
Oregon Agricultural College

Experiment Station

Umatilla Branch Experiment Station

*Windbreaks, Hedges, and Ornamentals
for Irrigated Sandy Soils
of Eastern Oregon*

BY

R. W. ALLEN



CORVALLIS, OREGON

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WINDBREAKS, HEDGES, AND ORNAMENTALS FOR IRRIGATED SANDY SOILS OF EASTERN OREGON

By R. W. ALLEN,

Superintendent of the Umatilla Branch Experiment Station.*

INTRODUCTION

The occurrence of periodical winds over Eastern Oregon renders necessary in certain districts protection of the soil and crops. As light soils predominate in the low altitudes, there is a great need for windbreaks in this region, especially along the Columbia river. Although not frequently severe, occasional winds erode the soil, making its development and manipulation uncertain and difficult. The loss of moisture by evaporation from unprotected land and plant tissues, is greater where there is no shelter than where protection is afforded. Without protection from prevailing winds, orchard trees are trained with difficulty, fruit and grain crops are injured, and damaging influences of minor consequence frequently occur.

A continuous need of shelter renders some permanent form of windbreak necessary for best and cheapest protection. Since permanent windbreaks should be more generally used than they are at present, a detailed discussion is given in this bulletin of the necessary steps in their care and development.

The use of shade trees, hedges, and other ornamental plants for farm yards, is also discussed, with suggestions for the growth and care of these protective agents. A limited number of native plants that deserve recommendation for ornamental use are briefly described.

Owing to the importance of knowing what plants are suitable for new districts, a number of trees and shrubs are being grown to determine their value for use about the farmstead. All plants in the experiment, which has been in progress five years, have received uniform cultural treatment and irrigation. Sufficient time has elapsed for the determination of adaptability and rapidity of growth of the plants under trial, but additional time will be required to determine the longevity of each.

WINDBREAKS FOR FIELD PROTECTION

Need and Desirability of Windbreaks. The value of windbreaks lies in their effectiveness in diminishing (a) soil erosion, (b) mechanical injury to soil and crops, and (c) evaporation from soil and plants.

*The Umatilla Branch Experiment Station is located on the Umatilla Irrigation Project near Hermiston, Oregon. It is supported and operated by the State of Oregon and the United States Government. The work is being directed by the Division of Horticulture of the Agricultural College and the Office of Western Irrigation Agriculture of the Department of Agriculture.

The soils of Eastern Oregon that are being reclaimed by means of irrigation, are mostly light in character. As a result of their light nature and low cohesive power, they are subject to erosion by wind or flowing water.

Wind action, by hindering development and cultivation, becomes an important factor in reclaiming land. These conditions, however, become less serious as the land is worked and improved.

By reference to Table I it can be seen that the average wind velocity for this district is very low as compared with Amarillo, Texas, and Belle Fourche, South Dakota. Readings were taken once a day. As severe winds at Hermiston are seldom of 24 hours duration, their maximum velocity, as shown below, is frequently modified by several hours of comparatively mild wind.

TABLE I. SHOWING COMPARATIVE WIND VELOCITY DURING THE GROWING SEASON AT STATIONS IN OREGON, TEXAS, AND SOUTH DAKOTA

Station	Miles per hour						Mean for period
	April	May	June	July	Aug.	Sept.	
<i>Umatilla Experiment Farm</i>							
Mean monthly velocity for three years	3.9	3.5	4.9	4.0	3.4	2.8	3.7
Maximum velocity, 1914	12.7	10.6	10.7	12.2	13.7	11.1	11.8
<i>Amarillo Experiment Farm</i>							
Mean monthly velocity for seven years	9.7	8.2	8.9	7.2	6.6	6.9	8.1
Maximum velocity, 1914	19.6	14.8	16.6	11.0	10.8	12.4	14.2
<i>Belle Fourche Experiment Farm</i>							
Mean monthly velocity for five years	8.6	9.3	7.8	6.7	6.3	6.3	7.5
Maximum velocity, 1913	16.5	12.4	18.9	14.4	9.0	13.8	14.1

Although the total mileage and maximum velocity of wind at the Texas and South Dakota stations is much greater than at Hermiston, crops are seldom injured by soil erosion. The soils are fairly heavy and not as easily disturbed.

When the influence of wind velocity overcomes the effects of gravity and cohesion of soil particles, blowing or soil erosion takes place. The amount and the rapidity of erosion depend upon the following factors: (1) degree of exposure; (2) severity and frequency of wind; (3) constancy of direction of the wind; (4) humidity or relative weight and drying effect of the air; (5) amount of moisture present in the soil; (6) size of soil particles; (7) slope of land; and (8) extent of protection afforded by crops and other protective agents.

Moving soils hinder irrigation by filling furrows, thus obstructing the flow of irrigation water and rendering necessary the refurrowing of the land.

One of the most harmful effects of soil erosion, and one that is frequently overlooked, results from the removal of fine particles from the soil. The finer portions, which result from weathering of rock particles, and from decay of vegetable matter growing upon the soil, are sifted out and carried away whenever movement occurs. This leaves behind the coarser and heavier particles that are of the least agricultural value. When blowing is allowed to continue, therefore, the condition of the soil cannot be improved, since the fine particles cannot be accumulated.

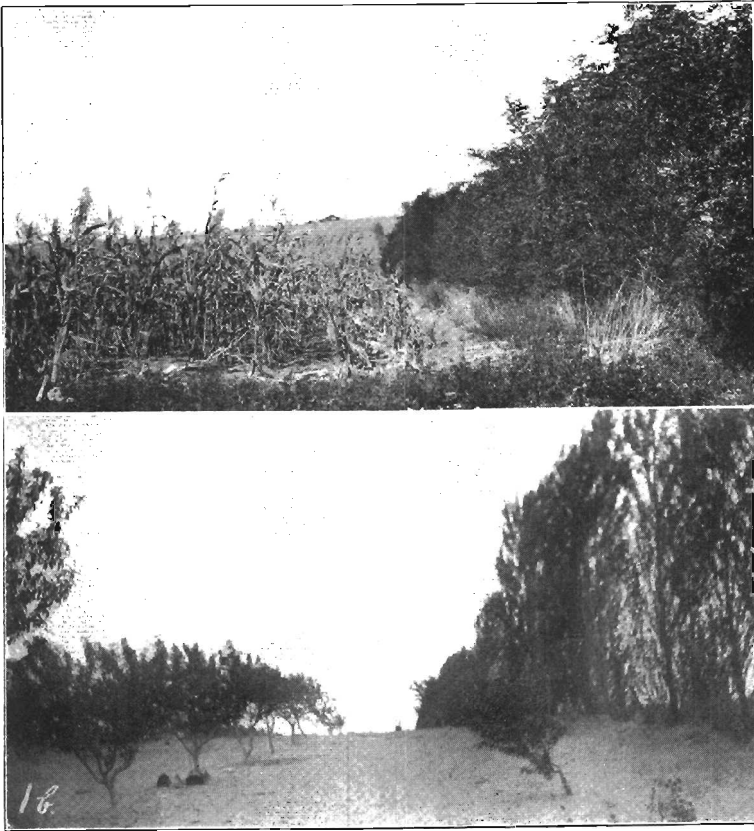


Figure 1. (a) Two outer rows of corn stunted by influence of windbreak, Umatilla Experiment Farm, September 15, 1913.
 (b) Stunted and irregular growth of peach trees caused by being too close to windbreak.

