Shelter Belts for Montana

By

E. E. Isaac, Extension Forester
INTRODUCTION

Trees and shrubs are essential to the building of permanent homes. They increase the loan and sale value of property and make living conditions more pleasant. A few rows of trees well placed will give protection to building and livestock from the chilling winds of winter, and to fruit and vegetable gardens from the drying winds of summer.

The early work in establishing shelter belts in Montana was largely in cooperation with the Northern Great Plains Field Station, Mandan, N. D. Information gathered from this demonstration work will be helpful to those who contemplate planting trees in the future. The interest that has been built up in planting trees, establishing fruit gardens, and improving the farmstead will be instrumental in placing Montana's rural development on a more permanent basis.

In furtherance of this work a state nursery known as: The Forest Nursery of the University of Montana has been established for the purpose of producing trees to be distributed to the people of the state at low cost. This nursery was established under the Clark-McNary Act, passed by Congress in June 1924. Section 4 of this Act reads as follows: "That the Secretary of Agriculture is hereby authorized and directed to cooperate with the various states in the procurement, production, and distribution of forest trees, seeds and plants for the purpose of establishing wind breaks, shelter belts, and wood lots upon denuded or non-forested lands within such cooperating states, under such conditions and requirements as he may prescribe, to the end that forest tree seeds or plants so procured, produced, or distributed shall be used effectively for planting denuded or non-forested lands in the cooperating states and growing timber thereon."

Planting stock produced by the Forest Nursery of Montana is not to be used for ornamental purposes.

The School of Forestry of Montana State University at Missoula was chosen as the cooperating agency for the production of tree stocks, and the extension service of Montana State college at Bozeman was named as the cooperating agency for distribution of the trees.

Any person owning a farm in Montana, either dry land or irrigated, may file an application for trees for a wind break, shelter belt, or wood lot planting for that farm. Application for trees should be made through the county agent's office of the county in which the farm is located. Farmers living in counties that do not maintain a county agent's office may apply for trees by writing to the Extension Forester's office, Bozeman. Blank forms are provided for making application for trees, and these can be obtained either from the county agent's office or from the Extension Forester's office at Bozeman.
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Location and Size of Shelter Belt

Shelter for Buildings and Yards—Protection to buildings and yards can be provided by planting a belt of trees 100 to 200 feet in width on the north and west sides. The rows of trees should extend well past the area to be protected. There are, however, some localities in the state where hills and canyons influence local conditions to such an extent that protection is needed from directions other than north and west.

If a belt of trees less than 100 feet in width is planted, the inside edge should be at least 100 feet from the buildings to be protected in order to guard against the inconvenience of drifting snow. This distance may be reduced to a minimum of 50 feet if a 30 to 50-foot snow trap is added to the planting. No difficulty is likely to occur from drifting snow if the strip of trees is more than 150 feet in width. Figure 1 illustrates the location of a shelter belt and the arrangement of tree species for winter protection to buildings and yards. This arrangement also includes space for fruit and vegetables. The garden area is protected from the south as well as the north and west.

Shelter for Orchards and Gardens—Orchards and gardens need protection against drying winds of spring and summer, but winter protection is also important for fruit trees. Many of the farmsteads are located so that ample area for fruit and vegetables can be included within the main shelter belt. If such an arrangement is not possible, then almost any plot of ground where the soil is fertile may be improved by planting a few rows of trees around the area. Caragana is best for planting the outside row on all four sides. There should be one or two additional rows of such kinds as box elder, Russian Olive, or green ash on the south and west to provide height. A row of evergreens planted on the inside on all four sides will make a valuable addition for density to such a planting. Fig. 2 illustrates the arrangement of tree species for orchard and garden protection.
Fig. 1—Showing arrangement of tree species for protection of buildings and garden.
Preparation of Ground

Moisture is a limiting factor in the growth of trees in Montana under dry land farming conditions. Trees have a fair chance to succeed only when planted in moist soil which is free from weeds and sod. Experiments conducted in the past point to the fact that thorough preparation of the land by summerfallowing the year preceding planting is essential to secure good stands. Land that has just been broken from native sod may require two years of cultivation to put it in suitable condition for planting.

