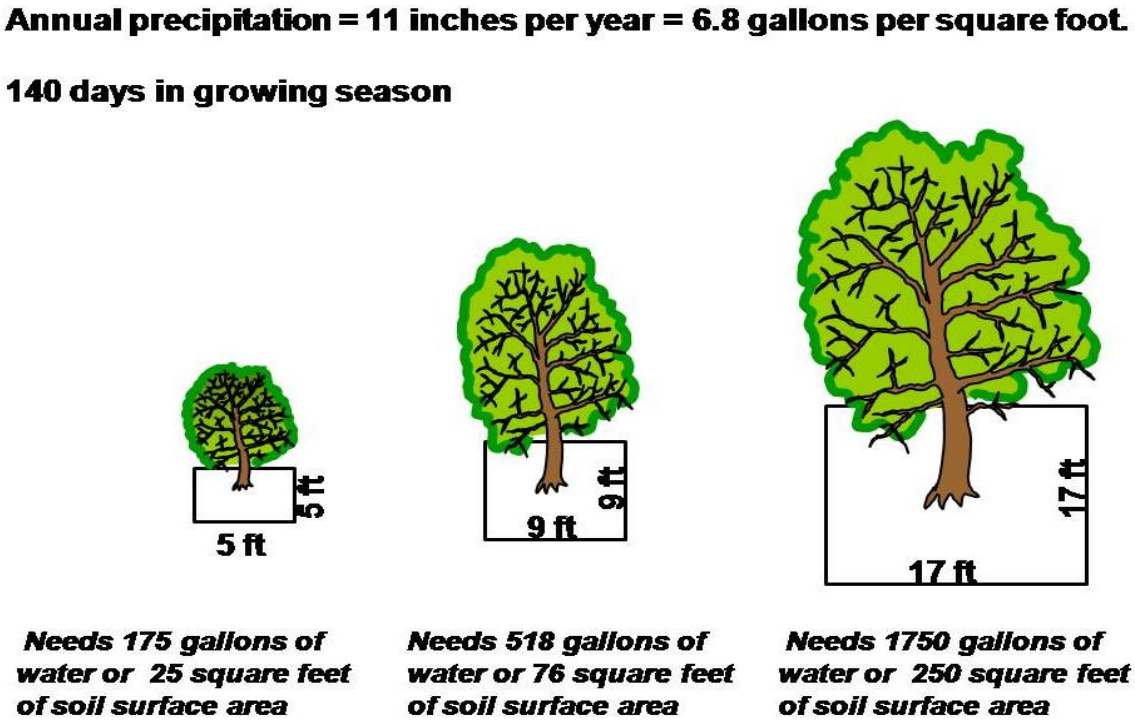



When wind is added to the picture potential water loss doubles with every increase in wind speed of 10 mph. Prairie ecosystems did not typically have trees or taller shrubs because soil water is too limiting and dry air sucks water out of leaves faster than it can be replaced. Windbreaks and shelterbelts can only be successfully maintained though a combination of cultural practices that provide trees and shrubs with enough water and through the planting of specific drought and wind adapted species. Water conservation and replenishment is the key. Water absorption and holding capacity of soil varies with texture. Sandy soils (feel gritty and soils don't stick together when rubbed between fingers) allow for quick water infiltration but can't store much water since large pores allow most to filter away. Clay soils (stick or greasy when wet, very hard when dry) do not allow water to infiltrate very easily, resist root expansion and tend to hold onto water so tightly that trees can't absorb it. Silty and loamy soils (can make crumbly pancakes or sausages when moist but not sticky) are the optimal soils for growing plants as they allow water to infiltrate and hold it in a plant available state. Soil organic matter is the key to most soils as it loosens clay soils, increased water holding in sandy soils and increased fertility in all soils. Amending excavated soils 30-40% by volume with decomposed organic matter helps most trees.

How much water does a broadleaf tree use per day? Consider the following example:




Obviously the larger a tree, the more water it needs. In a dry environment, where can water be obtained? Most dry-land farmers use a crop fallow system to allow fallow soil to store enough water for a crop. Tree and windbreak management uses a similar technique. Most trees and shrubs start to occur on landscapes that receive at least 16-18 inches of rainfall every year. In addition, soils need to be able to store that rainfall so it is available for plants to use. Controlling competing vegetation around a tree helps store water exclusively for tree use. Supplemental watering is the other alternative.



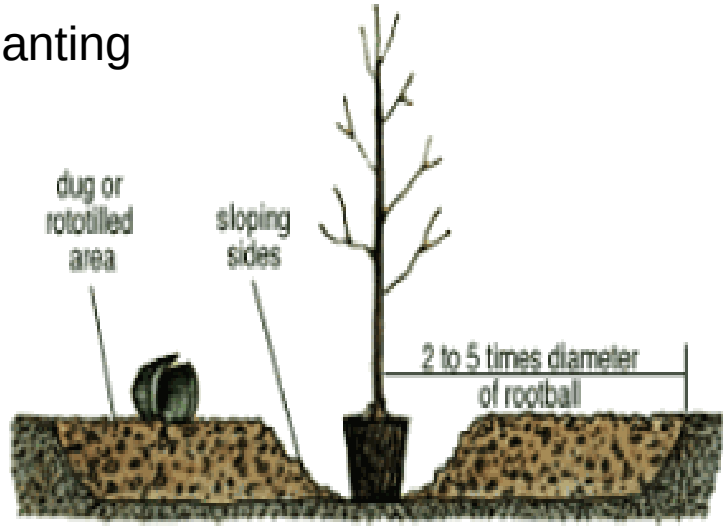

In the above example, fallow soil is used as a water collection system to provide trees and shrubs with enough soil water to survive and grow. In this example it is assumed that every square foot of soil surface area has enough soil underneath it absorb and hold 6.8 gallons of water. For the average soil this would require a loamy soil depth of 10-16 feet. Where these optimal conditions do not exist, the amount of surface area each tree needs to gather

