Use of Fire in Land Clearing

selection and preparation of the area to be cleared by planned application and confinement of fire important

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The second 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 at site of burn.

Landowners planning to clear brush land with fire as their tool will not find ideal burn areas on their property. They should look for characteristics of the ideal burn so they can select the best natural burning units on their property.

The ideal burn area has five characteristics:

1. Barriers to fire spread—control lines—completely surround the area.

2. Grass or other fine, dead fuels extend into the burn a short distance from control lines.

3. Ground surface slopes up from control lines into the burn.

4. Air movement into the burn will occur as firing is conducted along control lines.

5. Fuel conditions within the burn are such that, following ignition, fire will spread over the entire area in the desired manner.

Barriers to Fire Spread

Whether occurring naturally or constructed for the purpose, a barrier to fire spread—the control line—must stop two types of fire spread. It must stop surface fire and crown fire. In addition, it must be located to reduce the probability of spot fires. Any control line which is not located and constructed to do these three tasks is a source of trouble on the day of the burn.

Surface fires are stopped by an interruption in continuity of litter, grass or other materials which make up surface fuels. This part of the barrier need not be wide, but it must be cleared to mineral soil.

Any control line not having a portion of its width down to bare mineral earth is a source of upset firing schedules, unnecessary fire fighting, and often invites a costly escape on burn day.

Crown fires are stopped by a separation of the brush canopy. Width of canopy break necessary to prevent crowning across the control line depends on three things: *1,* the amount of heat generated on the burn side of the line; *2,* whether the heat is directed by wind and topography back into the burn or across the line; and, *3,* the nature and condition of fuels outside the burn.

To reduce the probability of spot fires, barriers are selected which bear a favorable relation to hazardous fuels, anticipated wind movement, and topography. Of the 46 escapes studied in 1950, 20 were due to spot fires and 80% of these spot-fire escapes were caused by changeable wind, crowning in live oak thickets, or debris accumulations near control lines.

Location of Control Lines

Existing barriers are the first consideration in the selection of control line locations. Physical barriers such as roads, rock outcrops, bodies of water, or recent burns are most commonly sought as control lines. Fuel-type barriers and topographic barriers should not be ignored.

Fuel-type barriers occur when vegetation or other fuel is sparse or high in moisture content. Any change from one fuel type to another wherein rate of spread of fire or resistance to control is reduced is such a barrier. An irrigated pasture is an ideal control line of this kind.

Topographic barriers occur along ridge tops or at the bottom of fairly wide canyons or draws. Because fire travels more readily uphill than down, location of control lines near these breaks in topography will take advantage of this fact.

Control lines should not be located in the bottom of narrow canyons where—because of heavy accumulations of fuel, shifting wind, and up-slope on both sides—there is a constant threat of escapes by the fire spotting and crowning across the control line.

The safest control line is one which is a combination of all three types; for example, a road—physical—near a ridge top—topographic—where adjacent brush density—fuel-type—is low.

Good control line location avoids hazards. In addition to live oak clumps and debris accumulations, snags, stumps, and rotten logs inside the fire become spark throwers; the same materials outside control lines are spark receivers.

The control line must be located to avoid fuels which will throw or receive sparks.

Piles of dead fuel which are impossible to avoid in line location should be burned during winter months.

One of the most commonly neglected elements of a good control line is straightness. A bend concentrates heat in a small area and makes line holding and patrol