The following procedure in preparing the land has been found practical: First, plow the land before the middle of May to a depth of 6 to 8 inches. As soon as the plowing is completed, go over the ground twice with a harrow to firm the soil. Second, cultivate the land as often as is necessary during the summer to keep it free from weeds and grass and also to keep the surface from crusting after heavy rainfall. A duckfoot type of cultivator is preferable to a disk for working the ground during the summer. Leave the soil in a rough or ridged condition for winter. Third, do not plow the ground again the spring that the trees are to be planted as such an operation results in loss of moisture, and a well settled soil is best for planting trees.

Preparation of Irrigated Sites—It is not necessary to summerfallow the land for trees if an abundance of water is available for irrigation unless the ground has just been broken from sod. Working freshly broken sod one year in advance of planting trees will reduce hand work after the trees have been planted.

Old ground should be plowed to a depth of 6 to 8 inches in the fall and left rough for winter to prevent blowing. The soil should be worked down as early as possible in the spring by diskimg or harrowing before planting.
Receiving and Caring for Trees Before Planting

Trees are likely to dry out and be seriously injured if the shipment is not removed from the station soon after it arrives. Exposure to the sun and drying winds during removal from the station is detrimental to them. This can be guarded against by covering with wet burlap or canvas. Another good practice to follow is to soak the roots in packing material thoroughly by submerging them in a tub of water a few minutes as soon as the planting place is reached. If the weather and soil condition permit, plant the trees without delay. If it is not possible to plant right away, they may be kept in good condition for several days by heeling them in.

To heel-in, dig a trench in a shaded, sheltered place with one side sloping and deep enough to bury roots and part of the top. Open the bundles and remove all packing material before heeling-in. Place the roots in the trench and the tops against the sloping side. Cover the roots and part of the top with moist soil, packing it firmly against them. A few buckets of water poured over the trees after they are in place will help settle the soil about the roots. Trees will remain dormant longer if a sheltered place is selected where they will not be exposed to the sun. A cave or root cellar is adaptable for storing nursery stock for a short time, providing the packing material is kept moist. Storing in a cave or heeling-in is only a temporary means of taking care of trees as they must be planted without delay when the buds are showing signs of bursting.

Methods of Planting

The specific method used in planting does not matter so long as the following principles are observed carefully:

1. Straight rows and accurate spacing will facilitate cultivation.
2. Cramping and twisting of the root system is detrimental to best development of trees. The holes should be deep enough and large enough to permit spreading the roots out in a natural position.
3. Deciduous trees should be set one to two inches deeper than they were in the nursery row.
4. Small evergreens should be set approximately the same depth at which they had previously been growing.
5. Pack the soil firmly about the roots by tamping each successive layer of soil during the process of filling the hole so as to exclude all air pockets.
6. When the hole is filled within about an inch of the top, pour in a gallon of water. After the water has soaked away, finish filling the hole to ground level with loose dirt. Never hill up about the trees as that directs moisture from rainfall away from them. It is best to keep the top two inches of soil about the trees loose either by cultivation or hoeing.
7. Broad-leaf trees can be kept in good condition during the planting operation by carrying them in a pail of water or by keeping them wrapped in wet packing material and burlap. This is to prevent the roots from drying.
by exposure to the air. Exposing the roots to the sun and strong drying winds for only a short time usually will kill young trees.

8. Small evergreens should be carried with the roots plunged into a bucket of clay, mud paste during the process of planting. Exposing the roots of evergreens to the air for only a few seconds is detrimental to the trees.

9. Planting on a cloudy or rainy day is preferable to planting on days when a strong wind is blowing.

Correct and incorrect planting practices are shown in Figs. 3, 4, and 5.

Fig. 3—Showing proper depth of planting. The holes should be made large enough to permit spreading roots out naturally. Pack soil firmly about the roots during process of planting so as to exclude all air pockets.

