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APPLYING HERBICIDES TO DESICCATE MANZANITA BRUSHFIELDS BEFORE BURNING

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On small plots in a greenleaf manzanita brushfield, herbicides applied as a foliar spray in May killed the small-fuel fractions of the shrubs (leaves, twigs, and small stems up to ½-inch diameter) by October, in tests near Mount Shasta, California. Late summer spraying did not kill most of the small fuels until the next spring, and September sprays required 1 year to produce equal kill. On those shrub branches having dead small fuels by October, the stems, up to 2-inch diameter, dried during cold winter weather; most stems were ready for burning by early spring. Picloram, not effective as a foliar spray on manzanita, produced almost complete kill of manzanita and understory shrubs when applied as pellets on the soil surface at 8 or more pounds, a.e., per acre. A mixture of 2,4-D and 2,4,5-T, or 2,4-D alone, sprayed in May or June at 4 pounds, a.e., in 5 gallons of diesel oil per acre adequately desiccated greenleaf manzanita in small plots and on large areas. The results suggest proper timing for both the desiccation treatment and the prescribed burning to remove brush from California mountain lands.

Oxford: 176.1 Arctostaphylos spp.:414.22 + 187x 42.5:436–432.16
Retrieval Terms: manzanita; herbicide applications; fuel dessication; chaparral control; 2,4-D; 2,4,5-T; picloram.

Increasing the proportion of dry to green vegetation, by mechanical treatment or herbicide desiccation, before broadcast burning of dense brushfields promotes better consumption of heavy woody material under relatively safe burning conditions. Mechanical fuel preparation—slashing, crushing, or uprooting of the shrubs—severs stems and compacts the plants into a continuous bed of dry fuel. Herbicide applications aim at killing and desiccating upright shrubs without compacting the fuelbed.

If a plentiful supply of dry litter and small dead stems occurs naturally under a stand of brush, desiccation of most of the green leaves and twigs will promote easy ignition and rapid buildup of a hot fire under a low burning index.[1] But if the naturally dry fuels are scanty, the herbicide desiccant needs to kill and dry all of the small fuels of high surface/volume ratio, including green stems up to ½-inch diameter. However, desiccating only the small woody fuels does not assure consumption of the upright green stems; larger stems also should be killed and dried by the desiccation treatment before attempts are made to remove all heavy woody material by burning.

The effects of different herbicides and application techniques on killing of the small fuel fractions and larger stems of shrubs in a manzanita brushfield were determined from small-plot tests started in 1967 near Mt. Shasta, California. On the basis of our results, we concluded that for proper timing of a spray-and-burn operation in California mountain brushfields...

1. Areal spray during the period of active shrub growth—in May or June or perhaps in early July—with low volatile ester of 2,4-D, singly or in combination with 2,4,5-T, in diesel oil to make a total of 5 gallons per acre. Delay of spraying later into the summer will slow the rate of plant dying; if delayed until fall the plants may not start to die until the next

spring, which will delay proper date for burning by one full year.

2. Allow stems as well as leaves and twigs to die and dry before burning. Even though leaves and twigs turn uniformly brown during summer and fall, the stems will still hold excess moisture and will provide little, if any, dry fuel. The dead leaves and twigs may add to buildup of a hot fire during the fall, but large green stems usually will not be consumed. Stems of sprayed brush plants will die and dry during cold winter weather, and will become dry fuel that is readily consumed.

3. Burn the dead and dry brush during the next spring or early summer under a prescribed low brush burning index. Schedule burning to leave about 1 year for the brush to die and dry after spring or early summer spraying with a systemic herbicide.

STUDY SITE

The plots were in a mature brushfield that contained a scattered stand of ponderosa pine (*Pinus ponderosa* Laws.) and white fir (*Abies concolor* Gord & Glend.). The dense shrub cover was dominated by greenleaf manzanita (*Arctostaphylos patula* Greene) which averaged 5 to 6 feet tall and formed a discontinuous canopy above the other shrubby species. Other shrubs were snowbrush (*Ceanothus velutinus* Dougl. ex. Hook), chinquapin [*Castanopsis sempervirens* (Kell.) Dudl.], bittercherry (*Prunus emarginata* Dougl.), and whitethorn (*Ceanothus cordulatus* Kell.). Oregon boxwood (*Pachistima myrsinites*) occurred as a semishrubby plant beneath the shrubs.