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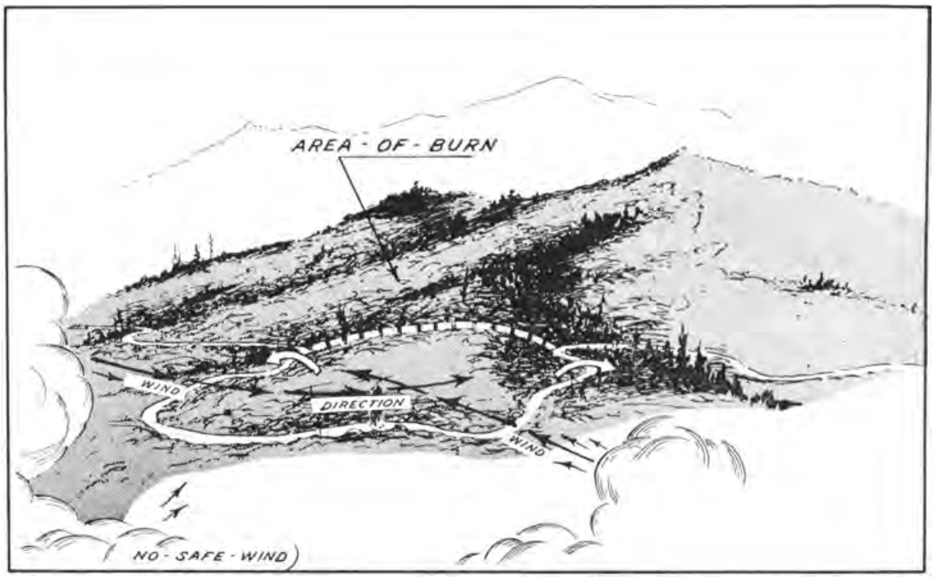
Left, **a good control line with an up-slope away from control line. Light fuel—grass—is adjacent to line and no heavy accumulations of fuel are on the outside of the line.** ***Right,*** **a good flame angle with the flame, hot gases and embers comprising the convection column deflected by wind and drafts.**

work longer and more difficult. Even more important, angles or bends in a control line increase the probability of spot fires being caused by shifting winds. A right angle turn in a control line, as commonly found at a property boundary, allows only a 90 degree change in wind direction before wind is blowing flame and embers over the line.

Whenever possible lines should be located where there will be little danger of rolling material carrying fire across the line. Lines located near the bottom of long, steep slopes are particularly vulnerable to rolling material.



A road which follows the contour along the side of a hill often has U turns around ridges or in canyons. Here a shift in wind direction of a few degrees will blow fire over the road. A simple construction job, indicated by the broken line not only shortens the control line but the probability of slop-over and spot fires is greatly reduced, the work of firing and holding crews is minimized, and patrol is shortened.

Line Construction

No matter how effective existing barriers may be, some type of line construction work is usually necessary. When existing barriers are inadequate at the mineral soil line or at the crowns, they must be improved.

The necessary width of line in mineral soil varies from a few inches in light litter to several feet in heavy fuels. The rotten remains of an old stump or log, a few leaves, or a patch of grass roots extending across this mineral path will nullify the barrier as a control to spread of surface fire.

Under ideal conditions canopy separation need be no wider than the height of the cover canopy which will be burning. As the actual situation deviates from the ideal, any condition of wind, topography, fuels or combination of these factors which increases radiant heat or directs flame and hot gases across the control line necessitates a wider canopy separation.

It is not always possible to avoid hazards by line location. In this case hazards are removed prior to the burn. Control lines to connect existing barriers and to shorten control perimeter are often constructed.

If control lines are located where rolling material may cross them, trenches must be dug which will catch and hold any rolling, burning fuels.

Secondary control lines are important safety measures. If these emergency lines are not available to fall back to, an escape may develop into a major wild fire. Landowners can well afford the insurance which an old road or an opened-up ridge provides.

Bulldozed primary or secondary lines should be planned as access roads whenever possible. Since transportation and communication are essential to a well-conducted burn, control-line roads increase the safety of controlled burning. Moreover, such roads may become part of the permanent road system for the property.

Control lines which follow arbitrary boundaries—such as shown below—are seldom satisfactory. In this illustration the line across the hill would be difficult to defend while a line in the grass would be safe, easy to build, and effective.

Topography and Wind

The adequacy of any control line largely depends on how fire burns in fuels adjacent to it. Hence barriers, line location and line construction only partially determine how well the lines will contain fire. Slope or wind movement as well as other factors may reinforce or destroy the effectiveness of a control line.