Fig. 4—Showing tree planted too shallow. It is better to plant deciduous trees one to two inches deeper than they were in the nursery row.

Fig. 5—Showing tree with roots twisted and cramped. This hinders normal development.
Transplanting Native Evergreens

Small specimens, 6 to 12 inches high, will stand the shock of moving better than larger trees. A bucket of mud paste made from clay soil should be carried along and the roots of the small trees plunged into it as soon as they are lifted from their native sites. Better root systems can be secured if the trees are selected where the soil is deep and fertile. Larger trees should be lifted with a ball of earth so as to get as much of the root system as possible. Wrapping the ball of earth with burlap will facilitate handling during the moving process.

Shading Evergreens

Young evergreens need protection from the sun and drying winds the first year. Shingles are used by some to provide shade. They are not very satisfactory where strong winds prevail as they are easily blown away. A more permanent protection is provided by enclosing each tree with four stakes and a wide strip of burlap. The burlap should extend from the ground to six or eight inches higher than the top of the tree, but not over the top, and placed just far enough away from the tree to give good clearance to the branches.

Spacing

Dry Land Situations—Spacing the rows 12 to 16 feet apart seems to be suitable for the machinery found on most dry land farms. Economy in cultivation is a factor to be considered. Spacing the trees 6 to 8 feet apart in the row is recommended. It will take but a few years for the branches of trees at this spacing to interlock and become effective in breaking the force of the winds.

Trees were spaced as close as 4 by 8 and 4 by 4 feet in many of the early shelter belts established throughout the state. It was thought that by spacing the trees close together they would produce a dense shade within a few years that would control weed growth. This close spacing brought about early competition for moisture and as a result the trees have not made as rapid growth and losses have been heavier than with greater spacing. Close planting results in a dense growth but this apparently retards trunk development. The effectiveness of a shelter belt is determined both by height and density of trees. Greater spacing will permit cultivation over a longer period of years and extend the time when the trees will come in competition with each other for moisture. Trees planted too far apart will develop into a grove rather than an effective wind barrier.

Irrigated Situations—On planting sites where an unlimited supply of irrigation water is available the distance between rows may be reduced to 8 or even 6 feet. The width between the rows is not so much a factor on irrigated farms as on dry land situations.
Cutting Back Broad-Leaf Trees

It is practically impossible to save all of the root system of trees when they are lifted out of the nursery row and for that reason it is necessary to cut back from a third to a half of the top immediately after transplanting. This cutting back, however, is not considered necessary with one-year old seedlings, unless they have reached abnormal size, with the following exceptions: Caragana, when used for planting the outside row to the windward side, should be cut back to about 4-inch stubs immediately after planting, and encouraged to form a bushy growth thereafter. The elms, both American and Chinese, should have at least half of the top cut back, and trained to a single trunk growth. One-year old green ash seedlings and box elders under 20 inches in height need not be cut back. If it is found necessary to head back either the box elder or green ash it must be borne in mind that they carry their buds in pairs and unless one bud of the top pair is removed after cutting back, a bad crotch is likely to form.

Evergreen trees should not be cut back. Cutting back instructions apply only to broad-leaf species.

Cultivation

Trees should be cultivated as soon after planting as possible and as often thereafter as is necessary to prevent weeds and grass from growing. It may be necessary to go through the planting once or twice during the growing season with a hoe to remove weeds and grass immediately around the trees and such other weeds as may be missed by the cultivator.

Fig. 6—A well cared for shelter belt. No weeds here. Thorough and timely cultivation is essential for trees to succeed on dry land. Weeds and grass rob trees of food and moisture.
Cultivation must be kept up each year, particularly under dry land conditions, until the trees have reached a size when it will not be possible to use a team and cultivator between the rows. The life of the trees will depend upon the thoroughness of cultivation. Trees cannot compete with weeds and grass under average dry farming conditions.

**Straw Mulch**

On first thought mulching seems a practical method to check growth of weeds and grass and to hold moisture. Following are some of the objections to mulching.