water from must be increased. For example, in the case of the largest tree, a soil that can only hold 3.4 gallons of water per square foot surface area would require a fallow soil area 34 x 34 feet – or double the example. Anything that affects the amount of water the soil receives, such as surface evaporation, runoff, snow dispersal, water use by grasses, drought, etc. requires that a larger area be used to collect water for the tree. For this reason a general recommendation of 20 ft of fallow soil between windbreak rows is recommended. Spacing within rows should be adjusted to provide adequate density to catch the wind, but enough spacing to allow for water collection. As trees get larger, thinning within rows may become necessary.

## Fertilizer

Trees need nutrients like nitrogen (N), phosphorus (P) and potassium (K). These are called macronutrients because plants require them in larger quantities than trace minerals such as iron, zinc, sulfur and magnesium. Commonly fertilizers have three numbers on them like 20-20-20. These numbers refer to the concentration of macronutrients in the order N-P-K. Nitrogen allows trees to produce sugar at a faster rate and stimulates growth. It can also cause leaves to use more water than the roots can supply which is why it should be used sparingly and only in the spring. Phosphorus and potassium have been linked to tree defenses against pests and are necessary for trees to produce chlorophyll (which makes them green). These are also best applied in the spring. All fertilizers should be used in moderation.

## Planting

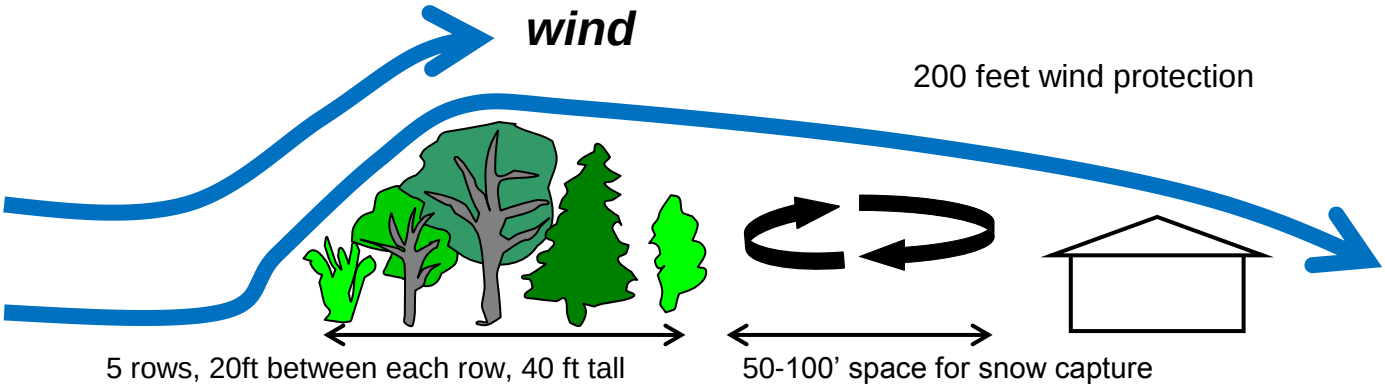



A hole about ¼ deeper and at least 1.5 times wider than the root ball or container should be excavated. Amending soils 2- 5 times the width of root ball around the new tree will help new roots form. The bottom should be backfilled with amended soil, the container or burlaped ball placed in the hole, container and burlap gently removed and amended soils filled and gently compressed around root system. For best results only plant trees when they are dormant in fall or spring.

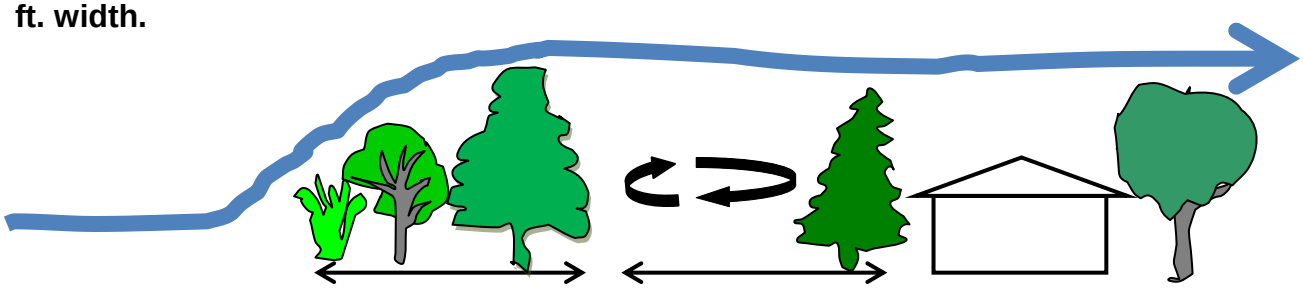
# Windbreaks

A windbreak is simply an obstruction that is placed at a perpendicular angle to the prevailing wind. Depending on its density it either slows or lifts the wind. Maximum wind slowing is found to be in an area that is 5 times as long as the effective height of the windbreak. It can be constructed out of inert or dead materials such as wood, hay bales, and plastic fencing, or put of living shrubs and trees. Well designed windbreaks and shelterbelts have been shown to reduce heating, cooling and livestock feeding requirements by up to 30%. Living windbreaks also provide excellent wildlife habitat.

