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WHAT actually constitutes "brush?" One easy description is the term "woody weeds." Plants commonly thought of as weeds are herbaceous (non-woody). Brush, however, differs in that individual plant cell walls have extra chemical support which imparts to woody plants their rigidity. Woody plants are all perennials which, under favorable conditions, increase in size from year to year until maturity. Readers will note that under this definition of brush young and mature tree species are also included.

Brush control is essential to transportation facilities and utilities because brush interferes with maintenance, repair, and patrolling operations. Highway visibility is necessary and brush which impairs drivers' vision is a definite hazard. Uncontrolled brush can cause outages on power lines and can damage communications systems.

Industrial storage areas become more efficient when material is free of brush. Rodent habitation in fields adjacent to food processing plants is eliminated when removal of weedy brush also removes rodent hiding places. Oil storage tank "farms" and pipeline operations require a "no weeds" policy for maximum protection from fire.

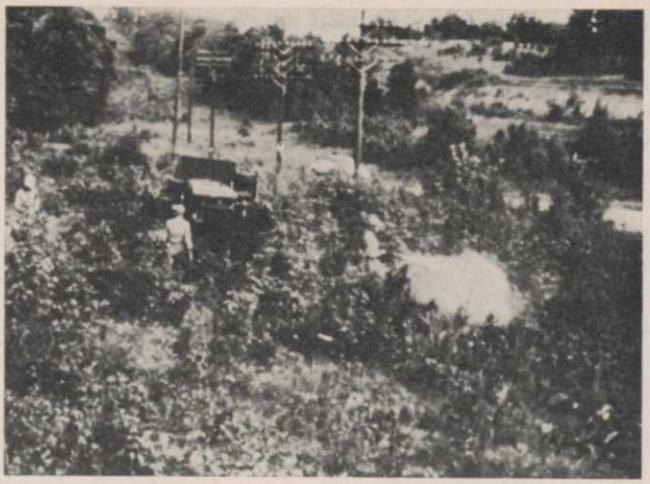
Brush removal improves rangelands and cultivated timber stands also. Destruction of brush along irrigation canals stops water robbery through evaporation. "Dried up" springs

Brush Up

ON BRUSH CONTROL

This basic manual on brush control is meant as a refresher for old pro's and as an introduction for neophytes.

Results of another *Weeds and Turf* field research project



Truck-mounted spray rig (left) is ideally suited for spraying roadside brush. Huskier vehicles (shown in distance at upper right) can penetrate some utility rights-of-ways. Crew on foot (lower right) can maneuver to pinpoint spray operations in rights-of-ways.

and wells have been known to flow soon after water-robbing brush was killed.

Brush control is used in fire breaks to prevent the spread of wildfires in drought-ridden areas which readily burn over. Fire fed by light fuels such as dry grass is more easily controlled than fire fed by dense brush.

In all of these endeavors, brush control by chemical means does the job more efficiently than hand or machine cutting, and with a greater degree of permanence.

All this means that by use of the various methods of chemical control described in this article, there is a good year-round market for contract brush control, and contract applicators may profitably participate if they keep abreast of the subject.

Classifying Brush

Some important points to consider are: the types of brush; identification of particular species, resistant and susceptible; why methods other than chemical are less effective; chemicals used for control and how they should be handled; equipment used in the control of problem brush.

Types of brush are arranged in three categories for better description. Stands of *small* brush have trunk sizes less than 1 inch in diameter; *medium* stands range from 1 to 2 inches; and *large* brush exceeds 3 inches trunk diameter.

Short brush varies from 2 to 4

Pistol-grip sprayer (far left) permits operator to direct his spray pattern with accuracy. Sometimes it is necessary to spray trunks around bottom (near left). Photo at right by O. A. Leonard of the University of California (Davis) demonstrates how firebreaks may be left standing after brush has been cut and seedlings sprayed.

feet high; *medium* height from 4 to 8 feet; and *tall* grows 8 feet and higher. Over 15 feet, one thinks of the species in question as a tree.

To estimate density of a brush stand, it is necessary to determine approximately how much ground is covered by the brush. If it is *light,* it covers 25% of the ground or less. *Medium* stands cover 25 to 75% of the area, and *heavy* stands, 75% and over.