A heavy mulch holds the moisture close to the surface of the ground, which encourages shallow rooting. A shallow root system will suffer more from a severe dry spell than one that has penetrated more deeply into the soil.

A mulch harbors rodents and insects that are often injurious to young trees. A mulch is also a fire hazard during the dry season.

In demonstration plantings at the Judith Basin branch station the mulched block of trees did not make as satisfactory growth as the cultivated block. Soil drifted over the mulch and made an ideal condition for weed growth.

![Fig. 7—An unpruned block of trees. They are making a dense growth and an effective barrier to ground winds. They are not making as rapid growth in height or trunk development as the moderately pruned tree.](image-url)
Pruning

Results obtained by different types of pruning as against no pruning at the Judith Basin branch station indicate that a very moderate amount of pruning is beneficial to shelter belt trees. Caragana, or other adaptable species, however, when planted in the outside row to the windward side should not be pruned after the initial heading back at the time of setting out. Other broad-leaf species such as the elm, ash, and box elder, will make larger trees if pruned to a single stem or trunk. Some of them, especially the box elder, have a tendency to produce a multiple stem or trunk growth if permitted to develop without pruning. The multiple stem growth will perhaps make a little more effective barrier to ground winds but it will be at the expense of growth in height. Fig. 7 shows trees that have received no pruning.

The type of pruning that will produce best development of the trees and still be an effective barrier to ground winds is a single trunk growth with all side branches left on from the ground up. Fig. 8 shows moderately pruned trees. Note the trunk development as compared with trees in Figs. 7 and 9.

Diseased and dead branches should be removed. When removing a limb, cut close to and parallel with the trunk of the tree. Never leave stubs as they hinder healing of the wound and decay is likely to set in and destroy

Fig. 8—A block of moderately pruned trees. Note trunk growth. Pruning to a single trunk with all side branches left on is recommended.
the heart wood of the tree. The best time for pruning is the dormant season.

A young tree that has killed back to the ground is likely to send out a number of shoots from the base and make little growth in height. Remove all of the shoots except one and train it to become the leader, but do not remove any of the side branches that may develop.

An evergreen tree should never be pruned, except to take out dead or diseased branches.

Fig. 9—Block of severely pruned trees. Note weak spindly trunks and almost total lack of wind protection. The tops of these trees are easily snapped off by strong winds. Trees will make a more sturdy growth and provide better protection when all side branches are left on from the ground up.

Trees for Shelter Belts

There are two distinct groups of trees from which selections may be made for shelter belt planting in Montana. These two groups are the evergreens and the broad-leaf species.

The evergreens are so called because they retain their green foliage throughout the entire year. In general they are harder to get established than broad-leaf kinds but when once established they are harder and more drought resistant. They are slow growing the first few years but after that they will make about as rapid progress as the broad-leaf kinds under dry farming conditions. Since they hold their foliage the entire year they are more valuable for planting for shelter against winter winds than the
broad-leaf kinds. Evergreens should be included in every shelter belt planting. A combination of both groups is desirable.

![Fig. 10-A few rows of trees well placed will break the force of winds and prevent snow from piling up about the buildings.](image)

**Evergreens**

Following is a list of evergreens adapted for farm planting; with a brief description of their habits of growth and requirements:

**Western Yellow Pine**—This is a native of southeastern Montana. It is not exacting in soil and moisture requirements and when once established will thrive on dry locations. Yellow pine reached a height of 9 feet in seven years after planting at the Northern Montana branch station. Its dense foliage and compact crown make it an ideal tree for protection from wind.

**Spruces**—The spruces do not grow as rapidly as the pines but they have the faculty of retaining their branches from the ground up. This, together with their compact habit of growth, make them desirable for shelter planting to check low winds. They should be used in combination with some faster growing kinds. Spruces prefer moist clay soils but will make satisfactory growth when planted on dry locations where the soil is fertile. Their rate of growth on dry sandy situations is too slow to justify planting them.

The Norway spruce is not as well adapted to dry land situations as the Black Hills spruce because of moisture requirements. It is more rapid in growth than the other spruces, if moisture conditions are good and is adapted
for planting either alone or in combination with other trees on irrigated farms.