# Home protection



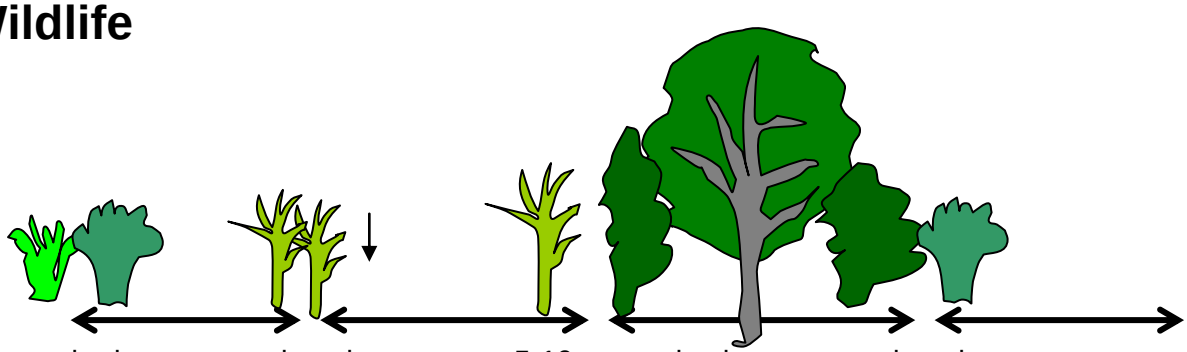

**Five row windbreak design of 3 rows deciduous and 2 rows evergreen - requires 100 ft. width.**



**Three row windbreak of two rows deciduous and one row evergreen – requires 60 ft. width. Trees within a homesite will keep wind up and out.**

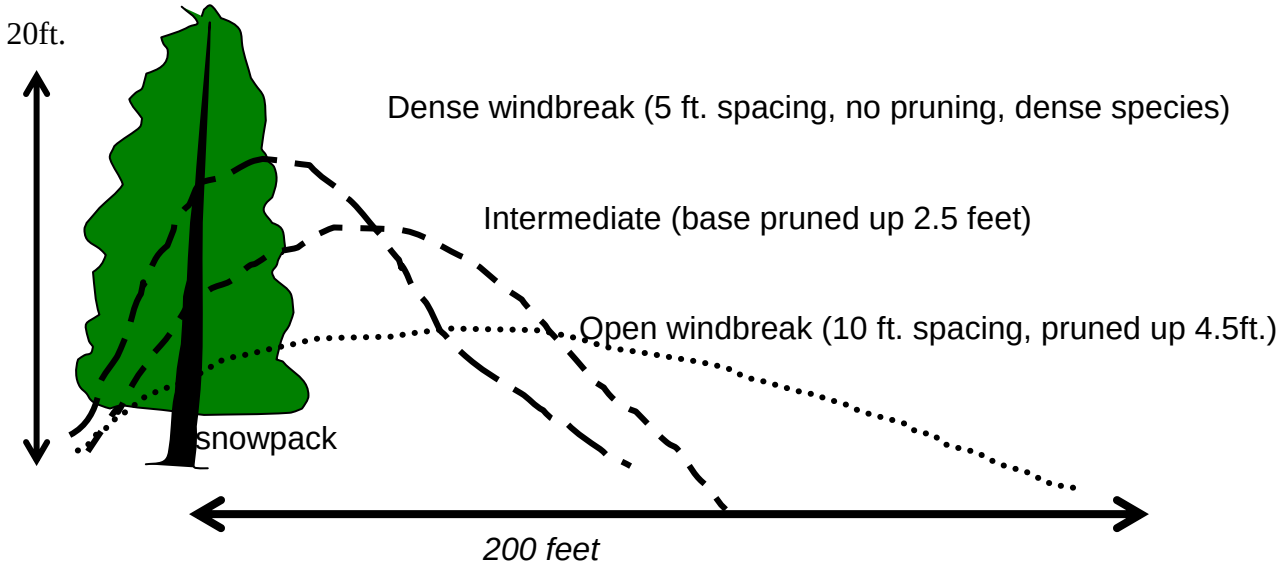
For home wind protection a 3 - 5 row windbreak with between-row spacing of at least 20 feet is recommended. Species sequencing should start with a low shrub species followed by an intermediate sized shrub, a taller tree species, a taller evergreen and finally a dense intermediate shrub or evergreen. This design lifts the wind giving the shelterbelt itself better protection from the wind. Trapping snow can also help provide more moisture for the survival and health of the windbreak.

# Wildlife




Wildlife prefers cover that is structurally diverse for nesting and hiding as well as providing food sources. Plant a variety of low shrubs that produce and hold fruit and seed at different times as well as trees that provide shelter. More dispersed clusters of 3-5 rows and up to 10 rows is considered adequate for pheasant habitat in central Montana. Multiple rows trap snow. To create bird protection zones rows can be double spaced 3 – 10 feet apart for shrubs and 5 – 20 feet for trees with 20 feet between double rows. Food species that retain berries during the winter are good to consider such as roses, silverberry, buffalo berry and Russian olive.

# Living Snowfence




Wind speed reductions of 80 – 60% can be found within a leeward zone that is 5 **x** windbreak height long. A single or double row of species that lose their leaves during the winter are best suited for living snow fences (Siberian elm, green ash, lilac or caragana).