The protection afforded by trees as windbreaks is more effective than that of other forms of windbreaks owing to the greater height of the trees and the greater space between the rows. Such windbreaks diminish evaporation of moisture from soil and from crops. The benefit resulting from them depends upon the extent to which they decrease wind velocity. The rate at which moisture is carried away varies with rate of movement, temperature, and humidity of the air. Warm, dry air in motion takes up much more moisture than air which is quiet and cool. Evaporation of moisture from field crops and orchard trees is greater than from the soil. With an increase in wind velocity, the rate of loss increases faster from plants than from soils.

These conditions must be met in the successful establishment of crops.

From their durable nature and great value, hardy, rapid-growing trees furnish one of the most effective means of protecting land and crops. With the many beneficial influences of windbreaks, must be considered a few influences that are detrimental. Fortunately, however, the undesirable features of properly established windbreaks are of decidedly less consequence than the desirable ones. The disadvantages, in fact, can be largely overcome by careful management.

The extent of injury resulting from shading depends largely upon the power of crops to tolerate shade. It appears to be much more detrimental to corn than to alfalfa. Crop growth upon the strip of land in the immediate vicinity of a windbreak is strongly influenced by the trees that feed upon the soil. Within this area alfalfa generally succeeds better than do fruit trees or corn, provided sufficient moisture is supplied for both the trees and the supplementary crop. Diminished yields of crops in close proximity to windbreaks can be offset by utilizing as much as possible of the space for headlands and roads. Figure 1 shows the damaging effect of windbreaks upon field corn and peach trees in locations where shading has effected only a slight influence.

An accurate cash valuation cannot be affixed to windbreaks. This results from variation not only in size and length of life of the trees, but also in the value of crops and in the management of the adjacent land.

Nature and Uses of Windbreaks. The term windbreak generally indicates a closely planted row of trees, so located as to diminish the velocity of air currents passing over an adjacent area of land. Large and elaborate windbreaks consisting of a number of rows of trees are frequently termed shelter belts. Such windbreaks are usually developed by growing several kinds of trees that range in habit from low-spreading types on the windward to very tall trees on the leeward side. Rows of tall trees, being relatively permanent and far apart, are the most practical and effective means of diminishing the harmful effect of high wind velocity upon the success of field operations and crop production.

Windbreaks of secondary value are formed by various objects that retard wind velocity near the ground. Among the most common are those established by piling sage brush in windrows, by leaving strips of native vegetation standing or by strips of tall, hardy crops such as rye or corn. The most effective protection for land is formed by low vegetation such as grass, rye, or alfalfa. Its uniform distribution and close proximity to the surface of the soil diminishes the movement of air to a minimum. Neither of the low forms of windbreaks can be used successfully and economically under general farming conditions. They need to be close together and consequently interfere with systematic cultivation of the land. Windbreaks of this nature are valuable for temporary use in reclaiming new land.

As shelter of the most permanent and effective nature is afforded by properly developed windbreaks of trees, it is with this form only that the following discussion deals.

Various uses can be made of windbreaks. Among the most important are the protection to fields, buildings, stock corrals, and feeding lots. Other

uses, sometimes resorted to, are the protection of irrigation ditches and highways from drifting soils.

Range of Effectiveness. The extent and degree of the effectiveness of a windbreak depend upon its density, height, and location. Where air passes through, as often occurs in single rows of trees, its velocity is diminished, but not effectively checked. A dense growth, of equal height, protects a large area and is of much greater value. The distance over which an effective windbreak exerts a beneficial influence has, from several statements of others, been found to be approximately ten times as great as the height of the trees. Location should be influenced by height of the trees and direction of the wind from which the buildings or fields are to receive protection. Prevailing winds are from the southwest, a fact which renders planting necessary on the south and west of buildings and fields.

Location is a difficult problem in this region, as the course of prevailing winds is diagonal to farm boundaries. The land is rolling and irregular in character.

Best results appear to accrue from planting on the south and west lines of each 10- or 20-acre unit. Hot, drying, summer winds of infrequent occurrence from the northeast are not of sufficient consequence on irrigated land to justify the establishment of windbreaks.

Assuming that the beneficial influence of a windbreak extends over a distance ten times its height, as cited above, the distance between windbreaks on each farm unit will depend upon the height of the trees used and the slope of the land. Plans should be made accordingly in selecting trees and locating windbreaks.

Formation of Frost Pockets. Windbreaks of tall growing trees should not be located so as to interfere with air drainage. Such barriers to air movement become a strong factor in creating local frost areas. It is by hindering the movement of cold, heavy air from high to low elevations that such areas or pockets are formed. To avoid this, open spaces through windbreaks should be left in depressions and on the lower sides of partly inclosed fields. Air drainage is similar to the removal of surplus water from the surface of the land. The cold, heavy air should be allowed to escape in a similar manner from the lowest portions of the fields.

Plants to Use for Windbreaks. Since it is practically impossible to get a tree with all the requirements for an effective windbreak, the best shelter can be developed by combining several species.

Deciduous trees are desirable for establishing windbreaks on new land, as they grow much more rapidly than conifers. They are also much cheaper and more easily started than evergreens. Although a few damaging winds sometimes occur in the spring before they leaf out, their value for the entire season is not materially lessened by the temporary absence of leaves.

Poplars are frequently chosen in preference to black locust, since they come into leaf earlier and are less subject to injury from frost.

With proper care, rapid-growing trees become of considerable value in three to five years. Black locust and Lombardy poplar range from 15 to 25

feet high at five and six years of age and are quite effective as windbreaks. Mature locust trees attain 50 to 65 feet and Lombardy poplars from 75 to 90 feet in height.

Black locust and honey locust must not be confused, as the latter grows slowly and is not desirable for the purpose under discussion. Considering all the qualities and habits of trees in common use, the black locust is the most desirable deciduous tree for general planting on coarse soils. It grows rapidly and spreads considerably. Next in importance come the Lombardy and Carolina poplars, which are tall and slender. They differ in shape, but not sufficiently to affect materially the manner of planting. The Carolina poplar is conical, or pyramidal, when young, and when mature more spreading throughout than the Lombardy. It has an objectionable habit of shedding part of its foliage prematurely during some years. Figure 5-b.