Cedar—The native cedar or juniper is a hardy tree and comparatively easy to transplant from its native site. It is small-sized tree and grows rather slowly, but its dense compact habit of growth and its ability to survive under adverse growing conditions make it a splendid tree to plant for shelter if used in combination with more rapidly growing species.

Fig. 11—Evergreens will break the winter winds better than broad leaf species. Western yellow pine in this shelter belt grew to a height of nine feet in seven years.

Broad-Leaf Trees

The broad-leaf group is made up of trees having flat leaves of more or less width, such as the elms, ash, poplars, and caragana. They are easier to establish than the evergreens and will make more rapid growth the first few years. They also reach maturity earlier and cannot be considered as permanent. Since they shed their leaves each fall they do not provide as efficient winter protection as the evergreens.

Shelter belt planting made up of a combination of broad-leaf and evergreen trees will give the desired results of quick effect and have the added
features of permanency and more efficient winter protection when the evergreens reach some size.

Caragana—Caragana is a dwarf, shrub-like tree, extremely hardy and drought resistant. This species is well adapted for use in the outside row on dry land farms. It should be spaced about three feet apart and clipped back to four-inch stubs at time of setting out. The object is to make it grow bushy so that it will stop drifting snow for the less drought-resistant species. Caragana responds to irrigation but will not tolerate heavy soils that are poorly drained or soils that contain much alkali. Blister beetles and grasshoppers are serious pests on caragana some seasons.

Box Elder—Box Elder is sometimes called ash-leaved maple and Manitoba maple. It is easily transplanted and makes a rapid growth the first few years. This species does well in the lower altitudes but is subject to winter killing in the higher altitudes. In general it is unsatisfactory when planted in the counties close to Glacier Park east of the Continental divide.

American Elm—This species is native to eastern Montana and is hardy in most sections of the state at altitudes up to 5000 feet. It, however, is not very satisfactory in the Glacier Park region. The American elm makes an excellent shade tree and is quite drought resistant. It may be used in combination with other species in shelter plantings. The chief objection to the American elm is that it becomes badly infested with Aphids. The Aphids can be controlled by applying a delayed dormant oil spray each spring but a power sprayer is needed for the job.

Green Ash—Green Ash prefers moist soil but is capable of adapting itself to dry locations. Its buds open in late spring and it does not make as rapid growth as the poplars and box elder but it will last longer in dry land plantings. It makes a desirable tree in mixed plantings but should not be planted between the more rapid growing kinds or its growth will be stunted. Ash is troubled too much by wood borers to justify its continued use in southeastern Montana.

Chinese Elm—Chinese Elm is a rapid growing tree and ranks next to caragana and Russian olive in its ability to stand drought. It would make a very desirable tree for dry-land use were it not for its susceptibility to winter killing. When planted on well-drained sites where growth is checked early in the season it has a fair chance to survive the winters. There are other species better for the irrigated farm than Chinese elm.

Russian Olive—The Russian Olive is a small tree, winter hardy in most parts of the state, and very drought resistant. So far it has not been bothered by insects to the extent that other species have. It is by far the most satisfactory species for dry locations in eastern Montana where it may be used to plant in the outside row in place of the caragana.

Cottonwood—The native cottonwoods are hardy, rapid-growing trees if there is an abundance of soil moisture. The cottonwoods are well adapted
to woodlot purposes on the irrigated farms but are not satisfactory as a barrier against winds when planted alone due to loss of their lower branches in the early period of growth. When used in combination with such species as willows and Russian olive, their greater height adds to the value of shelter planting.

Cottonwoods will last only a few years on dry locations in Montana and should not be used for shelter planting except where quick, temporary results are desired. When planted on dry land farms they should be used in combination with slower-growing, longer-lived species like Russian olive, ash, American elm and evergreens. By planting them in blocks of two or more rows it simplifies their removal and replacement with other species when they start to die. It is well to keep in mind that such a strip should be cultivated a year before replacements are made.