The study area is 3900 feet elevation on level terrain. Annual precipitation averages about 37 inches per year, nearly equally divided as rain and snow. Summers are warm, with slight rainfall. Soil is a light sandy to gravelly loam of volcanic origin. The area is classified as Site 111 for ponderosa pine growth.

HERBICIDE TREATMENTS

Foliar Sprays

The broadcast spray tests included different combinations of 2,4-D (2,4-dichlorophenoxyacetic acid), 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), and picloram (4-amino-3,5,6-trichloropicolinic acid) at various dosages and different seasons of applications. Some exceedingly high dosage rates, aimed at complete plant kill as quickly as possible, were far in excess of any herbicide rates contemplated for practical use on California brushlands; other tests compared 2,4-D and 2,4,5-T, singly and in combination, at rates potentially useable for desiccation of brushfields (*tables 1-3*).

Time available for applying sprays limited the replication to two plots for each treatment—one plot located at random in each of two blocks in each individual study. But observations of the many treatments provided excellent opportunity for selecting effective treatments which should produce consistent results.

The broadcast sprays were applied from a portable boom sprayer especially designed for uniform applica-

Table 1. Kill of small fuels (leaves, twigs, and stems up to 1/2-inch diameter) and time required for their dying, for foliar sprays applied at 3 different dates.

Spray date	Herbicides		Percent of small fuels killed, and weeks after treatment required to reach this rating, by species:										
	2,4-D and 2,4,5-T	Picloram	Greenleaf manzanita		Snowbrush		Chinkapin		Bittercherry		Whitethorn		All species
	Pounds per acre[1]		Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.
Sept. 1, 1967	9.0	0.0	100	50	---	--	67	55	100	70	100	62	78
	26.0	0.0	100	50	100*	65	99	75	93	90	99	60	86
	5.5	1.0	99	52	---	--	34	50	67	90	100*	60	82
	17.5	3.0	99	52	---	--	77	90	100	70	100	65	88
May 4, 1968	11.0	0.0	100	15	100*	40	100*	58	100	50	100*	40	98
	31.5	0.0	100	18	100*	60	73	58	93	55	93	45	89
	6.0	1.0	100	23	93*	40	84	58	98	55	98	40	86
	18.0	3.0	100	23	---	--	100	58	100	50	100*	35	95
July 30, 1968	9.0	0.0	99	35	---	--	47*	45	64	45	100	90	73
	27.5	0.0	100	30	93*	45	36*	45	98	45	100*	90	84
	6.0	1.0	100	32	100*	50	47*	45	100	45	100*	90	92
	18.5	3.0	100	32	100*	45	56	45	93	45	---	--	86

1/ Pounds acid equivalent n-butyl esters of 2,4-D and 2,4,5-T in a 1:1 mix, and isooctyl ester of picloram, mixed with solvent to make a total volume of 5 to 6 gallons per acre. NOTE: These herbicide mixtures and excessive dosages have not been recommended for practical use in California.

* Data from only one plot per treatment.

tions over tall shrubby vegetation.[2] The liquid spray material was applied from nozzles geometrically spaced along the outer 20 feet of a 25-foot boom which was rotated around the top of a tall tripod to cover a doughnut-shaped plot of 1885 square feet, 0.043 acre.

Pellet Applications

Picloram, the only herbicide tested in pellet form was applied at 4 to 16 pounds, a.e., per acre on two dates. Each plot, measuring 66 feet on a side, covered 0.1 acre. The pellets were hand broadcast by crew workers moving along lines cut through the brush at intervals of 33 feet. On each trip through a plot, they applied the pellets at a gross weight of 20 pounds per acre; repeated trips were made to apply gross weights of 40 to 160 pounds per acre.

DESICCATION RATINGS

Effectiveness of each herbicide treatment was recorded quantitatively by a rating scheme developed for studies of herbicide desiccation.[3] The scheme was designed to record the extent to which green leaves, twigs, and stems up to ½-inch diameter had been killed and would eventually become dry small fuels—the first objective of a desiccation treatment. Follow-up records of stem moisture contents were needed to select those treatments that killed and dried the larger stems—the final objective. Because dying and drying of a shrub branch proceeds from leaves and twigs to small stems to large stems, the only effective desiccation treatments are those producing almost complete kill of the small fuel fractions.