Small, hardy plants are necessary for use on the windward side of large

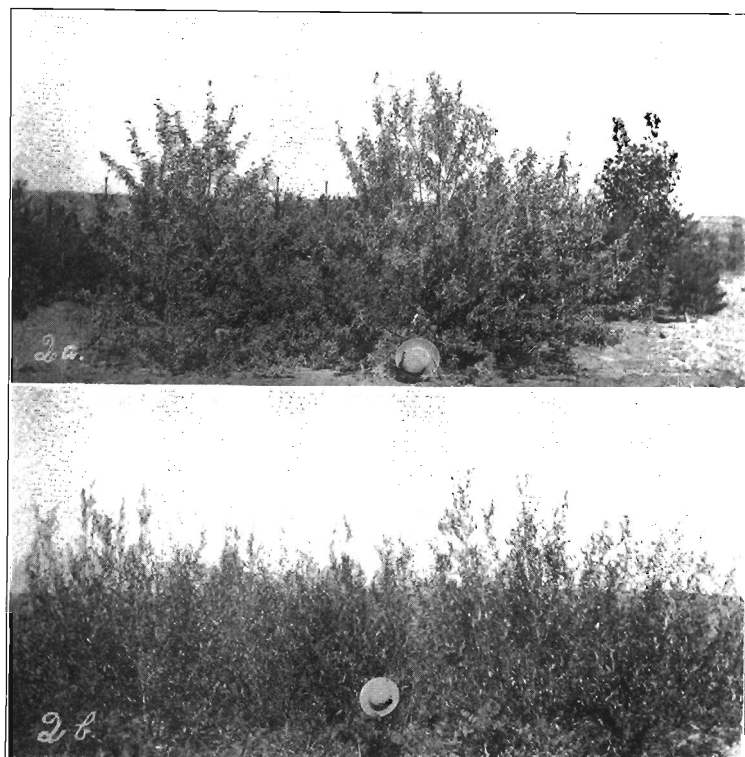


Figure 2. (a) Russian oleaster, *Elaeagnus angustifolia*, eight feet tall at three years of age. September 14, 1914.
(b) Russian golden willow, the same height and age.



Figure 3. (a) Western Yellow pine in the Branch Experient Farm nursery, seven feet tall at four years of age.
(b) Scotch pine, seven feet at four years of age. Photographed August 14, 1914.
(c) Red cedar, five feet tall at three years of age.

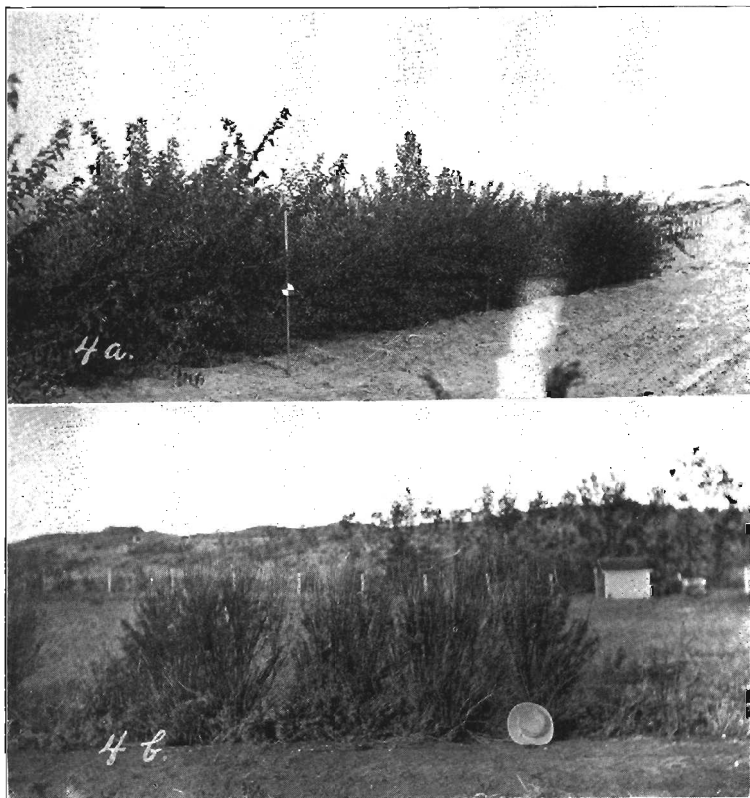


Figure 4 (a) Five-year-old mulberry windbreak, average height six feet. September 26, 1914.
 (b) Five-year-old plants of Russian artemisia, average height approximately four feet.
 This plant does not give satisfaction as a low windbreak.

windbreaks and for large hedges. For such purposes the Russian oleaster, *Elaeagnus angustifolia*, and Russian Golden willow, *Salix sp.*, are very desirable species. Figure 2. The oleaster is very hardy, drought-resistant and grows on alkaline soils. It is somewhat thorny and has an abundance of silvery foliage. While the tree is dormant, the silvery appearance of the young growth is very attractive.

The Golden willow is also quite hardy and is more spreading in habit of growth than the oleaster. Its foliage is dark green, and the bark on young wood is of a bright golden yellow color. The new growth is very attractive in winter, owing to its highly colored bark.

The value of evergreens for permanency has not been demonstrated, but from the success of two varieties of pine now under trial, it appears that they will thrive, and if so, they will doubtless live many years.

The Western Yellow pine, *Pinus ponderosa*, and Scotch pine, *P. sylvestria*, have been found to succeed quite well under irrigation in this locality. Figure 3, (a) and (b). Evergreens of this character are difficult to start, and grow much slower than the preferable deciduous species. On the other hand, they are capable of withstanding wide extremes of climate and when well established are more or less drought resistant. Their slow development is more than offset by their superior value. They afford as effective protection from cold winter winds as from drying winds in summer. An abundance of dark green foliage renders them very attractive at all seasons. The three most promising species are shown in Figure 4.

A row of pines planted to the leeward of a windbreak or shelter belt will be favored by the protection afforded it while young, and when mature will take the place of the shorter-lived deciduous trees.

Frequent occurrence of evergreens with their heavy foliage add greatly to the attractiveness of a neighborhood, especially in winter. This is particularly noticeable in arid regions where they are so infrequently found.

In selecting other than the desirable species of trees named above for use as windbreaks, considerable care should be exercised. Observations should first be made about the country to find what kinds succeed best, and from them the most desirable species should be chosen. If a tree not to be found in the locality is desired, a study should be made to determine its size and shape, its requirements of soil, and also what extremes of temperature it will stand.