## Care and maintenance

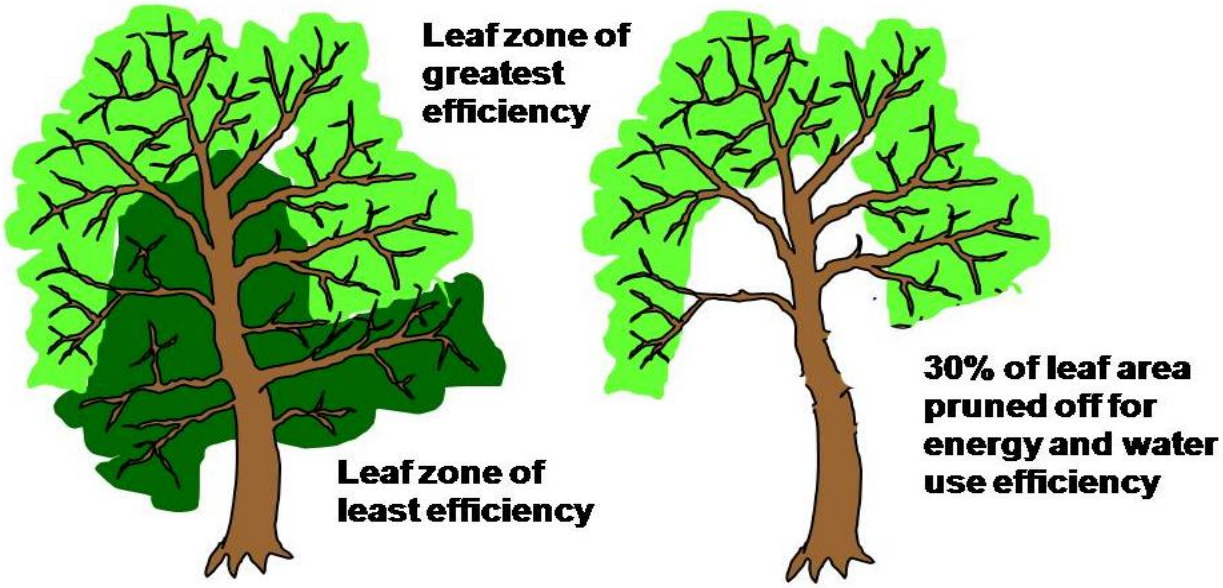
As with trees in yard settings, maintaining soil water is the key to keeping a windbreak healthy. The best way to do this is through the use of cultivation, weed barrier fabrics and herbicides.

Shallow cultivation of soils in the spring and mid-summer to control grasses and weeds prevents water loss from competing vegetation. The negative side effect may be wind erosion. Cultivation can be reduced through the additional use of a combination of herbicides. A common pre-emergent herbicide is *Casoron* that only effects germinating seeds and can help prevent the establishment of weeds and grasses where the seeds are dormant in the soil or have blown in. If undesirable vegetation has established, using a contact herbicide such as Roundup works well as it has little residual soil activity and won't be readily translocated by roots. Spray must make contact with the plant to have an impact and thus can be sprayed immediately around shrubs and trees, especially when they are still dormant in the spring. Be careful it does not drift onto leaves and thin bark of shrubs and trees. Weed barrier fabric is successfully used during the planting of windbreaks and shelterbelts where cultivating and spraying around seedlings is difficult. A good quality fabric will be very effective for up to 5-7 years, after which other means of weed control can take place. Mulching can also be very effective, however, applying mulch thicker than 2 inches can reduce soil water infiltration where water runs off or is trapped on the surface where it evaporates. Rodents may also use the mulch as cover to gnaw on tree and shrub stems. Irrigation may be helpful during unusual drought periods or for older stressed windbreaks, however, ensure that the watering is adequate to drain deeply into the soil (at least 4 feet) otherwise salt buildup in the shallow rooting zone could eventually damage the shelterbelt.

Pruning your shrubs and trees is an effective means of controlling leaf area and thus water use. Prune broadleaf trees up, and conifers down once they have reached the desired height for wind protection.

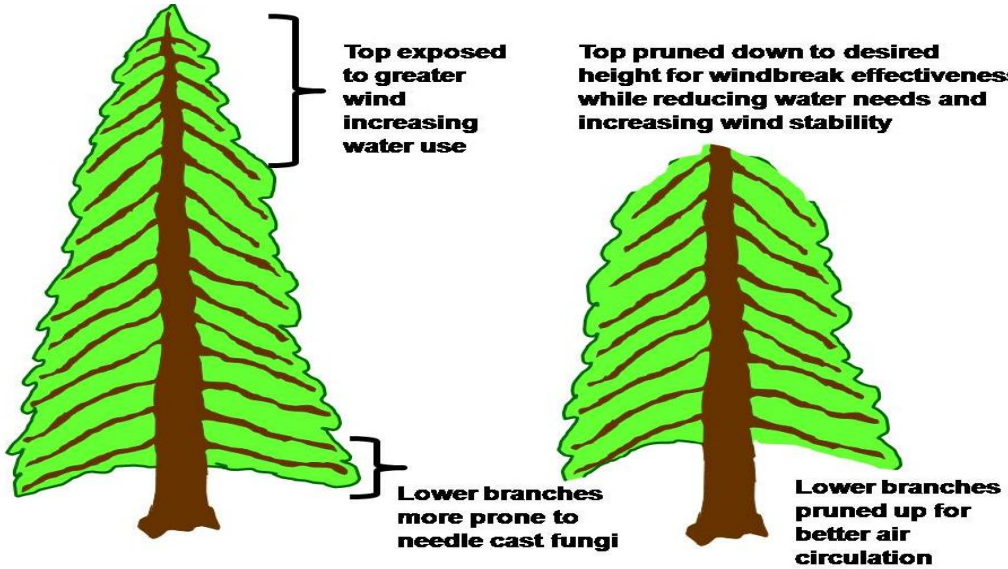
# Pruning and managing leaf area

Another technique for keeping trees and shrubs healthy is to manage their total leaf area. Broadleaf trees often produce “sun” and “shade” leaves depending on their positioning in the tree. Shade leaves are often inefficient energy producers yet use significant water. Pruning these branches off will decrease water use while preserving good energy production for the tree. Taller trees can be raised up for best results and should be positioned within a windbreak in second, third or fourth rows.