Normal green vegetation showing no effects from the herbicide was assigned a small fuel desiccation rating of 0. After the leaves started to die, the rating increased, and it reached 45 when the leaves and twigs were dead and some ¼-inch stems were dying. After ½-inch stems started to die, the rating gradually increased from 65 to 99; it reached 100 when all these small stems were dead or dying and had become potential dry fuels. This quantitative rating system for small fuels served well in comparing the initial

Table 2. Kill of small fuels (leaves, twigs, and stems up to 1/2-inch diameter) from applications of 2,4-D and 2,4,5-T, singly and combined, at different dates and rates per acre.

Spray date	Herbicides		Kill of small fuels, by species:						
	2,4-D	2,4,5-T	No. of plots[2]	Greenleaf manzanita	Snowbrush	Chinkapin	Bittercherry	Whitethorn	All species
	Pounds per acre[1]			Percent kill					
Sept. 15-22, 1967	4	4	4	100 a[3]	100	71	80	100	85
	2	2	6	89	54	41	60	100	69
	4	0	2	100	63	43	63	100	73
	0	4	2	78	67	44	43	86	70
			10	89 ab	61	43	55	95	71
	1	1	6	69	45	33	41	47	60
	2	0	2	93	23	38	37	36	68
	0	2	2	54	54	47	40	86	52
			10	71 c	41	39	39	56	60
May 24, 1968	2	2	2	100	100	43	100	100	88
	4	0	2	100	33	12	37	30	80
	0	4	2	100	100	44	100	100	78
			6	100 a	78	33	79	77	82
	1	1	2	66	---	3	23	100	58
	2	0	2	74	0	0	37	100	66
	0	2	2	100	100	55	73	100	81
			6	80 bc	50	19	44	100	68
July 10-17, 1968	4	4	4	97 a	70	41	100	100	84
	2	2	6	94	65	25	69	99	74
	4	0	2	60	22	0	28	24	40
	0	4	2	88	28	40	100	86	77
			10	81 bc	38	22	66	70	64
	1	1	6	93	71	16	61	100	78
	2	0	2	58	17	14	37	---	45
	0	2	2	67	53	7	43	---	57
			10	73 c	47	12	47	100	60

1 Pounds acid equivalent of propylene glycol butyl ether ester of 2,4-D or 2,4,5-T in commercial formulations mixed with diesel oil to make desired total volumes per acre.

2 Four plots = 2 at 5 gallons and 2 at 10 gallons per acre; 6 plots = 2 at 5 gallons and 4 at 10 gallons per acre; all others at 10 gallons per acre.

3 Means with same letter not significantly different at 5 percent level.

Table 3. Kill of small fuels (leaves, twigs, and stems up to 1/2-inch diameter) for spray mixtures containing different amounts of 2,4-D, 2,4,5-T, and picloram applied August 24 to September 8, 1967.

Treatments			Kill of small fuels, by species:					
Spray volumes	Herbicides: 2,4-D and 2,4,5-T	Herbicides: Picloram	Greenleaf manzanita	Snowbrush	Chinkapin	Bittercherry	Whitethorn	All species
Gals./acre	Pounds per acre[1]		Percent kill					
1.0	9.5	0.0	81	92	51	60	93	70
5.0	9.0	0.0	100	--	67	100	100	80
			90 a[2]	92	59	80	96	74
1.0	6.0	1.0	76	75*	27*	49	100*	72
5.0	5.5	1.0	99	--	35	70	100*	82
			86 ab	75*	31	59	100	77
1.0	3.0	2.0	47	34	36	61	45	51
5.0	3.0	2.0	76	13*	43	80	80	62
			61 b	23	39	70	62	56
1.5	0.0	4.0	42	36*	10*	63	63	39
4.5	0.0	3.0	13	--	21	43	43	17
			27 c	36*	15	53	53	28

[1] Pounds acid equivalent n-butyl esters of 2,4-D and 2,4,5-T in a 1:1 mix, and isooctyl esters of picloram, mixed with solvent to make desired total volumes per acre. NOTE: These heavy dosages have not been recommended for practical use in California.

[2] Mean values for manzanita, based on 4 plots, are not significantly different at 5 percent level if letters are the same.