These groupings are used because brush identification is a less familiar subject with some workers and infestations usually occur in what is called "mixed brush stands." Such arbitrary classification should not, however, eliminate the need for proper and accurate identification of species in a stand of mixed brush.

Know Species, Save Money

Time taken for an identification survey of a brush stand can save money by indicating the proper chemical to use, thereby saving time and expense involved in treating a reinfestation or re-treating an ineffective application because of resistant species.

In truth, a contractor cannot economically bid on a brush control job without knowing the composition of brush. The *least expensive* treatment may *not,* in cases where resistant species are involved, be the most *economical.*

Unfortunately space limitations prohibit a discussion of brush identification. A listing of sources at the end of this article gives names of books which deal with brush and tree identification. Lists of resistant brush species can be found in most university or governmental publications covering brush control. Two very good sources are "Chemical Control of Brush and Trees," U. S. Dept. of Agriculture Farmers Bulletin No. 2158, and for those interested in western brush, "Chemical Control of Woody Plants in California," California Agricultural Experiment Station (Davis, Calif.) Bulletin 755.

Chemical manufacturers are also happy to supply technical data concerning effectiveness of their chemicals against particular brush species.

Methods Other Than Chemical

A short discussion of nonchemical controls is in order so that it can be pointed out where these methods fall short of the results which are considered desirable.

Cutting has been the most popular control method for a very long time. For large modern-day operations, cutting requires many men or a lot of time; it may be a hazardous occupation. With present-day labor wages, such cutting operations may cost as high as $800 per acre.

Cutting has one inherent disadvantage which often creates more problems than it solves. When brush or trees are cut, sprouts often arise from the roots and stumps and create a dense impenetrable growth. This phenomenon is caused by removal of the dormant bud supressing effect or what botanists call "apical dominance."

The apex is the tip of a main stem or a twig where new growth normally begins. Those who study plants and their growth processes tell us that the apex or main stem tip produces a chemical hormone which suppresses any lateral growth from buds below the tip. If the apex is cut off, it no longer supplies the suppressing hormone and new twigs sprout. The object of control is to reduce the number of stems per area; this method actually increases the stems per area.

Large machines have been developed for use on ranges and pastureland for the uprooting or crushing of brush. These machines are too unwieldy for use anywhere else. Cables drawn between two tractors can uproot certain small brush species, but this process is expensive in terms of equipment, manpower, and the destruction of desirable range species which are run over in the cabling process.

Brush in some situations can be burned under control so that damage to adjacent areas is minimal. Patterns of ignition used to control brush, after a perimeter firebreak is mechanically cleared, are strip firing, center firing, and edge firing. These techniques are ticklish and should not be conducted without prior experience and expert supervision. Permission and cooperation of local fire departments are usually required. Burning is unpredictable because a slight change in wind direction can change an adventure into a calamity. Burning causes unsightly charred ground from which new brush growth sprouts. Burning destroys valuable ground cover also.

Girdling is the process used by the early settlers. This is an energy-saving way to kill a tree, but it takes several years to kill large ones. By removing the bark and the phloem (conducting cells which transport food from leaves to root storage), a person can starve a tree because the girdled part prevents food from being stored. The second year, girdled trees will have less reserve food to help it leaf out in the spring. By the third year, it will generally be dead. In species capable of sprouting from roots or from the root collar, sucker growth is encouraged by girdling. Sucker growth increases stem count and produces more brush. As we will see, this same principle can be used in conjunction with chemicals, and the whole task takes less time and is more complete because chemicals kill the roots too.

Chemical Results More Complete

In addition to advantages of less time and less hand labor with the use of chemicals, which have already been pointed out, we can state that chemicals more safely insure complete results over a reasonably long period of time before a treatment program is again needed.

Several chemical methods are used. Among them are foliage sprays, treatment of bark and soil around small tree bases, application of chemical into cut in bark, and application of oil solutions onto uncut bark of dormant plants in winter.

On small brush, short to medium height where density is medium to heavy, foliage sprays

Since brush is often classified under the category of "small trees," most identification texts will deal with trees and must be adapted for use with young trees.