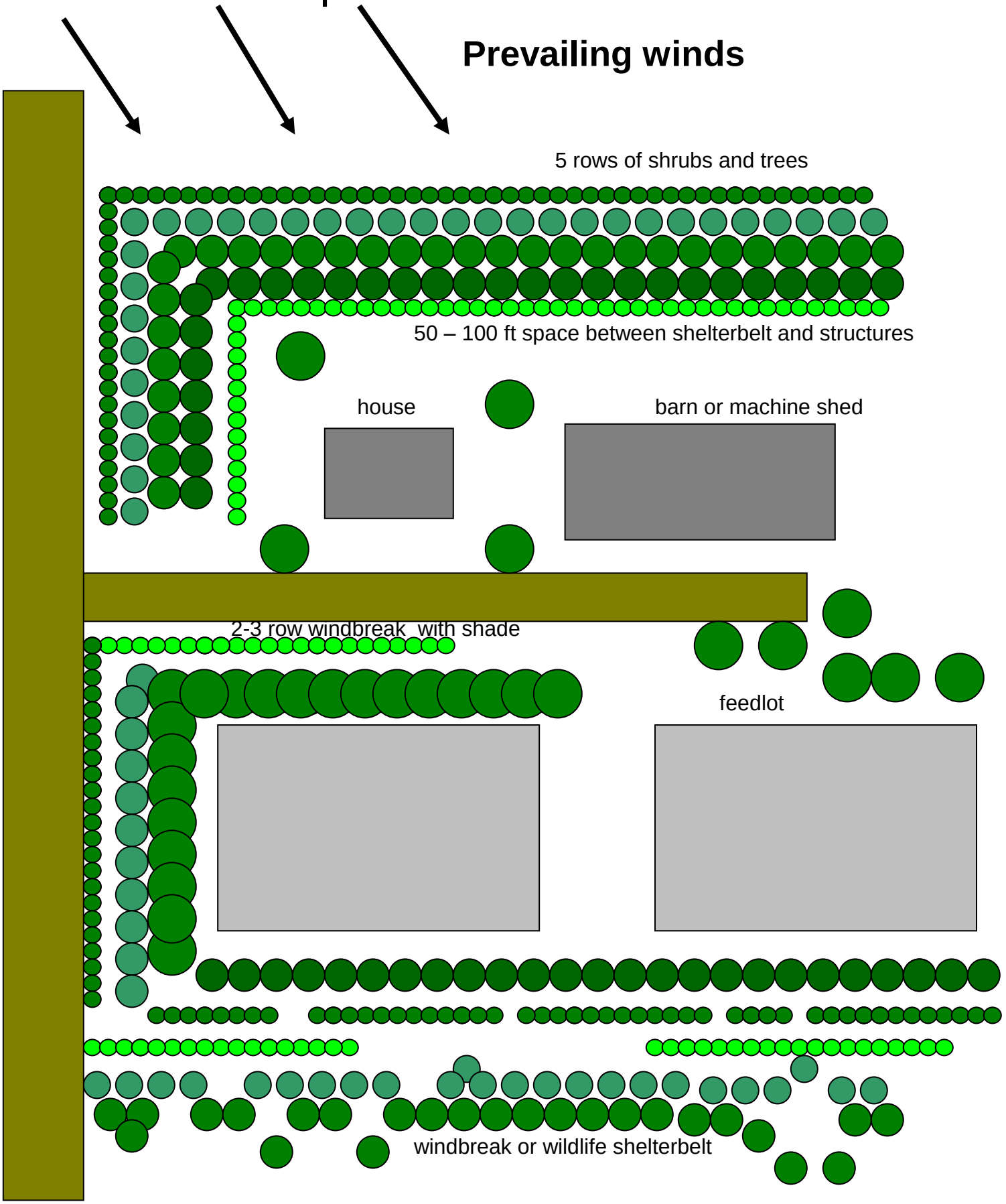

Con

ifer or needle trees that are adapted for windbreaks are very shade intolerant. As trees grow taller their upper branches will shade out and cause the loss of lower branches. Eventually they may become too tall for good windbreak effectiveness and also support more needle area than the available water can support. Conifers can have their upper 1/3 top removed to promote denser canopies and greater water-use efficiency. Spruces in particular are also very shallow rooted and may become unstable in high winds when they get too tall.




Lower branches that touch the ground are also prone to needle cast fungus diseases during wet spring weather. Pruning them up allows for better air circulation as well as cultivation/weed control around their bases.

