Use of Fire in Land Clearing

proper ignition techniques important requirements for successful management of controlled burns

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The fourth of five articles reporting the findings in investigations in the effectiveness, the safety and the cost of the use of controlled burning as a tool for land clearing. No attempt is made to provide one formula for prescribed burning in California; each fire is an individual case to be planned on the ground.

Successful ignition starts a controlled fire at a time and place, and in such a way, that it spreads over the entire burn area and consumes or kills undesired vegetation. In addition, prompt and certain ignition reduces the probability of escape, makes the fire easier to control, and may reduce the over-all cost.

Ignition is not a serious problem if the burn area has been selected and prepared to approximate ideal characteristics with fine, dry fuels adjacent to the control line, up-slope into the burn area, and air movement into the burn. However as actual conditions deviate from these ideal characteristics, prompt and certain ignition becomes more difficult. In fact some of the controlled burns fail because brush can not be made to burn under existing conditions. Certain ignition techniques may broaden the range of conditions under which ignition is possible.

Factors Affecting Ignition

The ease with which ignition—or firing—can be accomplished varies with the combined effects of fuel, topography and weather factors:

1. As the size and moisture content of fuel particles increase, ignition becomes more difficult.

2. As brush or grass becomes more sparse, ignition is more difficult. When sparseness produces definite breaks in fuel continuity, this factor acts as a barrier to stop fire spread.

3. On the other hand, as the amount of dead twigs and branches in brush increases, ignition becomes easier.

4. As wind velocity increases and air temperature increases, and relative humidity decreases, ignition becomes easier.

5. As slope steepness increases ignition becomes easier.

6. As the size of fire started at any one place increases, spread of that fire becomes more certain.

Dry fuels such as dead grass ignite quickly and burn rapidly. In a dense stand of grass where fuel particles are close together, heat from a single match is sufficient to touch off fire. Fire from a number of matches thrown down at intervals or from burning material dragged with a rake quickly forms a line which spreads rapidly up-slope or in the direction wind is blowing.

In contrast to dry grass, brush ignition is more difficult. Fuel particles are larger and their ignition time with the same heat source is slower. Fuel particles are farther apart in the brush canopy, and there may be no fine, dry fuels near the ground to carry fire. Only a small part of brush vegetation is dead. Green brush leaves during the summer are made up of water and dry woody material in nearly equal amounts.

Because of these conditions a few burning leaves or even a pile of burning brush may not radiate enough heat to adjacent unburned fuel particles to keep the fire spreading. But under these same conditions a larger volume of fire may trigger the combustion of nearby fuels.

A study of these characteristics of brush which make ignition difficult has shown what may be done to promote rapid and more certain firing. In all cases the aim is to provide a large volume of fire at each point of ignition and if possible to develop a line or wall of moving fire in order to direct more heat towards unburned fuel ahead.

Solving Ignition Difficulties

One approach to these ignition difficulties uses an ignition tool which produces large amounts of flame and heat. Pneumatic flame throwers such as the one illustrated and power flame throwers can be used to start lines of fire by walking along the brush edge and holding the flame until each section burns under its own momentum. Use of an intensive heat source makes it possible to ignite large fuel particles immediately and provides enough heat to dry out living green material.

Continued on next page

Left. Pneumatic flame thrower provides intense heat for ignition of larger fuel particles. Note application of heat close to ground. ***Right.*** Example of the V-ignition plan. The standing brush within this V would not burn on April 21, 1951 when the temperature was 63° F, the relative humidity was 48%, and the wind was across rather than upward along the slope.

FIRE

Continued from preceding page

Another method of facilitating ignition is by mashing or compacting brush along the control line. Walking a tractor or bulldozer over medium and light brush will mash it down so that when it dries it is easy to ignite. It will then burn clean and produce large volumes of heat and flame needed to start spread into standing brush farther inside the burn. Brushland has been successfully cleared for years by railing or smashing down the vegetative cover and burning it after it dries. High cost—$5 to $50 per acre—limits its use to good soils when applied to an entire burn area. However, railed strip next to the control line, is an inexpensive way to get more prompt and certain firing on burn day.

Weed Killers

A third approach to the brush ignition problem is the use of general-contact weed killers to dry-out green leaves and twigs. Solutions of di-nitro, pentachlorophenol, and trichloroacetate have been used successfully to spray brush foliage. In one to two weeks after application, leaves turn brown and moisture content is reduced to 20%–30% of its original amount.