Some of the important points to be learned for identification are: leaf shape, habit of growth, general form of branches, markings on bark, and form of new twig growth.

Following are some helpful source books for tree and brush identification.

Collingwood, G. R., and W. D. Brush, *Knowing Your Trees*, American Forestry Association, 1962.

Coker, W. C., and H. R. Trotten. *Trees of the Southeastern States*, Univ. of N. C. Press, 1934.

Dominion Forest Service of Canada, *Native Trees of Canada*, King's Printer, Ottawa, 1949.

Eliot, W. A., *Forest Trees of the Pacific Coast*, G. B. Putnam's Sons, 1938.

Emerson, A. I., and C. M. Weed, *Our Trees, How to Know Them*, J. B. Lippincott Co., 1936.

Graves, A. H., *Illustrated Guide to Trees and Shrubs*, Published by the Author, Wallingford, Conn., 1952.

Green, C. H., *Trees of the South*, Univ. of N. C. Press, 1939.

Harlow, W. M., *Trees of the Eastern and Central United States and Canada*, Dover Publications, 1957.

Hough, R. B., *Handbook of Trees of the Northern States and Canada*, The Macmillan Co., 1947.

Illick, J. S., *Tree Habits, How to Know the Hardwoods*, American Nature Association, 1924.

Mathews, F. S., *Field Manual of American Trees and Shrubs*, G. B. Putnam's Sons, 1915.

McMinn, H. E. and E. Maino, *Manual of Pacific Coast Trees*, Univ. of California, 1951.

Preston, R. J., Jr., *North American Trees*, Iowa State College Press, Ames, 1950.

Sargent, C. S., *Manual of Trees of North America*, Houghton Mifflin Co., 1933.

may be the most economical. Timing is important when spraying leaves of brush.

Best results are obtained in late spring to early summer when brush is still young and tender but is fully leafed out. Later in the summer leaves of many species develop a waxy covering which is more nearly impervious to spray penetration. This condition is known as "hardening off." Although results are less predictable when leaves have hardened off, some operators get results with the use of surface active agents (surfactants) added to their spray mix. Sometimes a small amount of fuel oil (1 to 2%) added to water-based herbicide will increase penetration. Of course, with any foliage application, adequate overall coverage is essential to get good results.

The object of foliage (leaf stem) application is not to kill leaves outright, but permit the herbicide to be absorbed and moved throughout the woody plant. In this way the whole living system is killed. Surface active agents and oil additives should not be so toxic themselves that they give a rapid top kill.

Foliage sprays become ineffective as soil moisture is depleted late in summer. Soil moisture is essential for control by the leaf stem spray method.

Sprays of the phenoxy compounds, 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), alone or together in equal amounts are translocated throughout plants after having been absorbed by leaves. Four to 8 lbs. of water-emulsifiable esters of the 50-50 mixture of 2,4-D and 2,4,5-T (4 lbs. per gallon formulation) mixed in 100 gallons of water works well when there are no susceptible desirable species in the vicinity. Silvex, 2-(2,4,5-trichlorophenoxy) propionic acid, is used instead of 2,4,5-T in some dry rangeland states where silvex-susceptible oaks abound.

As a precaution to avoid spray mist drift, it is advisable to abstain from spraying when winds are above 6 miles per hour. Keeping spray pressures below 60 psi prohibits formation of atomized droplets of spray which are easily carried on winds.

One should take the time to recognize the difference between spray mist drift and volatile vapor drift, a problem with use of simple ester formulations. Vapor fumes are most likely to form on hot days. Use of low-volatile forms and amine phenoxy preparations will eliminate the volatility problem, but the responsibility to prevent atomization and mist drift is left with the operator. *(See Weeds and Turf*, Jan. 1963, page W-12).

In the event nearby plants may be affected by drift of volatile fumes of esters, one should select a foliage spray of low-volatile esters or an essentially nonvolatile amine salt form. A completely nonvolatile preparation is the diamine salt forms of 2,4-D and 2,4,5-T called Dacamine-D and Dacamine-T.