Northwestern Poplar—This species is a native of North Dakota, hardy and of rapid growth. It is adapted to the same conditions as the native cottonwood. The only advantage in planting it in preference to the cottonwood is the elimination of the cottony seed crop.

Canadian Poplar—The Canadian Poplar is not recommended for planting on either dry land or irrigated farms. Its greater susceptibility to canker in Montana renders it inferior to either the cottonwood or northwestern poplar.

Willows—the willows are moisture-loving trees and are not adapted to planting on dry locations. The laurel leaf, Russian golden and diamond willows are suitable for planting on irrigated farms and around reservoirs. Reports indicate that the laurel leaf is slightly hardier than the Russian golden. Willows may be used alone or in combination with cottonwoods for wind barriers. They should be given about a 4x6 spacing and allowed to grow dense at the base in order to break the ground winds.

Buffalo Berry—This is a hardy, native, shrub-like tree which grows naturally under adverse conditions and responds readily to cultivation. It will grow to a height of 15 feet and makes a good addition to a mixed shelter belt planting. The currant-like berries are used by many for household purposes.

Protection of Young Trees

Trees cannot succeed if livestock is given the freedom of the shelter belt area. Animals will cause damage to the trees by nipping off the branches, peeling the bark, and packing the ground, causing it to dry out and thus rob the trees of moisture. Every planting should be fenced with rabbit-proof woven fence to keep out livestock and rabbits. Frequently snow piles up so that rabbits can go over the top of the fence. It then becomes necessary to trap or poison them for protection of the trees.
Shelter Belt Insects

Harlow B. Mills, State Entomologist

In the great plains area of eastern and central Montana trees planted for shelter belts or shade are liable to considerable insect attack. One of the primary reasons for this lies in the fact that such trees are not planted in a natural habitat, but are actually out of place—in situations where trees originally had not invaded the upland areas, the few which were present being limited to the water courses.

Trees in a vigorous, healthy condition are not only less susceptible to insect attack, but they are more capable of reducing or throwing off some attacks which may occur. Therefore, greater injury may be expected to shelter belt trees in abnormal conditions, and anything which can be done to keep the trees in good condition will reduce the importance of the attack of many insects.

Trees are not all equally susceptible to insect injury. Russian olive, on one hand, is highly resistant, while the poplars, on the other, are the prey of many pests. Some, such as the spruces, have insects specific to the group. Others are attacked by a variety of general feeders, and the widely planted caragana is a good example.

The following is a discussion of some of the most important Montana insects which attack shelter belt and shade trees. For convenience they are organized first into those groups that attack broad leaved species and those that attack conifers, and second, into those which eat the leaves, suck the sap, and bore into the branches and trunks.

Broad Leaved and Deciduous Trees

Forest tent-caterpillar (*Malacosoma disstria*). This North American insect is distributed over much of the United States. It attacks most forest and fruit trees. The eggs are laid in a collar-like cluster around the twigs and these egg masses are easily seen when the leaves have been shed. These eggs hatch into dark, moderately hairy larvae, with a row of white spots down the back and lighter stripes on the side. Their habits of working in groups and defoliating trees make them conspicuous. They are about one and one-half inches in length when fully grown. After pupation they emerge as light brown moths, about the size of cutworm moths, with a darker diagonal band across the forewings. There is one generation a year.

These insects are highly cyclic. In 1936 they were very abundant and destructive from the east slope of the Rockies to Minnesota. Since that time their appearance has been sporadic in Montana.

With proper equipment they can be controlled easily by spraying the foliage with three to five pounds of lead arsenate in 100 gallons of water to which has been added a commercial spreader.

Other Caterpillars. Several other insects may at times be injurious to shade and shelter belt trees. Larvae of the mourning cloak butterfly (*Aglais antiopa*) are velvet-black with many minute lighter spots. The
body bears several rows of branched spines. The damage done by these caterpillars is usually confined to a branch or two on a tree and is not so heavy as that of the forest tent-caterpillar. They attack willows, elms, poplars, and other trees.