* Data from only one plot per treatment.

effects of herbicide treatments and in selecting the most effective treatments. Until the small fuel rating had finally reached a high level near 90, the desiccation treatment had not materially affected the larger stems.

Estimates of plant dying were made on all plots by one experienced observer. For each species on a plot, he estimated the average degree to which small fuels had been killed. If the kill was fairly uniform on all main branches, he made only one estimate for the species. If kill was spotty, he grouped the branches of similar kill into a stratum, estimated the proportion of total branches in each stratum, and calculated a weighted average for the species. This provided a descriptive record of treatment effectiveness. He also estimated the proportion of total small fuels on each plot made up by each species for later calculation of an average desiccation rating for all shrubby vegetation on the plot.

All plots were rated at irregular intervals, but progress of shrub dying on a few key plots was checked during more frequent visits to the plot area. From these records, a curve could be drawn to represent the trend of dying and the time period required to reach maximum small fuel desiccation rating on each plot. Descriptive records were taken to show the extent to which large stems had been killed and to show the amount of new green vegetation, if any, produced from buds below the dead stem portions.

The desiccation rating, or description, at any point in time indicated the extent to which the shrubs had been killed and would eventually dry to a low moisture content in equilibrium with atmospheric conditions suitable for prescribed burning, referred to as EMC. Dead leaves and twigs dried quickly to EMC. Dead small stems dried slowly, over periods of weeks to months. However, all of the dead and dying stems, both small and large, had a low "Potential EMC." To determine the typical length of time required for stems to lose moisture down to EMC at different times of year required sampling of stem moisture contents on only a few key plots. On each of these plots at least 10 branches showing a specific degree of kill were selected for repeated sampling. The stem samples were dried to constant weight in an oven, and moisture content was calculated on a dry weight basis.

KILLING OF SMALL FUELS BY FOLIAR SPRAYS

Season of Spraying

The season of the year during which a foliar spray is applied proved to be of utmost importance in determining the length of time required after spraying before the shrubs will die and dry sufficiently for burning. In addition, the herbicide treatments most promising for practical use were most consistently effective if applied during the season when reactions from herbicides were most rapid. These results are well illustrated by the effects of spraying on greenleaf manzanita, the dominant overstory shrub (*table 1, 2*).

Similar results were obtained for the understory shrubs, although the effects were more variable than for manzanita and generally smaller proportions were killed because of poorer coverage by the spray. Variations in kill of understory species by different herbicides appeared to be caused mainly by variations in the amounts of overstory manzanita rather than by resistance of the various species.

Results from spraying four herbicides at excessively high dosages illustrates the effects on manzanita from different seasons of spraying (*fig. 1*). These herbicide treatments, including herbicides and dosages not recommended for practical use in California, were intended to be in excess of dosages required for killing woody vegetation under any situation. Any treatment that included a combined total of more than 5.5 pounds, a.e., per acre of 2,4-D and 2,4,5-T finally killed all of the manzanita small fuels. But the time required for dying ranged from 15 to 52 weeks for the different dates of spraying, as follows:

- As is typical from fall spraying in the mountains, the sprays applied at the first of September in 1967 did not produce visible effects until May 1968. Temperatures were favorable (daily mean above 60°F) for a few weeks after spraying, but herbicide reactions probably were limited by moisture stress at the end of the dry season. After the start of fall rains in October, the breakdown and action of the herbicides probably were controlled by low temperatures. Starting in May the dying of leaves, twigs, and small stems proceeded rapidly until the end of July; the small fuels were uniformly dead by October 1.

- Sprays applied in early spring ahead of the period of most rapid shrub growth—in May 1968—quickly produced visible effects. Leaves were dead or dying by June, and dying of small stems proceeded rapidly during June and July. The ½-inch stems were dead by October 1, 1968. Progression of dying was only 2 weeks behind that on the plots sprayed in September, almost 8 months earlier. The results from early spring spraying were typical of those previously observed from spraying during the period of most rapid plant growth in June.

- Results from plots sprayed in mid-July 1968 showed that this date was later than optimum for rapid and complete dying of the small fuel fractions. Leaves and twigs soon started to die and most were dead by October 15, but many of the small stems were still alive. Some manzanita branches still contained green leaves. Dying continued, however, through the cold winter months, and all leaves, twigs, and small stems were dead by May 1969.