Preliminary studies indicate that a 60-foot strip along the control line can be sprayed with a solution which applies four pounds of pentachlorophenol in a 10% emulsion of Diesel fuel and water for less than $24 per mile. This dead brush canopy next to the control line makes ignition easier.

V-Type Pattern

A fourth technique for easier ignition uses two pneumatic flame throwers in a progressive V type firing pattern. Heat from both flame throwers is applied to the point of the V which is formed by lines cut into the brush with the open end of the V pointing in the direction fire will normally travel. The flame throwers are moved up, one on either side, to supply new heat as the flame progresses. Under conditions where a fire will not burn under its own momentum until it develops a long traveling front, the extra heat supplied from each side under this method of ignition will usually allow a long traveling front to be started.

Ignition Tests

Trials of ignition aids were made in February, March, and April of 1951 in Santa Clara County. Tests were made on days when it was impossible to burn untreated standing brush using ordinary ignition techniques.

On February 19, V ignition started a line of fire 20 feet wide which continued to spread in the dense chamise fuel and to produce a small, clean burn. Air temperature was 58°, relative humidity was 46%, wind was 10 mph.

The following conditions prevailed on March 3, 1951 at 2:30 p.m.:

Brush type	Dense, mature chamise
Air temperature	55°
Relative humidity	45%
Days since rain	2
Wind velocity	7 mph
Fuel moistures:	
new chamise leaves	135%
old chamise leaves	92%
dead twigs	5%

Under these conditions five separate attempts to burn untreated standing brush using flame throwers failed.

Successful Ignitions

Plots which were sprayed with pentachlorophenol on February 19 and February 27 ignited easily on March 3 and burned clean. Chamise leaves from the plot sprayed February 19 had a moisture content of 31%.

Two plots on which the chamise had been smashed down on February 19 also ignited easily and burned clean. Leaves on this brush had a moisture content of 32%.

Two plots with untreated standing brush were burned clean when a line of fire was formed across them using V ignition.

Firing Plans

Three controlled burn firing plans have been described by investigators of the U. S. Forest Service as center firing, strip firing, and edge firing.

Center firing is limited to small, level areas where little or no wind is anticipated. The first fires are started in the center and allowed to spread until a large volume of heat is generated. Then other fires which are started farther from the center are drawn toward the center by indraft of air to the original fires. Fires started in the center seldom run toward the edge because the large volume of heat acts as a stabilizer. Wind velocities of eight to 10 miles an hour from all sides toward the center are often experienced when center firing is employed.

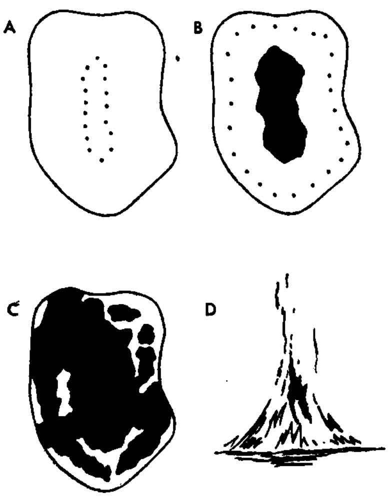
Strip firing is used on slopes or where prevailing wind will cause fire to run in one direction. The purpose of this method is to burn the area by small fast-running head fires, with no large volume of flame near control lines. The first fires are started on the up-slope or leeward edge. When that is burned out, firing crews are moved 100 feet farther in. As each successive strip is fired, larger strips can be burned because the firebreak ahead is widened.

Edge firing is used when fires are started along control lines and allowed to burn into the center of the area. It is commonly used because it is the simplest firing plan. In dense brush it is the only safe plan which can be used unless trails are cut or smashed in advance of the actual firing.

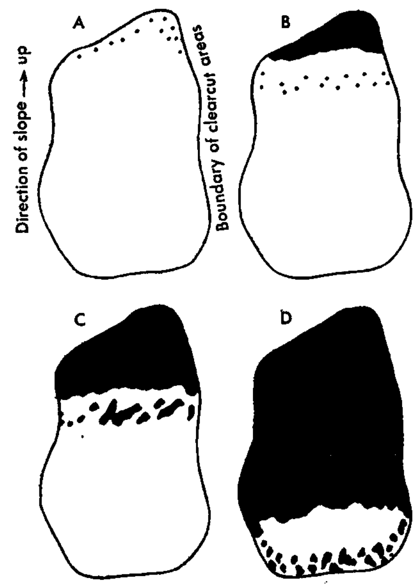
It is rare that any one area can be fired effectively with just one of these plans. A combination of strip, edge, and center firing tailored to fit the topography, fuel type, and anticipated weather conditions usually is the most satisfactory.