The giant silkworm, (Samia gloveri) may be locally abundant at times on a variety of hosts. The larva, when fully grown, is three or four inches long, pale blue-green, and covered with spiny tubercles which may be red, yellow, or blue. Both this insect and the mourning cloak butterfly are commonly attacked by parasites and are seldom abundant. They can be kept in check by picking off or by the lead arsenate spray described above.

Cottonwood and Willow leaf beetles. These beetles (Lina scripta and L. interrupta) are about the size of the potato beetle but are flattened above instead of rounded. The head and thorax are mainly black and the wing covers are yellow or red with black spots. The larvae are soft bodied and about one-third of an inch long. Both the larvae and adults feed openly on the leaves and can be controlled by the lead arsenate spray previously described.

Leaf cutting bees. These bees (Megachilidae) cut circular pieces from the leaves, which are used in nests. Rarely have they been so abundant as to destroy most of the leaves of various shelter belt trees. It is possible that a heavy spray of lead arsenate on the leaves might poison them. Specific control measures are not known.

Aphids. Aphids, or plant lice are small bodied, soft insects which suck the juices from the leaves. When abundant, feeding injury can be serious, but it is not the only difficulty involved in aphid infestations. Plant lice give off a sweetish sticky fluid upon which certain moulds grow, and this growth mars the appearance of the trees. Cars parked beneath such trees may be badly spotted by falling droplets of this “honey-dew.” Further, the feeding of some species produces unsightly galls.

The Elm aphid (Eriosoma americanum) badly curls the leaves of this tree, and in Montana is the most important elm insect. It spends the winter in the egg stage on the elm bark, migrating in early summer to the roots of service or june berry. Here it has several generations, returning in the late fall to the elm where the overwintering eggs are laid.

Cottonwood-leaf gall aphids (Pemphigus spp.) form unsightly, disfiguring galls quite commonly in the state. The two gall forms which are most common are vagabond gall, an irregular, large, rather fleshy growth at the tips of the twigs, and the leaf stem gall, a roundish swelling on the leaf stems. These plant lice also have two hosts. Some species migrate in the summer to the roots of plants of the beet family or cabbage family; for others the summer host is unknown. They return from the summer hosts in the fall and lay their eggs on cottonwoods.

The box elder aphid (Chaitophorus negundinis) often infests this tree in great numbers, and serious injury may result. Unlike the previously mentioned species, this aphid stays on the trees throughout the season.

A number of other kinds of aphids infest shelter belt trees to a lesser extent than the above.
Aphids which do not produce galls can be controlled readily by a thorough spraying with nicotine sulphate used at the rate of one pint to 100 gallons of water to which five pounds of soap flakes have been added. Pyrethrum sprays may be used also. There are many brands on the market, and these should be used according to the manufacturer's directions.

Gall-forming aphids are usually so well protected that such sprays do not reach them. However those that overwinter in the egg stage may be reduced in numbers by a thorough spraying with a three to four percent lubricating oil emulsion. This should be applied to the trunk and branches in the late winter when the temperature is above freezing and before the buds have started to swell. In some sections of the state trees have been banded to prevent aphid injury. This is of no value where the overwintering eggs are laid on the trees.

Carpenter worm. This borer (Prionoxystus robiniae) is an important pest of cottonwood, willow, locust, poplar, ash, maple, and other trees. In Montana the records would indicate that cottonwoods have suffered the most from its attack. The larva, which excavates large tunnels in solid wood, gets to be two and one-half inches long. The head and the part of the body attached to it are brown. The body generally has a pale greenish cast and may be tinged with pale rose. The body hairs are short and not abundant. The dirty looking, sticky eggs are laid in bark crevices and wounds in June or July. The newly hatched caterpillars burrow into the inner bark and sapwood and later tunnel into the heart wood. A single generation lasts at least three years.

Badly infested trees should be cut down in the fall or winter and used for fire wood. If the tunnels can be found, a teaspoonful of carbon bisulphide, or the same amount of a mixture of three parts ethylene dichloride to one part carbon tetrachloride, can be injected into the hole which should be plugged with putty. These materials produce a gas which kills readily the insects in the tunnels.