From these results and from previous observations of large areas sprayed in June, we concluded that spray-and-burn operations could best be planned around spray applications made in late May or in June. During this period in all years, the air temperature and soil moisture conditions are favorable for rapid growth of new leaves and twigs.

Delay of spraying until mid-July probably would produce adequate kill of small fuels, but reactions would be slow. Spraying in late summer or fall would delay reactions for many months, and burning should be delayed one year longer than after June spraying.

Kind and Rate of Herbicide

Either 2,4-D or 2,4,5-T, or a 1:1 mix of the two, produced uniform and almost complete kill of manza-

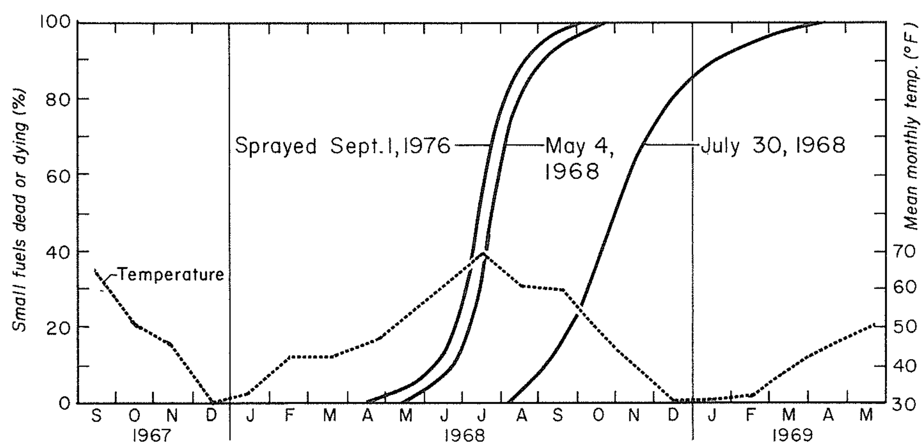

Fig. 1—Trends in dying of manzanita small fuels (leaves, twigs, and stems to ½-inch diameter) in plots sprayed on three different dates with herbicides at heavy dosage.

nita small fuels on plots sprayed with 4 pounds, a.e., per acre, provided the herbicide was applied before mid-July (*table 2*). On plots sprayed in mid-July or in September, 8 pounds was required to produce a kill comparable to that from 4 pounds during the optimum spray season. At lower rates, the herbicides produced inconsistent results, as shown by the variable kills from 2 pounds in May or 2 to 4 pounds in July or September.

The tests were inadequate to show consistent differences between effects from 2,4-D and 2,4,5-T, if differences do occur, in killing manzanita small fuels. An interaction between herbicide and application date was suggested. Other variations in the data were unexplainable.

Application of a 1:1 mixture of 2,4-D and 2,4,5-T along with combinations of picloram showed that the 1:1 mixture was consistently effective at 6 or 9 pounds per acre, but produced inconsistent effects at 3 pounds per acre when sprayed under unfavorable weather conditions (*table 3*).

Picloram, when applied alone, was relatively ineffective as a foliar spray for desiccating greenleaf manzanita (*tables 1,3*). When combined with the 1:1 mix of 2,4-D and 2,4,5-T, any possible effects from picloram were masked by heavy rates of the 1:1 mix. Other studies have shown that picloram is much less effective than 2,4-D in controlling greenleaf manzanita.[4]

Volume of Spray Material

Application of a 1:1 mix of 2,4-D and 2,4,5-T, for all rates of 2 to 8 pounds per acre combined, showed the same average kill for a 5-gallon per acre volume as for a 10-gallon volume.

In tests comparing 1 and 5 gallons per acre (*table 3*), the two volumes produced about the same degree of kill when relatively heavy rates of the 2,4-D/2,4,5-T mix were applied. At lower herbicide rates, however, the results from a 1-gallon volume were inconsistent, particularly for understory species. Observation of the plots showed that insufficient herbicide penetrated through the manzanita crowns from the low volume application.

In larger scale aerial applications, a 5-gallon per acre volume produced uniform desiccation of a manzanita brushfield where phenoxy herbicides were applied at 4 pounds, a.e., per acre.[5] The 5-gallon total volume per acre appears to give adequate crown coverage for use as a desiccation treatment on manzanita brushfields, provided sufficient amount of herbicide is applied.