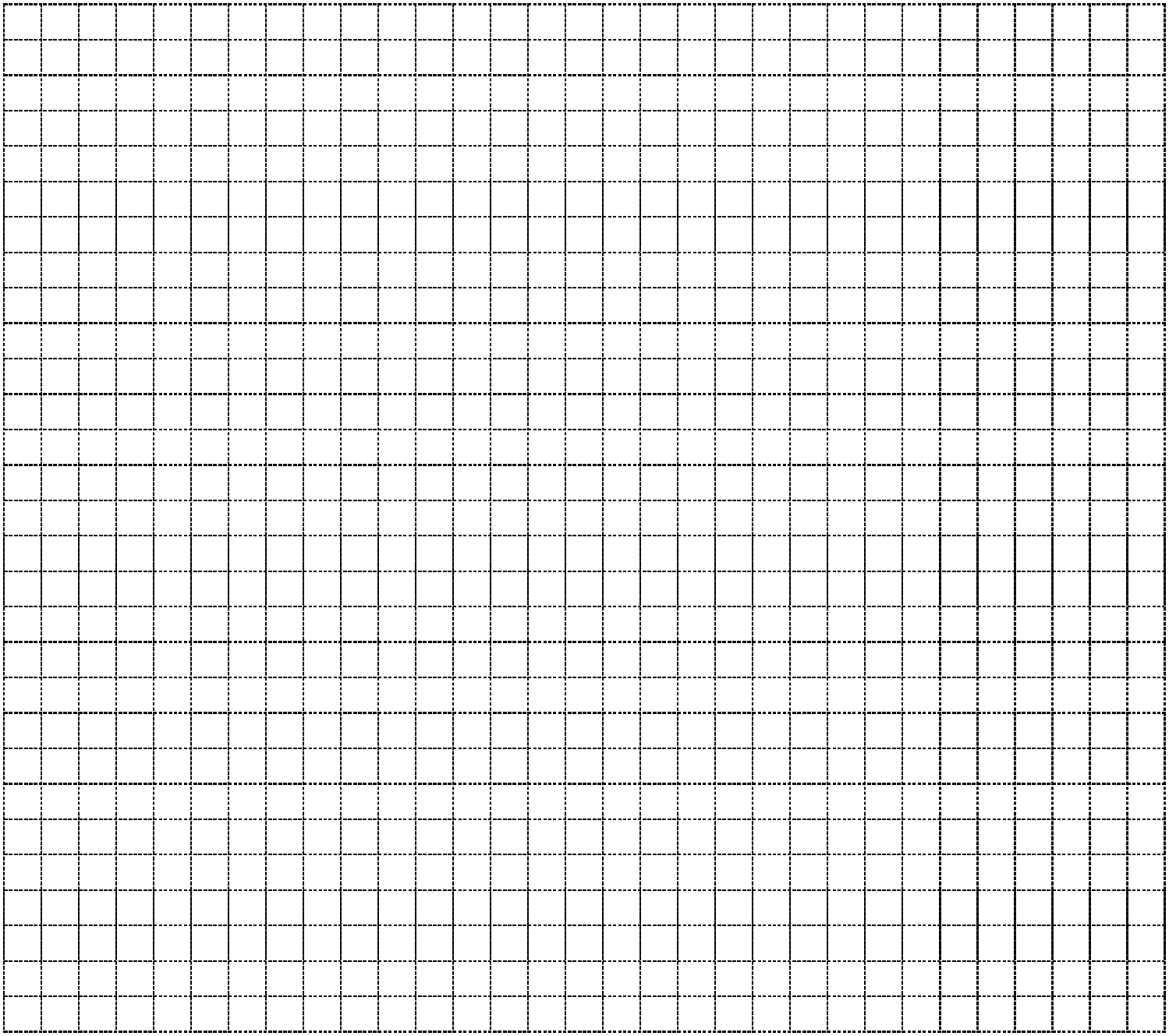
# The overall picture



# Planning a Windbreak Design

**Sketch in the site you want to protect, your access routes and the prevailing wind. Next determine the width of the space you have between the prevailing wind and your structures. Mark in 20 ft. wide lanes for each row of shrubs or trees you want to plant.**

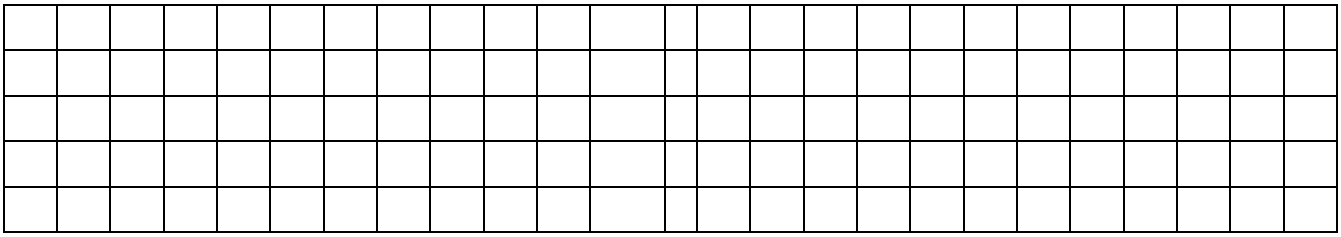
**Windbreak map:** **Scale (circle one): 1square = 10ft 20ft 40 ft**



# PROFILE OF DESIRED WINDBREAK

**Spacing: 1 square = feet**

**Height: 1 square = feet**



| WINDBREAK SPECIES | width | height | # needed |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**ZONE 1**
*Average Annual Minimum Temperature:* -50 degrees Fahrenheit or below
*Trees that grow in this zone's temperature extremes:*