Lack of attention to the value of trees often results in the planting of very undesirable kinds. The silver-leaf poplar, *Populus nivea*, on account of its habit of sending out numerous suckers from the roots, which spread over a large area, should not be planted on other than waste land, and in out-of-the-way places. The tree also has a disagreeable habit of shedding large quantities of "cotton" in the fall of the year. This cottony-appearing material, which is in the form of a small sail or float attached to the seed, enables it to be carried through the air and scattered for long distances. Russian mulberry, *Morus*, Figure 4, Box Elder (cut-leaf maple), *Acer negundo*, Hardy Catalpa, *Catalpa* sp., and Osage Orange, *Toxylon pomiferum*, are not thrifty on this soil and make insufficient growth to be of value.

Arrangement of Trees in the Windbreak. Careful study should be made of the height and vigor of growth, and general success of trees to be used in a windbreak to determine in what manner they should be placed to give the best results.

The manner of placing depends upon habit of growth of trees and the number of rows that are to be planted. Spreading trees set five feet apart in single rows make an effective shelter, as numerous strong branches closely fill the intervening spaces. Slender trees should always be planted in two or more parallel rows with the trees in one row opposite the spaces in the other. These two types, the spreading and the slender, should never be planted alternately in the same row. At some point in such a row one type usually

succeeds best, making the windbreak effective only to the full height of the spreading trees. Figure 5.

When but one row is used, planting should be quite close. Slender trees should not exceed four feet and spreading trees six feet apart in the row. Single rows of spreading trees will occupy more space if not pruned or trimmed up than two rows of slender ones. The two rows of slender trees, however, are more effective than the single row of the spreading trees. Figure 6 shows typical single-row windbreaks of black locust and of Lombardy poplar.

The second and additional rows of trees render windbreaks much more effective. For a tall and comparatively permanent shelter, a single row of spreading trees with two rows of tall ones to the leeward are very effective.

A very desirable large windbreak for this district can be established by planting two rows of Russian oleaster, *Elaeagnus angustifolia*, one or two rows of black locust, and two rows of Lombardy poplar. To place one or two rows

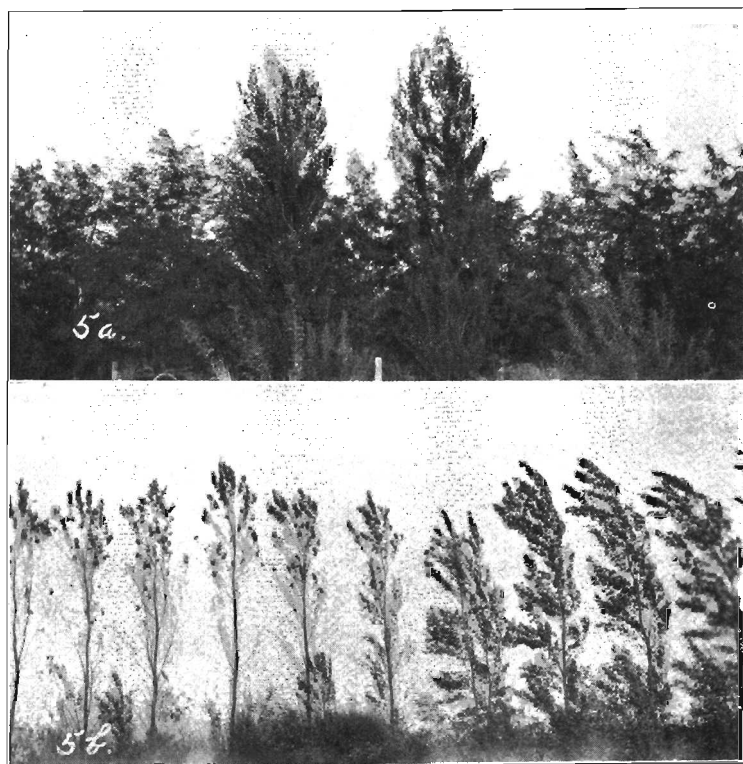


Figure 5. (a) Black locust and Lombardy poplar planted alternately in the row. The locusts are one year younger than the poplars.
(b) Carolina poplar, showing loss of leaves in midsummer.

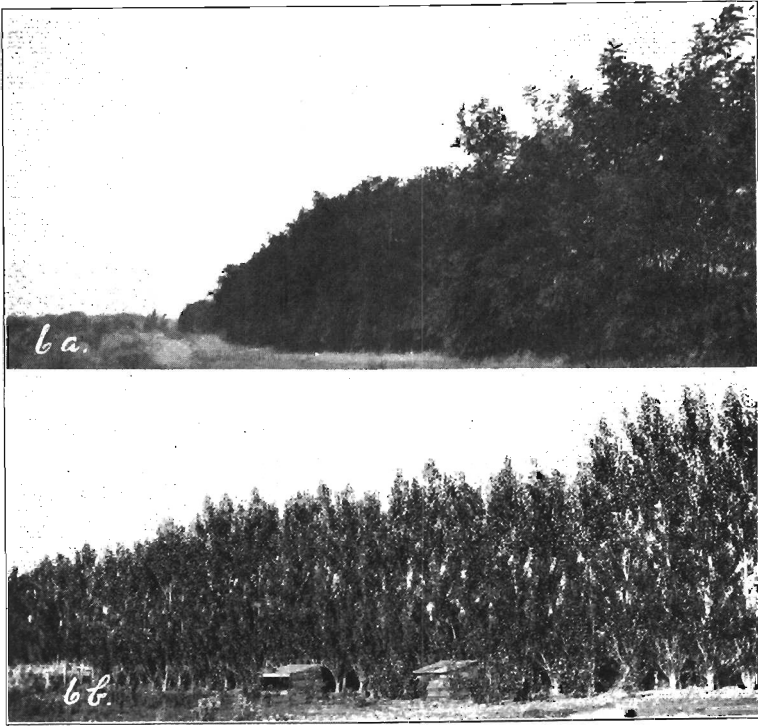


Figure 6. (a) A typical single-row windbreak of black locust.
(b) A single-row windbreak of Lombardy poplar.

of western yellow or Scotch pine to the leeward of the poplars serves to make the shelter more permanent and of greater value in winter.

Selection and Care of Stock. One-year-old seedlings of black locust from 12 to 14 inches tall, and one-year rooted cuttings of the poplars, are most desirable for general planting. They are listed by nurserymen as forest tree seedlings, and can usually be procured more cheaply, including cost of transportation, from nurseries in the Middle West than at Pacific Coast points. Such trees of the best quality should not cost more than \$5.00 a thousand, and they give better satisfaction than older and more expensive stock. Oleaster and pine seedlings are more expensive. Pines that have been transplanted once or twice are preferable and cost from \$15.00 to \$20.00 a thousand.

Planting should be done as early in the spring as water is available for irrigation, and not later than May 15. Fall and early winter planting is not desirable as the trees are liable to injury from drought and from the attack of rabbits.