PELLET APPLICATIONS

Picloram in pellet form effectively desiccated the shrubby vegetation regardless of application date, indicating little leaching loss from winter precipitation. Effects from an October application were apparent by early spring, and dying proceeded during the summer about 1 month ahead of that shown for the September foliar spray (*fig. 1*). From the March application of pellets, the trend of dying was similar to that from the May foliar spray. Effects from an August application in 1968, not complete at termination of the study, were later observed to be similar to those from the October pellet application.

Picloram pellets were consistently effective at rates of 8, 12, and 16 pounds, a.e., per acre (*table 4*). At the 4-pound rate, however, the kill of small fuels was not so uniform and dying extended over a longer period of time. Spotty occurrence of unaffected plants on the 4-pound plots reduced average kill on these plots; it appeared to be caused in part by uneven coverage with the small amount of pellets.

The pellets produced more complete desiccation of the entire shrub stand than was obtained from foliar sprays. More of the shrubs were killed under the manzanita canopy which did not intercept the pellets as it did foliar spray. More of the large stems were killed to ground level, and regrowth of green sprouts was greatly reduced. Even though the pellets proved to be more effective than foliar sprays, the most effective foliar sprays killed enough of the shrub top growth for adequate desiccation of manzanita brushfields. They have the advantage of being cheaper than pellet applications, and the phenoxy herbicides are less persistent than picloram.

DRYING OF DEAD STEMS

On plots having a small-fuel desiccation rating of 100 for manzanita, by October 1968, only the finest fuels—leaves and twigs—had dried to EMC. Although many small stems were visibly affected by the herbicide treatment, they still contained considerable moisture. On all plots with lower desiccation ratings the small stems were still green and had near normal moisture content; on some plots part of the leaves also were green.

Three important stages, or classes, of dying and drying of foliage and small stems on manzanita branches were apparent in October:

1. Dead, dry leaves; dead or dying ½-inch stems; plot rating 100.

2. Dead, dry leaves; mainly alive ½-inch stems; plot rating at least 50.

Table 4. Kill of small fuels (leaves, twigs, and stems up to 1/2-inch diameter) from applying picloram in pellet form to the soil at different rates on two dates.

Application date	Amount of picloram	Percent of small fuels killed, and weeks after treatment required to reach this rating, by species:										
		Greenleaf manzanita		Snowbrush		Chinkapin		Bittercherry		Whitethorn		All species
	Pounds per acre[1]	Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.	Wks.	Pct.
October 18, 1967	4	80	85	13	40	14	45	61	80	14	50	55
	8	100	50	100*	45	69	85	99	55	99	85	86
	12	100	45	100*	50	100*	45	100	55	100	60	93
	16	100	45	100	60	100	65	98	60	93	85	98
March 4, 1968	4	92	65	18	25	30	25	53	55	43	25	64
	8	100	35	100*	85	35*	25	100	55	100	75	81
	12	100	25	100*	30	100*	75	93	55	100	75	86
	16	100	25	100*	27	100*	50	100	55	100	40	92

[1] Pounds acid equivalent = 10 percent of gross weight.

* Data from only one plot per treatment

3. Both dead and green leaves; green ½-inch stems; plot rating below 50.

In October 1968, samples for stem moisture content determinations were taken from each of the three classes of branches. The ½-inch, 1-inch, and 2-inch stems were sampled on two, or more, plots having small fuel desiccation ratings of 100, over 50, and under 50. Stem samples were taken again in May 1969 from the same branches sampled in October to determine the patterns of overwinter drying of stems on each class of branches.

Small fuels on those manzanita plants partially dead in October continued to die during the cold winter weather; by May the desiccation rating was 100 for all plots from which stem samples had been taken, even those plots having ratings below 50 in October. Stem moisture contents dropped materially during the winter on all plots having October desiccation ratings from less than 50 up to 100 (*fig. 2*). For all manzanita branches which had dead, dry leaves and twigs in October, and either dead or living small stems, the moisture contents of individual samples in May ranged from 9 to 12 percent for ½-inch stems, 9 to 13 percent for 1-inch stems, and 14