Another chemical which can be used to avoid drift problems is ammonium sulfamate (AMS) which is trademarked Ammate X. This is a nonvolatile, nonflammable, inorganic compound applied in a water solution to which a few ounces of wetting agent have been added. It should be applied to undesirable brush only. If applied as an overall area spray, it will inhibit growth of grasses and other desirable ground cover.

AMS is a corrosive compound and should not be left sitting in a spray tank for an extended period. Chemical manufacturer's recommendations for removing residues of AMS from sprayers should be carefully followed after each use. AMS can also be applied in an oil-based formulation. In this form, it is said that corrosion is minimal, but the same careful cleanup procedures should be followed.

A new brush killer which

could be considered alternative to the use of phenoxy compounds is 4-amino-3,5,6-trichloropicolinic acid, trademarked Tordon. It is said to be translocated inside woody plants more efficiently than phenoxy derivatives. Translocation downward from a leaf stem (foliage) application to the roots gives a more complete kill. Tordon is also said to stifle suckering (small shoots which emerge from roots and root collar around the base of trees) because it is transported to and kills root cells.

After spraying, carefully follow manufacturers' recommendations for removing spray residues of phenoxy herbicides from tanks, etc. Sprayers used to apply brush killers should be restricted to this use and not be used for treatment of lawns, crops, or ornamentals. Phenoxy herbicide residues are very difficult to remove from sprayers.

Basal Bark Treatments

To selectively kill certain brush species and leave desirable shrubs or to treat thin stands of brush it is advisable to use the basal bark treatment method. This method which can be performed any time during the year thus extending spraying season, involves spraying the base of brush and the trunk up to a height of 18 inches with an oil solution of brush killers. Applied to thoroughly wet all sides of a trunk or stem under two inches diameter, the chemical penetrates to the growth layer (cambium) and the tree is "chemically girdled." It will generally be dead the next season.

Six pounds of 2,4,5-T ester or brush killer mixture in which at least half the active ingredient is 2,4,5-T can be applied to the bark in 100 gallons of oil solution. A gallon of spray will treat 100 diameter inches of tree bark. In other words, 1 gallon will treat 50 trees with 2-inch diameters or 25 trees with 4-inch diameters. Chemical should be applied to the runoff point. Spray should run down the tree and saturate the root collar where new sprouts arise.

If both sides of a trunk are not adequately sprayed, flourishing growth on one side of a tree will be noted the following season.

Dormant Cane Broadcast

A relatively recent proven development of brush control is dormant cane broadcast. This method is similar to basal bark treatment. Brush is sprayed when dormant between the time of fall leaf drop and spring bud sprouting. Leafless brush is sprayed from top to bottom with 6 lbs. of heavy esters of 2,4,5-T in 100 gallons of No. 2 fuel oil or diesel oil. Generally 150 to 200 gallons per acre is sufficient. Rate per acre depends upon the density of brush.

Dormant application kills by prohibiting spring leafing out. Chemical which penetrated to the growth layers is transported to the roots when spring sap begins to flow up and down the trunk.

Several problems are overcome by spraying dormant brush. Normally brush sprayed in the spring becomes brown by midsummer. When spraying is done along highways, it often presents a repulsive sight to passing motorists who see the browned-out foliage.

Dormant broadcast also eliminates danger of drift to susceptible crops because there are no susceptible crops being grown. Larger areas can be treated in less time and lesser volume of spray is needed because there is no foliage to block the spray and resist penetration.

Granular Soil Treatments

Applications which can be made if spraying is not feasible are with either a pelleted form of fenuron called Dybar or with the granular form of picolinic acid called Tordon 10K.

Fenuron is a substituted urea compound which has a high herbicidal activity especially to brush and small trees. Fenuron treatment is effective for thin stands of brush or for use as a followup treatment to stands which have been initially sprayed with foliage herbicide.

Fenuron from the pellets leaches into the soil and is taken

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up by the roots of brush. Rates of application depend upon the species of brush and density and age of stands.

Fenuron is a water-soluble compound and care must be exercised when applying it near any desirable species. Fenuron can "run" and affect trees on the downhill side of the application point. Also since tree roots often travel extensively underground, the fenuron must be applied where it will affect only the target species.