**Central & Eastern U.S.**
None

**Western U.S.**
Black and white spruce (*Picea mariana, and Picea glauca)*

**ZONE 2**
*Average Annual Minimum Temperature:* -40 to -50 degrees Fahrenheit
*Trees that grow in this zone's temperature extremes:*

**Central & Eastern U.S.**
American Basswood, American Linden Tilia americana
American Elm Ulmus americana
American Hornbeam Carpinus caroliniana
Black Spruce Picia mariana
Boxelder Acer negundo
Bur Oak Quercus macrocarpa
Colorado Blue Spruce Picea Pungens
Common hackberry Celtis occidentalis
Eastern Arborvitae, Northern Whitecedar Thuja occidentalis
Eastern Cottonwood Populus deltoides
Eastern Redcedar Juniperus virginiana
European Larch Larix decidua
Jack Pine, Scrub Pine Pinus banksiana
Norway Spruce Picea abies
Paper Birch Betula papyrifera
Russion-Olive Elaeagnus angustifolia
Scotch Pine Pinus sylvestris
Thinleaf Alder, Mountain Alder Alnus tenuifolia
White Spruce Picea glauca

**Western U.S.**
Balsam Poplar *Populus balsamifera*
Blue Spruce, Colorado Blue Spruce *Picea pungens*
Bur Oak *Quercus macrocarpa*
Common Chokecherry *Prunus virginiana*
European White Birch *Betula pendula*
Hackberry *Celtis Occidentalis*
Limber Pine *Pinus flexilis*
Peachleaf Willow *Salix amygdaloides*
Paper Birch *Betula papyrifera*
Russion-Olive *Elaeagnus angustifolia*
Subalpine Fir *Abies lasiocarpa*
Thinleaf Alder, Mountain Alder *Alnus tenuifolia*
Whitebark Pine *Pinus albicaulis*
White Spruce, Blackhills Spruce *Picea glauca var albertiana*

**ZONE 3**
*Average Annual Minimum Temperature:* -30 to -40 degrees Fahrenheit
*Trees that grow in this zone's temperature extremes:*

**Central & Eastern U.S.**
American Basswood, American Linden Tilia americana
American Beech Fagus grandifolia
American Elm Ulmus americana

**Western U.S.**
American Basswood, American Linden Tilia americana
American Elm *Ulmus americana*
Amur Maple, Ginnala Maple *Acer ginnala*

American Hornbeam Carpinus caroliniana
American Mountainash Sorbus americana
American Plum Prunus americana
Balsam fir Abies balsamea
Bigtooth Aspen Populus grandidentata
Bitternut Hickory Carya cordiformis
Black Cherry Prusus serotina
Black Cottonwood Populus trichocarpa
Black Locust Robinia pseudoacacia
Black Maple Acer nigrum
Black Oak Quercus velutina
Black Spruce Picia mariana
Black Tupelo, Blackgum Nyssa sylvatica
Black Willow Salix nigra
Boxelder Acer negundo
Bur Oak Quercus macrocarpa
Butternut Juglans cinerea
Chokecherry Prunus virginiana
Cockspur Hawthorn Crataegus crusgalli
Colorado Blue Spruce Picea Pungens
Common hackberry Celtis occidentalis
Downy Hawthorn Crataegus mollis
Eastern Arborvitae, Northern Whitecedar Thuja occidentalis
Eastern Cottonwood Populus deltoides
virginiana
Eastern Redcedar Juniperus virginiana
Ginkgo Ginkgo biloba
Green Ash Fraxinus pennsylvanica
Honeylocust Gleditsia triacanthos
Horsechestnut Aesculus hippocastanum
Jack Pine, Scrub Pine Pinus banksiana
Kentucky Coffeetree Gymnocladus dioicus
Littleleaf Linden Tilia cordata
Lombardy Black Poplar Populus nigra var. italica
Norway Spruce Picea abies
Paper Birch Betula papyrifera
Plains Cottonwood Populus deltoides var. occidentalis
Ponderosa Pine Pinus ponderosa
Quaking Aspen Populus tremuloides
Russion-Olive Elaeagnus angustifolia
Balsam Poplar *Populus balsamifera*
Black Cottonwood *Populus trichocarpa*
Black Hawthorn *Crataegus douglasii*
Blue Spruce, Colorado Blue Spruce *Picea pungens*
Boxelder *Acer negundo*
Bur Oak *Quercus macrocarpa*
Common Chokecherry *Prunus virginiana*
Crabapple *Malus species*
Crack Willow *salix fragilis*
Downy Hawthron *Crataegus mollis*
Eastern Redcedar *Juniperus virginiana*
Engelmann Spruce *Picea engelmannii*
European Ash *Fraxinus excelsior*
European Mountainash *Sorbus aucuparia*
European White Birch *Betula pendula*
Gambel Oak *Quercus gambelii*
Ginkgo *Ginkgo biloba*
Green Ash *Fraxinus pennnsylvanica*
Hackberry *Celtis Occidentalis*
Honeylocust *Gleditsia triacanthos*
Horsechestnut *Aesculus hippocastanum*
Lanceleaf Cottonwood Populus X acuminata (hybrid of P. deltoides and P. angustifolia)
Limber Pine *Pinus flexilis*
Littleleaf Linden *Tilia cordata*
Lombardy Poplar *Populus nigra var. italica*
Narrowleaf Cottonwood *Populus angustifolia*
Pacific Willow, Yellow Willow *Salix lasiandra*
Paper Birch *Betula papyrifera*
Plains Cottonwood *Populus sargentii or Populus deltoids var. occidentalis*
Peachleaf Willow *Salix amygdaloides*
Quaking Aspen *Populus tremuloides*
Red Maple *Acer rubrum*
Rock Elm, Cork Elm *Ulmus thomasii*
Rocky Mountain Juniper *Juniperus scopulorum*
Rocky Mountain Maple *Acer glabrum*
Russion-Olive *Elaeagnus angustifolia*
Scouler Willow *Salix scouleriana*
Siberian Elm *Ulmus pumila*
Silver Maple *Acer saccharinum*
Subalpine Fir *Abies lasiocarpa*
Thinleaf Alder, Mountain Alder *Alnus tenuifolia*
Utah Juniper *Juniperus osteosperma*
Water Birch, Red Birch *Betula occidentalis*
Washington Hawthorn *Crataegus phaenopryum*
White Ash *Fraxinus americana*
Whitebark *Pine Pinus albicaulis*
White Fir *Abies concolor*
White Spruce, Blackhills Spruce *Picea glauca var albertiana*
laricina
Thinleaf Alder, Mountain Alder Alnus tenuifolia
White Ash Fraxinus americana
White Oak Quercus alba
White Poplar Populus alba
White Spruce Picea glauca