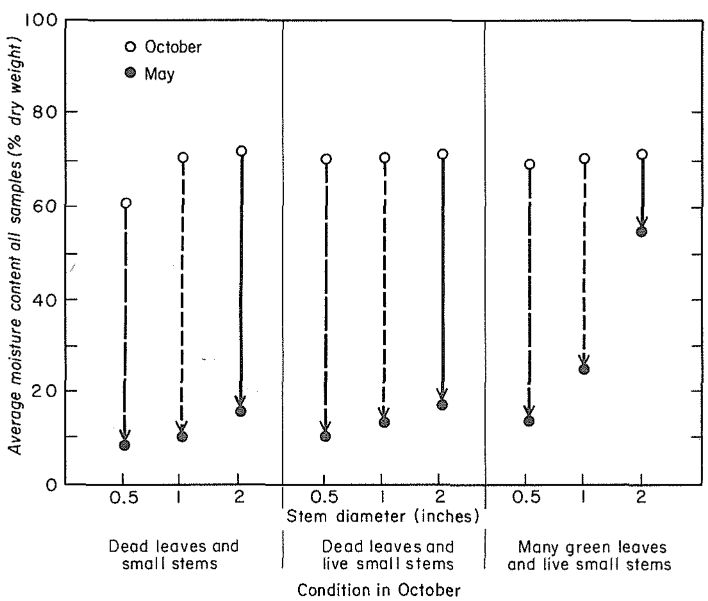

Fig. 2—Over-winter drop in stem moisture contents for manzanita plants affected to different extents in October by earlier herbicide spraying.

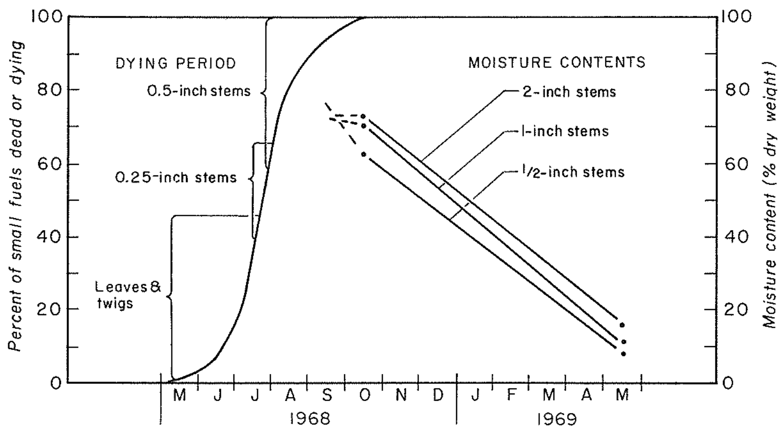

Fig. 3—Observed trend in dying of manzanita small fuels and approximate trends in loss of stem moisture in plots sprayed on May 4, 1968 at heavy herbicide dosage.

to 20 percent for 2-inch stems. For the branches containing many green leaves in October but only dead, dry leaves in May, the individual samples showed much more variation in stem moisture content in May: 10 to 39 percent for ½-inch stems, 11 to 61 percent for 1-inch stems, and 14 to 66 percent for 2-inch stems. This difference shows the need for spraying during late spring or early summer to kill all small fuels by October—to assure drying of all stems before burning the brush during the next spring.

A typical pattern for dying of small fuel fractions and the subsequent delay in drying of brush stems in the California mountains is shown in *figure 3* for greenleaf manzanita effectively sprayed during the springtime.

NOTES

[1] Bentley, Jay R., C. Eugene Conrad, and Harry E. Schimke. 1971. *Burning trials in shrubby vegetation desiccated with herbicides.* USDA Forest Serv. Res. Note PSW-241, 7 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

[2] Graham, Charles A., and Jay R. Bentley. 1975. *Portable tripod-mounted boom sprayer for applying herbicides on tall shrubs.* USDA Forest Serv. Res. Note PSW-302, 4 p., illus. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

[3] Bentley, Jay R., and Charles A. Graham. 1976. *Rating effectiveness of herbicides in desiccating woody vegetation.* USDA Forest Serv. Res. Note PSW-311, 3 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

[4] Bentley, Jay R. 1970. *Use of herbicides to control brush regrowth of manzanita brushfields burned in early spring.* (Unpublished report on file, Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.)

[5] Carpenter, Stanley B., Jay R. Bentley, and Charles A. Graham. 1970. *Moisture contents of brushland fuels desiccated for burning.* USDA Forest Serv. Res. Note PSW-202. 7 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

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