Propagation. Deciduous trees can be successfully propagated at home. Black locust seed can be gathered in quantity from mature trees in the fall. The seed is quite hard and should be stratified during the winter or soaked in lukewarm water immediately before planting. When the seed is put in water, a portion of it will swell in a short time, and should be separated from the rest to prevent its being injured before the remainder begins to germinate. It should be planted the same as other seed of the same size. A growth of 12 to 24 inches can be expected the first year, and the trees will be ready for transplanting the following spring.

Poplars are readily propagated by cuttings. Pieces of young wood from 8 to 12 inches long should be taken in early spring and planted to their full length in damp soil. With proper care, they will grow two to four feet, and frequently much more, the first season. If the soil is quite moist, cuttings can be successfully planted in their permanent locations. Russian oleaster, *Elaeagnus angustifolia*, is easily propagated. Trees are usually grown from seed, although layering and cuttings are sometimes resorted to. Golden willow, *Salix sp.*, is propagated by cuttings. The propagation of pines and other conifers is much more difficult than of locust and poplars, and if attempted under ordinary farm conditions will be attended by heavy loss and frequent failure.

Planting. To plant small forest trees a deep furrow should first be made with a lister or turning plow. By digging sufficiently in the bottom of this furrow to accommodate the larger roots, the trees can be placed and dirt brought in from the sides of the furrow and compacted to hold them in place. The furrows can then be filled in with a cultivator or plow. Irrigation should be applied immediately, in order to settle and moisten the soil about the roots, and at frequent intervals thereafter in order to stimulate rapid growth. Careful cultivation and the application of manures will facilitate the development of the trees. No less care should be exercised in planting windbreak trees than in setting fruit trees, as thorough work is necessary for success. On account of their small size, forest trees can be handled quite rapidly. Conifers require care as they are difficult to start. They should be shaded during the first one or two summers. This can be accomplished by placing a shingle or wide plank to the southwest of each tree, or by covering with lattice.

Suckering. Locust and poplars alike sprout from the ground when root injuries occur. By placing roads and driveways near windbreaks the narrow strip of land adjacent to them, which is rendered comparatively unproductive by shading and the draft made upon its store of plant food, can be used to advantage. In this way less injury is inflicted upon the roots than if the soil is disturbed by cultivation, and less of sprouting will result. Distributing flumes and headlands should be located near the windbreaks whenever possible to diminish injury to the tree roots. Where sprouts occur, the roots, if not severed, should be cut off and the free ends taken out. The injured end of the remaining portion should be cut off smooth in order to facilitate healing.

Training. Locust trees require occasional pruning while young, to prevent the formation of crotches, which frequently cause splitting down of old trees.

They should also be pruned at infrequent intervals for several years to remove drooping branches that interfere with cultivation. Wood taken from locusts can be used for fuel and posts. The upright habit of the poplar seldom renders thinning necessary. The timber is inferior to that of the locust.

TREES AND PLANTS FOR HOME GROUNDS

Windbreaks, shade trees, hedges, and ornamental shrubs are valuable for planting about farm buildings. The chief purposes are for protection, shade, and ornament.

Protection of Buildings and Corrals. Windbreaks of this character should be established in the same manner as those in the field. Care must be taken to avoid obstructing the outlook from residences, and not to interfere with the convenience of access to buildings. Each farm has its peculiar problems, hence the most desirable location for windbreaks cannot be definitely stated. It is important to have trees close to the buildings on one side, but they should not be close on all sides on account of too heavy shading. It is very desirable to have a windbreak near the south or west of the buildings. When so placed the trees become of considerable value for shade in summer and thereby serve a double purpose.

Ornamental hedges can be grown from a number of hardy shrubs. The general preference is for privet, *Ligustrum*, of which the California, *L. ovalifolium*, or a European variety, *L. vulgare*, is usually selected. California privet grows more rapidly than the European variety. Figure 7.

Hedges for Ornament and for Screens. Attractive deciduous hedges can be



Figure 7. California privet, *Ligustrum ovalifolium*, on the right, and European, or common privet, *L. vulgare*, on the left. Note the comparative vigor of the two, which are the same age.

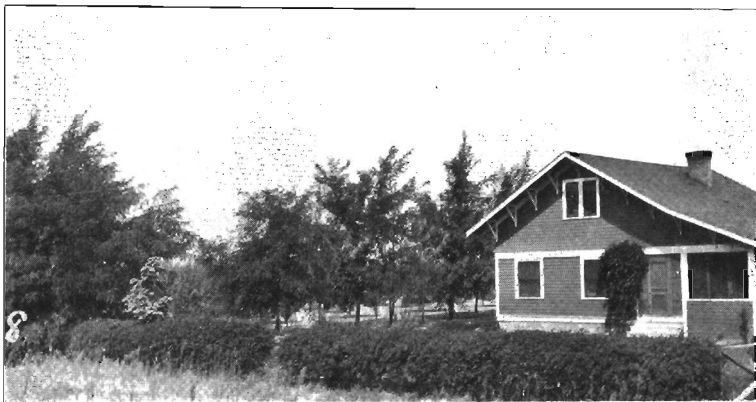


Figure 8. Windbreak, shade trees, and hedge of black locust, showing to what extent the trees in the hedge have been kept down by pruning.

grown from two common barberry plants, *Berberis vulgaris atropurpurea*, and *B. thunbergii*. The purple barberry, *B. vulgaris*, has purple foliage and the other dark green. *B. thunbergii* is frequently quite attractive in winter owing to a reddish color resulting from many small red berries which it produces. These hedges do not respond to frequent heavy pruning as well as the privets and are less desirable.

Privet makes a nice rough hedge when not pruned, but is usually trained into rectangular shape by frequent pruning. It is easily propagated by cuttings. Pruning should begin by cutting back severely the first or second year to cause the plants to spread out and send up a large number of shoots from near the ground.

Large hedges are valuable for screens. When so used, they form a part of the background for the yard and fill an important place in the general scheme of decoration about the buildings. Two very desirable plants for this purpose are Russian oleaster, *Elaeagnus angustifolia*, and Russian golden willow, *Salix sp.*, Figure 2.

Hedges of this nature cannot be made to serve the purpose of a fence. When they are placed near a corral, a substantial fence should be built at sufficient distance to prevent injury to the trees by stock. Large hedges require pruning, but usually at less frequent intervals than the smaller types.

All details of operations and care in planting, treated under the discussion of windbreaks, is applicable to hedges and ornamentals.

The most successful method of starting hedges is to use two parallel rows with the plants in the second row located opposite the spaces in the first. The distance between rows should be influenced by the width of hedge desired. Plants are usually placed 12 inches apart with the same distance between the rows.

Planting should be done in early spring on soil enriched by a liberal application of partly decayed stable manure.