Ideal characteristics of up-slope and air movement into the burn are similar in their effect on fire spread. They tend to bring the convection column and its flame and hot gases closer to the unburned fuel ahead of the fire. Wind bends the convection column toward the fuels, while slope has the effect of bringing the fuels closer to the convection column. The result is a more rapid rate of spread upslope and with the wind.

Up-slope and in-wind make line holding and patrol work easier because they tend to direct heat and flames away from unburned fuels across the control line. Probabilities of spot fires are also reduced when these ideal characteristics are approximated. Favorable slope conditions can be obtained by proper location of control lines. Orientation and shape of a burning unit should take full advantage of prevailing winds expected at the time the burn is to be conducted. Ignition can often be timed to coincide with the daily shift of wind in a particular locality. This, along with creation of drafts by proper firing techniques, often makes it possible to achieve the ideal characteristic of air movement into the burn as firing is conducted around the burn perimeter.

Fuels

Control lines located in grass or other light fuels—the second ideal characteristic—give maximum safety and minimum cost due to:

1. Easy control line construction by machine or by hand.

2. Easy ignition for rapid and certain firing.

3. Brief, easy line holding.

4. Minimum patrol effort.

Easy ignition to obtain rapid and certain firing is one of the most critical aspects of controlled burning. In 1950, 45% of the burns were not considered satisfactory due to poor removal of vegetation. Most of these unsatisfactory results

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Insufficient quantities of fine dead fuel result in a spotty burn.

Raisins for Turkeys

fed at will with no harmful effects on growth and quality

F. H. Kratzer and D. E. Williams

Raisins may replace 30% of the grain portion, or 16% of the entire ration for turkeys in the late growing periods without markedly affecting the gains in body weight, efficiency of gain or market grade of the birds.

Cull raisins are frequently available—and in times of surplus—top grade raisins are relatively inexpensive for livestock feeding.

Raisins contain 3% to 4% crude protein and about 80% carbohydrate. Their value in animal feeding depends on their carbohydrate content which makes them a possible substitute for cereals.

An experiment was conducted in which various levels of raisins were fed to growing turkeys to test their value as substitutes for cereals in the ration.

Crossbred turkeys were divided into four groups ranging from 30 to 33 birds per group. The turkeys were started on the feeding trial at 18 weeks and were continued until 30 weeks of age.

The control ration was a practical growing mash plus a mixture composed of 60% whole barley and 40% whole wheat. During the first four weeks of the trial 40% of the total ration was grain; for the remaining period a mixture of equal parts of grain and mash was fed.

In the second group 10% of the grain was replaced by raisins; in the third group the replacement was 30%; and in the fourth group the turkeys were fed the grain and mash mixture, and also were allowed to eat raisins at will from a separate feeder.

The levels of raisins consumed by the various groups were 4.7% for group two, 14.3% for group three, and 16% for group four.

Some difficulty was experienced early in the trial in getting the turkeys in group four to eat the raisins. When they were mixed in the feed the birds selected them out but when they were fed alone the turkeys were reluctant to eat them. After some raisins were scattered in the feed for a few days the birds started consuming them and no more difficulty was experienced.

The gains for the experimental period were similar in all the groups, showing no reduction in growth even when the turkeys were permitted to eat the raisins at will. Nor was the efficiency of gain significantly different in the other groups.

Breast measurements were taken at the completion of the experiment, and no significant differences between groups were found in the width of the breasts.

The toms were dressed and market grade data obtained for them. There was little difference in the percentage of grade *A* birds between the groups fed high levels of raisins and the control group—group *1*.

No deleterious effects were observed during the feeding trials even among turkeys in group *4* which were allowed to eat the raisins at will and as much as 16% of the total ration.