Scotch Pine Pinus sylvestris
Silver Maple Acer saccharinum
Yellow Buckeye Aesculus octandra
Yellowood Cladrastis lutea

# Commonly available windbreak species for Montana

| SPECIES | HEIGHT | WIDTH | GROWTH | HARDINESS | DROUGHT | SPACING |
|---|---|---|---|---|---|---|
| Woods Rose | 3-5 FT. | 1-3 FT. | fast | -40 | good | 2-3 FT. |
| Snowberry | 2-4 | 2-4 | medium | -40 | good | 2-3 |
| Golden Currant | 3-6 | 3-6 | medium | -40 | medium | 3-5 |
| Honeysuckle Blue | 4-6 | 4-6 | medium | -30 | good | 6-10 |
| Skunk Sumac | 3-8 | 4-10 | medium | -30 | medium | 5-10 |
| Willow-Sandbar | 5-10 | 5-10 | fast | -30 | poor | 4-10 |
| Nanking Cherry | 6-10 | 6-10 | medium | -40 | medium | 6-10 |
| Dogwood Red-osier | 7-10 | 10-15 | fast | -40 | poor | 3-5 |
| Lilac-common | 8-12 | 6-12 | medium | -40 | good | 3-10 |
| Lilac-late | 6-10 | 6-10 | medium | -40 | medium | 3-10 |
| Caragana | 6-14 | 6-12 | fast-medium | -40 | good | 4-10 |
| Buffaloberry | 6-14 | 8-14 | medium | -40 | medium | 10-15 |
| American Plum | 8-15 | 8-15 | medium | -30 | medium | 6-15 |
| Willow-purple | 8-20 | 8-20 | fast | -30 | poor | 6-15 |
| Manchurian apricot | 10-15 | 12-18 | medium | -30 | medium | 10 |
| Serviceberry | 10-20 | 10-15 | slow | -40 | medium | 6-10 |
| Hawthorn | 10-20 | 10-20 | medium | -40 | medium | 6-10 |
| Amur Maple | 10-20 | 15-20ft | medium | -40 | medium | 8-12 |
| Russian olive | 15-25 | 12-25 | fast | -40 | good | 10-20 |
| Siberian Crabapple | 15-25 | 15-25 | medium | -40 | medium | 8-20 |
| Chokecherry | 15-25 | 10-20 | medium | -40 | medium | 6-15 |
| Common Apple | 15-25 | 10-25ft | medium | -30 | medium | 10-20 |
| Bur oak | 20-70 | 35-60 | slow | -40 | medium-good | 10+ |
| Siberian Elm | 25-65 | 20-40 | fast-medium | -40 | medium-good | 10+ |
| Green ash | 25-65 | 30-40 | fast-medium | -40 | medium-good | 10+ |
| Honey locust | 30-40 | 30-40 | medium | -20 | medium | 10+ |
| Black locust | 30-50 | 30-40 | medium | -30 | good | 10+ |
| Boxelder | 30-60 | 30-60 | medium-fast | -40 | medium | 10+ |
| Black Cherry | 30-60 | 25-50 | slow | -30 | medium-poor | 10+ |
| Poplar hybrid | 40-60 | 20-35 | fast | -30 | medium | 10+ |
| Golden Willow | 40-65 | 40-60 | fast | -40 | poor | 10+ |
| Linden American | 50-70 | 30-45 | medium-fast | -40 | poor | 10+ |
| Cottonwood | 50-100 | 40-75 | fast | -40 | medium | 10-20 |
| Mugo pine | 3-20 | 5-30 | slow | -40 | medium | 8-12 |
| Juniper Rocky Mtn. | 20-40 | 12-20 | slow | -40 | good | 8-15 |
| Limber pine | 30-45 | 15-30 | slow | -40 | good | 8-20 |
| Scotch pine | 25-50 | 20-35 | medium | -30 | medium | 10-20 |
| Austrian pine | 30-65 | 20-30 | medium | -30 | medium | 10-20 |
| Spruce Blue | 30-65 | 15-25 | medium | -40 | medium | 6-20 |
| Spruce Black Hills | 30-60 | 15-25 | medium | -40 | medium | 6-10 |
| Douglas-fir | 40-70 | 20-30 | medium | -40 | medium-good | 10-20 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ponderosa pine | 40-70 | 20-30 | medium | -40 | medium-good | 10-20 |