One sticky problem which should be pointed out is that trees of the same species growing near one another often graft roots, in other words they have some roots in common. If an attempt is made to take one and not the other, damage to the "untreated" tree may result, because herbicide is transferred through roots underground.

Pelleted formulations such as Dybar and Tordon prove useful where brush stands are inaccessible to spray rigs. Although the material is applied by hand, which increases labor and time expense, there is no need to make machinery investments.

If desired, both Dybar and Tordon 10K can be applied by mechanical application or by airplane if large areas are to be treated.

Cut Surface Application

When stems or trunks of plants over 4 inches in diameter are cut or wounded before chemicals are applied, treatments act much faster. Chemical is placed in the layer of phloem (conducting cells which transport sap to roots) and the roots are killed quickly. Several methods of cut surface application are presently in use.

With a hand axe, one can make a series of overlapping notches (called a frill) in bark of a trunk. This should be done as near to the ground as possible. Phenoxy herbicide, AMS, or picolinic acid sprays can be applied into the frill. In the case of AMS, fenuron, and picolinic acid, dry crystal or pellets can be spooned into the frills.

Six lbs. of 2,4,5-T herbicide in 100 gallons of oil is a sufficient rate for frill application. AMS liquid is applied at the rate of 7 lbs. per each 2 gallons of water. If crystals of AMS are used, apply 1 to 2 tablespoons for each inch of trunk diameter. Pelleted fenuron and Tordon are used in frills at the same rate as used for basal soil applications.

Use of a water-soluble amine form of phenoxy herbicide instead of oil-soluble ester forms is becoming increasingly popular for treating frills. Water-soluble amine products containing 4 lbs. of herbicide per gallon can be applied without any dilution by using a pump-type squirt can to place liquid into the frills. There are also aerosol products which apply herbicide to frills.

Use of tree injectors to kill medium to large trees eliminates the need to carry an axe and a separate bag, bucket, or can of chemical. A tree injector is a long tube filled with an oil solution using approximately 3½ lbs. of active esters (either 2,4-D, 2,4,5-T, or silvex, depending upon tree susceptibility) for each 10 gallons of solution. An amine form can also be used; it is diluted one to one with water.

The tube has a hard sharp point. The point is rammed into the bark at the base of the trunk; one injection is made for each two inches of trunk circumference. Chemical enters the sapwood and is carried through the tree to both leaves and roots.

Stump Treatment

If one takes the trouble to completely cut and remove a tree in a brush control program, precautions should be taken to see that the stump does not resprout. Saturation application of AMS crystals, picolinic acid, or 2,4,5-T sprays at basal bark concentrations will prohibit resprouting and stump and roots can be completely killed. Stumps with very thick bark should be given a few axe cuts very near ground level.

Sprouts which do emerge from stumps are usually very hard to kill because the small bush has such a large supporting root system. Some species which resprout from the roots rather than from the root collar region around the base of the stump will be very difficult to control. Several years of foliage sprays may be required to completely kill these. Some root sprouters are aspen, sumac, black locust, and sassafrass.

There are a couple of special-use chemicals which should be mentioned. Amitrole at 1 lb. (50% formulation) per 10 gallons of water with ½ oz. of spreader sticker added is an excellent control chemical for poison oak.

Certain polychlorobenzoic acids are considered highly effective against woody brush which has a vining habit of growth.

Application Equipment

As the reader has probably noticed equipment for brush control varies widely. There are many chemical formulations and just as many ways to apply them.

Following is a summary of some of the more familiar equipment:

- a spoon or scoop
- pump-type squirt can
- knapsack sprayer
- compression hand sprayer
- tree injector
- truck-mounted spray rig with booms and/or hand gun
- airplane or helicopter mounted with spray boom or granular applicator
- helicopter mounted with attachment for applying invert emulsion (See *Weeds and Turf*, Jan. '64, page 12)
- truck-mounted mist blower for dormant low-gallonage spray
- back pack mist blower to apply invert emulsion.

With the many types of application and chemicals available, alert operators can profitably meet the demand of the brush control market.

Next month in W&T

Controlling the

Bermudagrass Mite