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Effect on Growth, Feed Efficiency and Market Grade of Feeding Various Levels of Raisins to Turkeys from 18 to 30 Weeks of Age

Group	Levels of raisins fed (as per cent of grain replaced)	Raisins consumed (as per cent of total feed)	Number of birds	Average gain in weight of males and females (pounds)	Pounds gained per pound of feed	Av. breast width at 3 cm from tip of keel (cm)	Per cent of males in A grade
1	0	0	31	7.3	0.143	7.68	83
2	10	4.7	33	7.7	0.137	7.66	100
3	30	14.3	33	7.5	0.142	7.38	84
4	At will	16.0	30	7.5	0.132	7.46	82

FIRE

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occurred because fires could not be started when and where the landowner wished. This ignition problem is reduced when fire lines are located in grass, for this fuel usually burns rapidly when relative humidity is less than 30%. Rate of spread in grass is rapid and rate of combustion is rapid—thus the effective fire line is widened rapidly and flame is adjacent to the line for just a few minutes.

Ideal fuel conditions within the burn—the fifth characteristic—should be such that the fire will spread over the area in the desired manner. Fuel characteristics which may limit or promote the effective spread of fire within the burn are moisture content, size, amount, and distribution of fuels.

Many different fuel moistures exist in wildland areas and each changes at varying rates. The moisture content of dead fuels varies directly with relative humidity. Moreover the moisture content of fine, dead material—grass or leaves—reacts almost immediately to changes in relative humidity. Under normal summer weather conditions, when relative humidity is above 35%, the moisture content of fine fuels is above 12% and they will rarely carry fire. Thus an effective burn seldom can be obtained when relative humidity is over 35%. Relative humidity measured on the fire line is useful in predicting fire behavior. However, caution should be exercised in using relative humidity as an absolute indicator of how fire will behave. Changes in moisture content of larger fuel particles such as large twigs and brush limbs lag several hours behind changes in relative humidity. When humidity is falling these fuels may not be dried out enough to burn well though fine fuels are ready to burn. They will, however, continue to burn well after fine fuels become noninflammable as humidity increases. Fuels like down logs and snags progressively dry out all through the summer and ordinarily do not burn very well until late in the season.

In contrast to dead fuels, green leaves and other living plant materials have a high moisture content. The water content of new foliage in the spring lies between 150% and 300%. This drops steadily until in July or August it reaches a minimum between 65% and 85%, to rise back to about 100% through the winter. The fact that at its minimum moisture content green material has four to 10 times as much water as comparable dead material shows how important the percentage of dead material in a brush stand may be in the carrying of fire.

There must always be sufficient quantities of fine, dry, dead fuels to carry the flame. A stand of dry grass, an inch or two of dry leaves and twigs on the ground, dead leaves and small stems in

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COTTON

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defoliation are also typical of the two-spotted mite.

The spots in the body of two-spotted mites are considered by some entomologists to have characteristics that distinguish this from other species; others say these are not dependable characters. During the investigations in the 1949 and 1950 seasons it was found that adult females very rarely had spots close to the caudal tip even though the body spots are variously broken into sections. It is believed—in looking at many mites of a large population—that the character of no-tail-end spots is of considerable value in field identifications of this spider mite.

In some recent life history studies of the two-spotted mite in Virginia it was found that the life cycle was greatly shortened by high temperatures. The males and females molted three times, although some previous studies had shown the male molted only twice. At constant temperatures of 75° F the males developed to adults in six days, the females in seven days. Oviposition occurred any month of the year when temperatures rose to about 50° F and even though the temperature fell to 0° F and there was snow, the overwintering adults, eggs and larvae were found on new growth of weeds in the fields in late February and early March. Incubation of mite eggs varied from three days at a constant temperature of 75° F to 21 days at 52° F. The time of larval, nymphal and molting stages was similarly affected by the temperature.

The greatest color variations of the two-spotted mites occur between host plants, although there are color variations on any one host. On cotton in the San Joaquin Valley there is a predominance of shades of green with some amber and slightly pink color. Late in the season the overwintering mites are mostly orange.