Hedges of Locust and Other Large Trees. To confine trees of large growing habit to the area of a yard hedge is a difficult undertaking. Frequent attempts have been noted of black locust and Russian mulberry being restricted by frequent pruning to a small hedge. They make a fair hedge while young, but later become thin by loss of foliage and eventually die out in places. Such trees should not be planted for a hedge, as they are not suited to this purpose. Figure 8 shows a hedge of young black locust trees that is kept in nice shape by frequent pruning. It will become rough and less attractive, however, as the trees become older.

Ornamental Trees and Plants. Trees and shrubs suitable for use as orna-

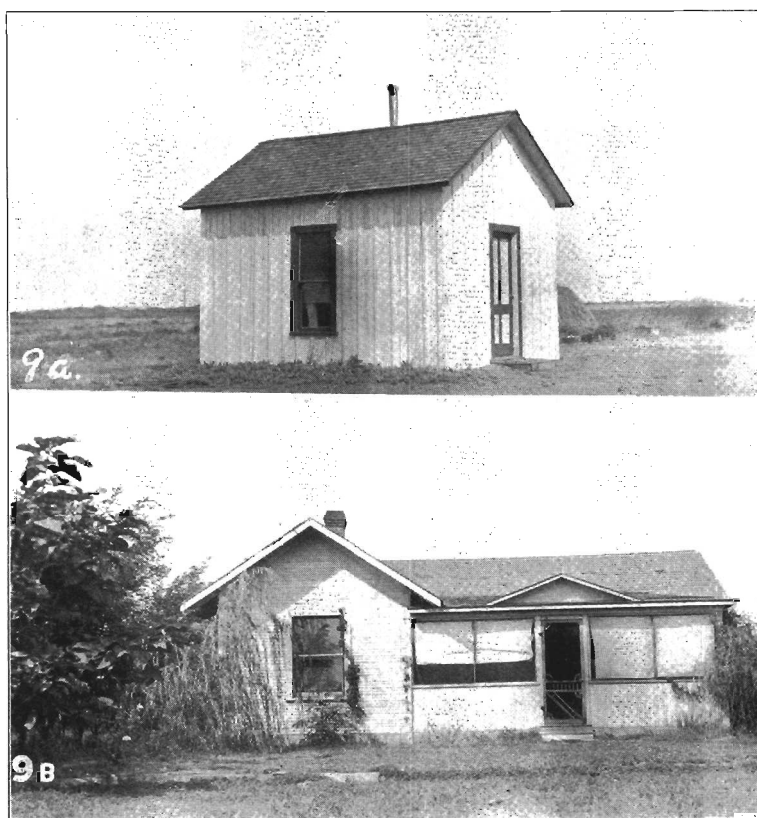


Figure 9. (a) Residence on irrigated homestead, occupied for four years without improvement of surroundings.
(b) Residence in the same vicinity and under identical soil conditions, showing the result of planting and caring for trees during four years.



Figure 10. (a) Perennial hollyhock, or Rose of Sharon, showing mass of foliage and showy blossoms.
 (b) Virginia creeper. This is a very hardy and attractive vine.
 (c) The honeysuckle is also a very desirable climber.
 (d) Boston ivy in its proper place.

mentals have been grown in limited number at the Branch Experiment Station. The success of others has been observed in well kept yards about Hermiston.

A few trees of ornamental character should be planted about the yard and buildings of every home, not only to furnish shade, but also to add to the comfort and attractiveness of the place. Figure 9. Landscape effects are best developed by the massing of trees and shrubs at the sides and rear of buildings and lawns. Plants disposed in this manner succeed better owing to protection and shade resulting from their being close together.

The following lists include the most hardy and attractive ornamental plants that thrive in this locality:

Trees. Soft or Silver Maple *Acer saccharinum*, American Elm *Ulmus americana*, Sycamore *Platanus occidentalis*, White Ash *Fraxinus americana*, Green Ash *F. lanceolata*, Russian Oleaster *Elaeagnus angustifolia*, and English Thorn *Crataegus*; Scotch Pine *Pinus sylvestria*, Western Yellow Pine *P. ponderosa*, Red Cedar *Juniperus virginiana*, and European Larch *Larix decidua*.

Shrubs. Spirea, Hydrangea, Lilac, *Syringa*, Snowball *Viburnum*, Perennial Hollyhock or Rose of Sharon *Hibiscus syriacus*, Figure 10, Tamarix, and numerous varieties of roses.

Vines. (Figure 10, b, c, d.) Virginia Creeper *Ampelopsis quinquefolia*, Clematis, Honeysuckle *Lonicera*, Wistaria, Boston Ivy *Ampelopsis tricuspidata*, Hop Vinc *Humulus lupulus*, Gourds *Cucurbita*.

Perennial Flowering Plants. Golden Glow *Rudbeckia lainiata*, Hibiscus, Iris, Narcissus, Crocus, Violet *Viola*, and others of hardy nature.

Annuals. Carnations *Dianthus*, Cosmos, Asters, Nasturtium, Sweet Peas *Lathyrus odoratus*, Hollyhock *Althaea rosea*, and other well known species.

A large number of common ornamental plants can be grown successfully. Those that succeed with least attention are preferable for farm grounds. Tender sorts should be avoided, as winter protection is laborious and frequent losses cause discouragement. Ornamentals for the farm should be selected largely from permanent plants. When pruned and fertilized in winter, they require little attention during the busy season. The rush of work on a farm does not allow sufficient time for the proper care of annuals.

Native Trees and Plants of Ornamental Value. A number of small trees and shrubs that are found along the Umatilla river and its tributaries are desirable for ornamental use. The most common of these are Clematis *ligusticifolia* (Piper), Choke cherry *Cerasus demissa*; a red flowering currant *Ribes sanguineum*; a yellow flowering currant, *R. aureum*; Sumach *Rhus glabra*; Elder *Sambucus glauca*, and Mock orange *Philadelphus lewisii*.

Figure 11-a shows a characteristic growth of clematis displaying a mass of silky white akenes, or tails to the seed, which hang until heavy frosts occur.

The choke cherry is usually a small tree with an abundance of glossy dark green foliage. Its long racemes of white blossoms appear in early spring.

The red and yellow flowering currants blossom very early, are quite showy and attractive.

Sumach is a very attractive shrub or tree, reaching a height 10 to 14 feet,



Figure 11. (a) Wild clematis, climbing over a growth of willows. Its silky white appearance is due to the long and much-branched appendages borne by the seed.
 (b) Wild sumach, showing its characteristic habit of growth.

Figure 11-b. Its foliage is dark green until autumn, when it turns to a bright red and is very showy.

The elder, which is quite common, produces large cymes of white flowers in midsummer and matures its fruit in the fall. The fruit is edible.

Mock orange is a medium-sized shrub, irregular in shape. It produces an abundance of fragrant white flowers in early spring.

RESULTS OF EXPERIMENTS WITH WINDBREAKS AND ORNAMENTAL TREES

A number of plants varying in nature from forest trees to ornamental shrubs have been planted on the Experiment Farm to observe their growth and to learn the value of each for windbreak, hedge, and ornamental use. The common and the botanical name, date of planting, and success of each plant included in the experiment prior to 1913, are shown in Table II.