Other borers. Other boring insects, primarily of the families Buprestidae and Cerambycidae attack various trees. All borers are difficult to control. The measures described for the carpenter worm should be applied where possible and the trees should be kept in a vigorous, healthy condition.

Coniferous Trees

Spruce gall aphid. This tiny insect (Adelges cooleyi) feeds in colonies on the new growth of various species of spruce, causing unsightly galls, and stopping the terminal growth of twigs. It is native to and common in Montana. All spruce are attacked but there seems to be a preference for black hill and Norway spruce. Certain individual trees seem to be more susceptible than others although the reason for this is not known. This insect has a complicated life history. It appears to over-winter on Douglas fir, and as new growth starts on spruce, certain winged females fly to it, lay their eggs, and the nymphs migrate to the bases of the tender new needles. Their feeding here causes the galls to form. About mid-summer these nymphs mature, the galls dry and open, and the insects fly back to Douglas fir.
Green galls should be picked and burned before they have opened.

Good control can be obtained by spraying just as the young hatch and move to the new growth. For this purpose, a spray consisting of two and one-half gallons of a summer miscible oil and one pint of nicotine sulphate to 100 gallons of water should be used, and all of the new growth should be thoroughly covered. It is probable that individual trees which are especially attacked every year should be cut out and replaced.

Pine leaf scale. Tiny white scales appearing on the needles of pines and some spruce, firs and hemlocks, are usually the pine leaf scale (Chionaspis pinifoliace). The winter is spent in the egg stage beneath the old scale. They begin to hatch in early June usually, and on warm days they migrate out and settle down on the needles. They are adults by August and lay the most of their eggs in September. When abundant they do considerable damage, killing the needles and causing premature dropping. They can be checked by spraying, as the nymphs are hatching and settling down, with oil-nicotine mixture recommended for the spruce gall aphid.

Tussock moths. In recent years a tussock moth larva (Olene sp.) has been noticed in the Billings area feeding on the needles of spruce. This caterpillar is thickly covered with pale hairs. From these extend brushes of light and smoky gray hairs on the back. Along the sides and on the front and back are long slender tufts or pencils of black hairs. When fully grown the larvae are about an inch long. As it is an external, unprotected feeder, it and other external feeders should be easily controlled by the usual lead arsenate sprays.

Borers. Three kinds of borers commonly attack conifers. Round-headed borers (Cerambycidae) usually make cylindrical tunnels into the heart wood. Flat-headed borers (Buprestidae) make flat twisting tunnels just beneath the bark. Bark beetles (Scotytidae) usually make regular tunnels beneath the bark consisting of a central gallery, and others at right angles to it as the larvae work out from the sides of the central gallery where the eggs are laid. Under some conditions it is possible to kill round-headed borers by injecting carbon disulphide, or the ethylene dichloride-carbon tetrachloride mixture discussed in connection with the carpenter worm, into the tunnels. They are all difficult to control, and the trees should be kept in a healthy condition by supplying sufficient water and plant food, and by keeping all injured and dead wood pruned out.

Miscellaneous Pests

During outbreak years such insects as grasshoppers and blister beetles may completely strip shelter belts of their leaves. When they are very abundant little can be done. In moderate or light infestations certain treatments will give a good measure of control. Caraganas are especially liked by hoppers and blister beetles, and even sugar beet webworms have been seen eating the leaves and girdling the stems by gnawing the green bark. Grasshoppers may be reduced in numbers by the use of poison bait in the protection of crops. The shelter belts may be sprayed with calcium arsenate at the rate of one pound of the poison and one pound of lime to 16 gallons of water. Several fluosilicates have been tried with varying results. These should be used at rates recommended by the manufacturer. Dusting with magnesium arsenate, calcium arsenate, sodium arsenite and sodium fluosilicate have been recommended in North Dakota with the caution that the last two may have a tendency to burn the foliage.