The two-spotted mite attacks about 200 known host plants including weeds, truck, field, and orchard crops as well as ornamentals, native annuals and perennials.

Control Methods

The districts in which spider mites have been pests of cotton and other crops should be thoroughly cleaned of weeds and well cultivated before cotton is planted. Fence rows, ditches, orchards, vineyards and weedy areas of unfarmed land nearby are some of the most important sources of these infestations in crops.

The two-spotted spider mite has been the most difficult to control on California cotton. None of the dusts or sprays has given more than an occasional satisfactory control when applied by aircraft. Sulfur has given good control of the Atlantic mite but not of the others and nothing has been found to replace the sulfur or to be a near substitute for it.

In 1949 the serious infestations of the Pacific mite were controlled with dusts containing 1% parathion. It was found then that if the maximum temperature reached 95° F or above, the residual effect of parathion was not sufficient to control mites hatching three to four days after it was applied. Therefore, two applications with an interval of four days is required when temperatures are high. This treatment of two applications of 1% parathion dust was found to control the two-spotted mite if thorough coverage was obained with row-crop equipment.

Dusts containing 3% and 4% Aramite—88R—were effective in but one application per treatment. Both of these gave mostly poor control of two-spotted mites when applied by aircraft.

Physical properties close to those of a good grade of dusting sulfur are most desirable in cotton dust formulations.

Findings indicate that if the diluents used produce a dust of greater or less density and dustability than dusting sulfur—95% of which will pass through a 325 mesh screen—good underleaf coverage will not be obtained with the usual applicants by aircraft.

Results with several other new acaricides are inconclusive.

Some of the other injuries of cotton foliage resemble that of spider mites. The term, rust-of-cotton, is frequently used for this reddening of foliage but it should be used only for the potash deficiency disease of cotton.

Cotton foliage injured by bean thrips is discolored but the color is a metallic silvering changing to bronze in the advanced stage and with shiny black specks of excrement throughout the injured leaf areas. There is none of the webbing which spider mites produce. Cotton growing on excessively alkaline soils shows a marginal reddening of the leaves.

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FIRE

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the brush crowns are the fine fuels needed to do the job.

Fuel volume and distribution deals with quantity as well as horizontal and vertical distribution of fuels. When fuel particles are too sparse horizontally, fire will not spread and in many cases will go out and leave areas unburned. Vertical distribution is just as important as horizontal distribution in creating a fuel bed structure which will support fire. There must be fine, dead fuels both on the ground and in the crowns to generate enough heat to keep a crown fire going.

Caution

There is no ideal burn, and selection and preparation of any area to be control-burned, involves a great deal of judgment. Controlled burning involves a calculated risk.

The skill and judgment which an individual uses to balance the effects of width of fire line, slope, vegetation type, anticipated wind and other climatic factors must come from experience. State or county fire control organizations—from which a landowner obtains his burning permit will advise with him.

It is impossible to set down by rule or law specifications for control lines applicable to all conditions in the state or for all types of burning weather; circumstances alter cases and there is no substitute for on-site study of selection and preparation problems.

(To be continued)

Part III, "Planning and Organizing for the Fire" will be published in May. Sections on "Managing the Fire: Ignition" and "Managing the Fire: Control, Patrol and Mop-up" will be published in subsequent months.

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CORRECTION

In the article, *Olive Tree Spacing*, published on page 13 of the March, 1951 issue of CALIFORNIA AGRICULTURE the figures for the yields should read as shown in the reduced table below.

	Yield per tree		Yield per acre	
	Close spacing (30 x 30)	Wide spacing (44 x 44)	Close spacing (30 x 30)	Wide spacing (44 x 44)
Average of 5 years	**32 lbs**	**137 lbs.**	**1,496 lbs.**	**3,132 lbs.**
Annual increase in yields due to wide spacing		**105 lbs.**		**1,636 lbs.**
Per cent increase in yields		**328%**		**109%**