Firing dense brush is dangerous at best. Under no condition should one man

***Left.* Railed and dried live oak and ceonothus in the foreground before ignition on April 21, 1951. *Right.* Hot fire in the railed brush when comparable standing brush could not be burned even with flame thrower.**



• Starting point of fire
■ Area burned over



• Starting point of fire
■ Area burned over

Courtesy of Kenneth P. Davis and Karl A. Klehm, U. S. Forest Service

Left. Diagramatic illustration of center firing method of burning. A.—First fires started in center of area. B.—Fires in center united; second series of fires started near edge. C.—Inner and outer fire beginning to merge; fire spreading out to edge of area. D.—Cross-sectional view of C showing smoke and flame drawn toward center. *Right.* Diagrammatic illustration of strip firing on slopes. A.—First fires started along extreme upper edge. B.—As soon as upper edge is well burned out, second strip of fires started 50 to 100 feet down the slope. C.—Third strip of fires started. D.—Final strip of fires started along lower edge.

be sent into dense brush to start fires. Two or three should always work together under such conditions. In center or strip firing a tractor or bulldozer should be walked along lines where firing is to be done to provide easy means of access and escape.

Any one of the four firing techniques—flame throwers, spraying, smashing, or V-ignition—can be used to start fire according to the plan prepared. Whenever there is doubt as to whether fire can be started at a given time or place, some special firing technique should be employed. Even then fuel and weather conditions can make successful firing impossible.

Time of Ignition

The question of when to burn must be answered at the site of the proposed burn after a careful study of the fuel structure, topography, type of control lines, manpower and equipment available, present and anticipated weather conditions, and size of the burn. The co-ordination of the effects of all these factors must come from past experience and from rule-of-thumb guides.

Under severe conditions of wind, temperature, and humidity, it may be impossible to control any fire which is started. Conversely with little or no wind, low temperature, and high humidity, ignition may be impossible.

The fire-boss who selects the best combination of firing plans for the conditions under which he must burn, and who uses appropriate fuel manipulation or ignition techniques increases the probability of obtaining an effective burn while decreasing the probability of escape.

(To be continued)

The fifth and last section will be published in July.

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ORANGEWORMS

Continued from page 4

with the regular oil spray for scale insects and mites, or by making a subsequent spray treatment after the oil spray has been applied. When incorporated in the oil spray, cryolite, one pound, or DDD, 50% wettable powder, one pound per 100 gallons of oil spray are satisfactory.

Under no circumstances should cryolite or DDD be added to the regular oil spray except under the approval of the manufacturer of the oil being used.

For water sprays in the fall any one of the spray formulae suggested for spring treatment of navels and Valencias may be used.

Usually the only time that pyroderces on Valencias need control treatment is during the fall when the fruit is mature and still on the trees. For application with a conventional spray rig, less tower, as a thorough outside coverage one of the following formulae should be used: *1*, DDD, 50% wettable powder, two pounds in 100 gallons of water; or *2*, parathion, 25% wettable powder, three fourths to one pound in 100 gallons of water. For application with a speed sprayer, sprayduster, or boom sprayer and in 300 to 500 gallons of water per acre, either DDD, 50% wettable powder, 12 pounds per acre; or parathion, 25% wettable powder, nine pounds per acre is satisfactory.

If it is desirable to add materials to the regular oil spray application for scale and mite control DDD, 50% wettable powder, at the rate of 1½ pounds per 100 gallons of oil spray is recommended.

Where mixed populations of various orangeworms occur in sufficient numbers to make control desirable, the formulae suggested for the control of pyroderces should be used.

Applications against orange tortrix on lemons should be made when the populations of orange tortrix occur in sufficient numbers to make control desirable. For sprays, one pound of cryolite should be added per 100 gallons of the regular oil spray formulation for scale and mite control, with a conventional spray rig. Water sprays may be used as suggested for orange tortrix on navel and Valencia oranges. Dusts of straight cryolite at 75 pounds, cryolite, 50% at 90 pounds, or DDD, 5% at 90 pounds per acre, may also be used to control orange tortrix on lemons.

Ability to judge whether or not a treatment for control of orange tortrix and pyroderces is warranted at a time when maximum results would be obtained is very difficult. No entirely satisfactory criterion is currently known. Therefore, except in groves that have a history of annual losses from orangeworms or where infestations are heavy enough to be evident at the time, treatment must necessarily become one of insurance and should be so considered.

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