Final notes for this bulletin were taken August 31, 1914.

TABLE II. DECIDUOUS PLANTS

Common name	Botanical name	Year planted	Remarks
Artemisia or wormwood.....	<i>Artemisia</i>	1910	Not desirable. Growth slow and uneven. Fig. 4 b.
Ash, green.....	<i>Fraxinus lanceolata</i>	1910	More rapid growth than white ash. Ornamental, hardy.
Ash, white.....	<i>Fraxinus americana</i>	1910	Slow growth. Pretty foliage, ornamental, hardy.
Barberry, Japanese.....	<i>Berberis thunbergii</i>	1911	Desirable for ornamental use. Thrives in well kept lawns.
Barberry, common.....	<i>Berberis vulgaris</i>	1911	Desirable for ornamental use. Thrives in well kept lawns.
Basswood of linden (American).	<i>Tilia americana</i>	1910	Not well adapted to locality. Did not succeed.
Basswood or linden (German).	<i>Tilia platyphyllo</i>	1911	Not well adapted to locality. Did not succeed.
Birch, paper.....	<i>Betula papyrifera</i>	1910	Did not succeed.
Birch, white.....	<i>Betula alba</i>	1910	Not adapted to exposed location. Desirable for ornamental use in lawns, etc.
Birch, yellow.....	<i>Betula lutea</i>	1911	Did not succeed.
Catalpa, hardy.....	<i>Catalpa, sp.</i>	1910	Growth slow and irregular. Ornamental in protected places. Not desirable for windbreaks.
Cherry, black.....	<i>Prunus serotina</i>	1910	Slow growth. Might be used in landscape massing.
Chestnut, American sweet.	<i>Castanea americana</i>	1910	Growth very slow. Ornamental.
Coffee tree, Kentucky.....	<i>Gymnocladus canadensis</i>	1910	Growth very slow. Ornamental.
Elm, American.....	<i>Ulmus americana</i>	1911	Fair growth. Ornamental.
Elm, cork.....	<i>Ulmus racemosa</i>	1911	Similar to American Elm. Not as desirable.
Empress tree.....	<i>Paulownia imperialis</i>	1912	Not suitable. Growth slow. Freezes down.
Hackberry.....	<i>Celtis occidentalis</i>	1910	Growth very slow.
Hickory, shagbark.....	<i>Hicoria ovata</i>	1910	Did not succeed.
Hickory, pignut.....	<i>Hicoria glabra</i>	1910	Did not succeed.
Hydrangea.....	<i>Hydrangea penticulata</i>	1912	Fairly hardy shrub. Desirable for ornamental planting.
Lilac.....	<i>Syringa vulgaris</i>	1911	Desirable ornamental. Very hardy.
Locust.....	<i>Robinia pseudacacia</i>	1910	Rapid growing tree. Most effective single row windbreak. Desirable for shade.
Maple, cut leaf (Box Elder).	<i>Acer negundo</i>	1912	Fair growth. Might be used to limited extent as an ornamental.
Maple, Norway.....	<i>Acer platanoides</i>	1911	Growth very slow.
Maple, red.....	<i>Acer rubrum</i>	1911	Fair growth. Ornamental.
Maple, silver.....	<i>Acer saccharinum</i>	1910	Desirable shade and avenue tree. Wood brittle and branches sometimes break during severe winds.
Maple, sugar.....	<i>Acer saccharum</i>	1910	Growth slow. Ornamental.
Mock orange.....	<i>Philadelphus</i>	1912	Desirable ornamental. Four to ten feet tall.

TABLE II—Continued

Common name	Botanical name	Year planted	Remarks
Mulberry, Russian	<i>Morus</i>	1910	Desirable for medium height windbreak and for shade in damp locations.
Oak, burr.....	<i>Quercus macrocarpa</i>	1910	Slow growth. Hard to start. Ornamental.
Oak, red.....	<i>Quercus rubra</i>	1910	Not well adapted. Growth very slow.
Oak, Scarlet.....	<i>Quercus coccinea</i>	1910	Did not succeed.
Oak, white.....	<i>Quercus alba</i>	1910	Best species of oak. Difficult to start but makes a fair growth when once established. Ornamental.
Oak, yellow bark.....	<i>Quercus velutina</i>	1910	Did not succeed.
Oleaster, Russian.....	<i>Elaeagnus angustifolia</i>	1911	Desirable for large hedge, low windbreak, or windward side of shelter belt. Very hardy.
Oleaster, Russian.....	<i>Elaeagnus longipes</i>	1912	Adapted to use as ornamental or for low hedges.
Osage orange.....	<i>Toxylon pomiferum</i>	1910	Not desirable on account of slow growth and injury by frost.
Pea Tree, Siberian.....	<i>Caragana arborescens</i>	1912	Growth fair. Desirable ornamental. Mass of yellow blossoms in early spring. Quite attractive.
Poplar, Carolina.....	<i>Populus carolinensis</i>	1910	Rapid growing trees. Conical in shape while young. Frequently loses part of foliage in summer. Not suitable for single row windbreak.
Poplar, Norway.....	<i>Populus</i>	1910	Very similar to Carolina Poplar.
Privet.....	<i>Ligustrum ibota</i>	1912	Quite spreading in habit. Very hardy.
Privet, California.....	<i>Ligustrum ovalifolium</i>	1910	One of the most desirable plants for small hedges.
Privet, common or European.....	<i>Ligustrum vulgare</i>	1910	Slower growing than ovalifolium. More spreading in habit, foliage smaller and darker in color.
Scotch Broom.....	<i>Genista scoparia</i>	1912	Desirable for limited use as an ornamental.
Snowberry.....	<i>Symphoricarpus racemosus</i>	1912	Fairly hardy shrub. Produces white berries which hang on greater part of the winter.
Spirea.....	<i>Spirea prunifolia</i>	1912	Very desirable ornamental. Two to five feet tall. Blossoms profusely in early spring.
Sweet Gum.....	<i>Liquidamber styraciflua</i>	1912	Growth fair. Subject to frost injury. Not desirable.
Sycamore.....	<i>Platanus occidentalis</i>	1910	Fair growth. Ornamental. Fair for windbreaks.
Tamarisk.....	<i>Tamarix chinensis</i>	1912	Hardy shrub. Ornamental in foliage and blossom.
Tamarisk.....	<i>Tamarix germanica</i>	1912	Hardy shrub. Ornamental in foliage and blossom.
Tamarisk.....	<i>Tamarix hispida</i>	1912	Hardy shrub. Ornamental in foliage and blossom.
Tulip Poplar.....	<i>Liriodendron tulipifera</i>	1910	Slow growth. Ornamental.
Walnut, black.....	<i>Juglans nigra</i>	1910	Growth very slow. Ornamental.
Willow, diamond.....	<i>Salix sp.</i>	1910	Suitable for large hedge or low windbreak.
Willow, golden.....	<i>Salix sp.</i>	1910	Suitable for low hedge. Grows more rapidly than Diamond Willow.

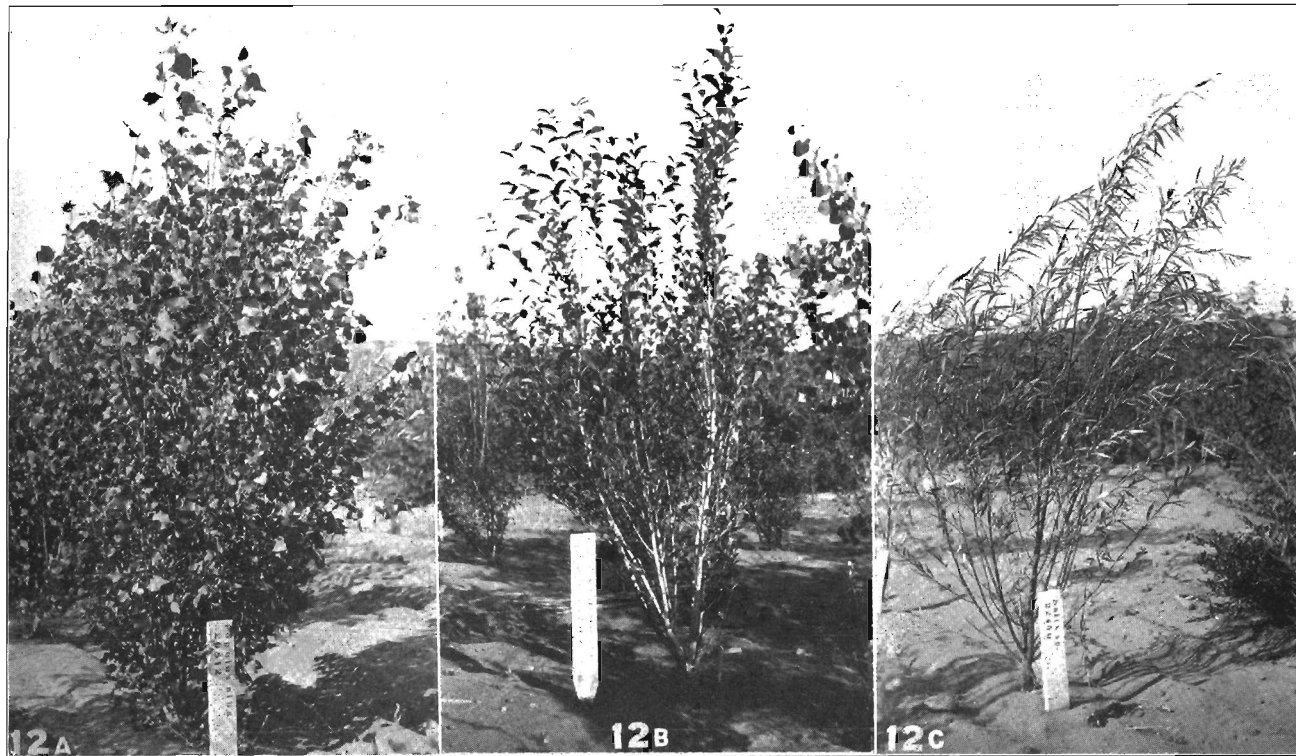


Figure 12. (a) A poplar, promising for use in windbreaks, that was introduced from Crimea, Russia, by the United States Department of Agriculture. Has made a growth of eight feet in two years.
 (b) A very attractive poplar, also promising for use in windbreaks, introduced by the Government from Taidjatsoa, China. At two years of age it measures seven feet in height.
 (c) An upright willow introduced from Pantingfu, China. It has made a growth of seven feet in two years and is promising for use in large windbreaks.

TABLE III. CONIFERS

Common name	Botanical name	Year planted	Remarks
Cedar, red.....	<i>Juniperus virginiana</i>	1912	Very desirable ornamental varying from ten to twenty feet in height. Fig. 3 c.
Cedar, Rocky Mountain Silver.....		1911	Very desirable for hedge or for ornamental use. Hardy although slow to start.
Fir, Douglas.....	<i>Pseudotsuga tazifolia</i>	1911	Growth very slow. Might succeed in well kept lawn.
Fir, white.....	<i>Abies concolor</i>	1911	Not desirable.
Larch, European.....	<i>Larix decidua</i>	1911	Desirable ornamental. Requires careful attention in starting.
Pine, Austrian.....	<i>Pinus austriaca</i>	1911	Deciduous. Not adapted to conditions. Growth very slow. Loss heavy.
Pine, red.....	<i>Pinus resinosa</i>	1911	Not desirable.
Pine, Scotch.....	<i>Pinus sylvestria</i>	1911	One of the best evergreens. Suitable for windbreaks or ornamental use. Vigor and growth about the same as Western yellow pine.
Pine, Western yellow.....	<i>Pinus ponderosa</i>	1911	One of the best evergreens. Suitable for windbreaks or ornamental purposes.
Pine, white.....	<i>Pinus strobus</i>	1911	Not desirable.
Spruce, Colorado blue.....	<i>Picea pungens</i>	1911	Difficult to start. Growth very slow.
Spruce, Norway.....	<i>Picea excelsa</i>	1911	Growth very slow. Suitable only for well attended lawns.

A number of species of poplar and willow, introduced by the Office of Foreign Seed and Plant Introduction, that were planted in 1913, are very promising for windbreak purposes. Figure 12 shows the most promising of these. A pretty Caragana (S. P. I. No. 21967), known as *C. chamlaque*, is promising for ornamental use and for large hedges. Two elms, *Ulmus* sp., (S. P. I. No. 34063), and *Ulmus pumila* (S. P. I. No. 22975), received in the same lot, are very promising for use in shelter belts, in avenue planting, and as ornamentals.

The mild winter of 1913 and 1914 prevented a demonstration of the ability of this stock to endure low temperature; but much of it was brought from countries having severe winters.

The stock in this experiment has been growing long enough to show what species are best adapted to this soil and climate and to indicate for what purpose the individual varieties are best suited.

The above determinations are generally applicable to all the irrigated lands at low elevations in the Columbia river valley, as the soil upon which they have been made is a coarse sand, low in fertility and waterholding capacity, and located in an exposed place. Under similar climatic conditions it is reasonable to suppose that species found to thrive here would succeed on a congenial soil, and that a number of those found undesirable here might also be desirable. The scope of this experiment, therefore, should be much greater than that of the irrigated sandy soils adjacent to the Columbia river and its tributaries in the semi-arid climate of eastern Oregon and Washington.