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PROMISING GRASSES FOR SOUTHERN CALIFORNIA FUEL - BREAKS

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By
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Control of any large brush fire in southern California is difficult, dangerous, and very costly. Great expanses of dense, highly flammable brush, a dry summer climate, spells of hot, windy weather, and steep, rough topography underlie these difficulties. The brush cover can be modified, accessibility greatly improved, and fire control made easier by the establishment of fuel-breaks. These are grass-covered strips 200 to 600 feet wide, which break up the brush fields and improve their accessibility to men and equipment.

Some grass species are widely adapted and can be rather easily established in place of the brush. Others are more limited but are useful under specific conditions. This paper describes the conditions under which several grasses have performed satisfactorily over the past few years.

Grasses appear most satisfactory of the plants tested for revegetating large acreages because seed of many grass species is commercially available, techniques for sowing have been developed, and a few species already have proved to be adapted to sites in southern California. In addition, grasses sown during the conversion process are not damaged by the selective sprays used to eradicate regrowth of native shrubs.

A grass cover is suitable on fuel-breaks because it allows easy access for firefighters, and because fire in grass can be readily controlled. It is not always an ideal cover, however, because fire can spread rapidly in dry mature grass. Plants which stay green as long as possible in the fall, as do many of the perennial grasses, are preferable for fuel-break cover.

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For southern California foothills and lower mountains, Hardinggrass and smilo have been recommended as two basic perennial grasses.^{3/} Both of these species had survived well in tests by Department of Agriculture agencies and the University of California--both of these species produced large vigorous plants, superior to all other species. Veldtgrass was recommended to replace part of the Hardinggrass on light-textured soils. Wheatgrasses were recommended for trial at elevations too high for Hardinggrass, particularly on the desert side of the mountains. Little information on species adaptation was available for these sites.

Plots sown by the Agricultural Research Service in 1956^{4/} on burned areas in the San Bernardino National Forest confirmed that Hardinggrass grew poorly above about 3,500 feet elevation, but wheatgrasses were adapted at this elevation and grew well at higher elevations. This report gives the results from recent tests in southern California mountains and brings up-to-date the recommendations for grasses to sow on cleared brushlands in that region. The tests were conducted in the 1958-59 and 1959-60 growing seasons as part of the FUEL-BREAK program.^{2/} The Pacific Southwest Forest and Range Experiment Station is testing the adaptation of commonly used species to different sites, and is cooperating with the Forage and Range Research Branch of the Agricultural Research Service and with the University of California in a study of new species and strains. Seed of some noncommercial species is supplied by the Plant Materials Center of the Soil Conservation Service. The University of California also supplied part of the seed of commercial species on two large areas.

THE PROBLEM AREA

The area directly concerned in this report extends southward from central San Luis Obispo County along the coast to the Mexican border. It includes all of the coastal mountains, but not the southern part of the San Joaquin Valley, the Mojave Desert, nor other deserts of southeastern California. The Cleveland, San Bernardino, Angeles, and Los Padres National Forests are included.

It is a region of extremely steep topography. High, youthful mountains are dissected by deep V-shaped valleys. Soil over most of the area is shallow, sandy loam. Elevations range from sea level to nearly 11,500 feet.

^{3/} Bentley, J. R., L. J. Berry, D. R. Cornelius, and R. M. Love. Range species recommended for sowing on cleared brushland in California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note '111, 9 pp. 1956.

^{4/} Office report by D. R. Cornelius, Agricultural Research Service, Berkeley, California.

^{5/} A cooperative program organized by three of the major fire-fighting agencies in southern California--California Division of Forestry, Los Angeles County Fire Department, and U.S. Forest Service.

The climate in southern California is generally warm and dry with winter precipitation and hot, droughty summers. Precipitation varies from about 10 inches at low elevations and in rain-shadows of mountains to 35 inches or more at high elevations (table 1), but during this 2-year study rainfall was about half of normal at plot locations.

Native brush cover over much of this area is dominated by chamise on the south slopes and scrub oak on the north. The chaparral also has various species of other shrubs, including sages, sumac, ceanothus, mountain mahogany, and manzanitas.

Grazing by domestic livestock, mainly cattle, is an important use of the mountainous areas in San Luis Obispo, Santa Barbara, and Ventura counties. Farther south, where the terrain is more rugged, less of the land is grazed by livestock, and watershed values are dominant.

Table 1.--Average monthly and annual rainfall in southern California

Month	: Tanbark :Angeles NF	: Barrett Dam : Cleveland NF	: Raymond Flats :San Bernardino NF	: Ozena :Los Padres NF
	<u>Inches</u>			
Sept.	0.28	0.36	0.99	0.18
Oct.	1.13	.64	1.62	.48
Nov.	2.07	1.21	2.57	.81
Dec.	4.99	3.43	6.79	2.60
Jan.	5.33	3.14	5.26	2.38
Feb.	5.75	3.64	7.18	2.35
Mar.	4.23	3.01	5.22	2.13
Apr.	2.56	1.53	2.23	.85
May	.56	.38	.58	.30
June	.13	.05	.16	.04
July	.004	.09	.62	.07
Aug.	.08	.23	1.02	.10
Annual	27.11	17.71	34.24	12.29
Elev., feet	2,720	1,623	7,070	3,705
Reseeding zone ^{1/}	6	4	8	10

^{1/} For description of zones see table 2.

PROCEDURE

RESEEDING ZONES FOR GRASSES

Climate and soil, two major factors determining the distribution of native vegetation, will no doubt similarly effect the growth and adaptation of introduced grasses. The problem area was divided into 10 reseeding zones (table 2) logically based on plant growth requirements and limitations. These zones will be used initially in recommending species for reseeding. Soil groupings will be added to zone characteristics after soils information has been obtained.

Seven of the zones average more than 15 inches precipitation annually and are considered suitable for tests of perennial grasses. The mild coastal area divides into two zones, one with more than and one with less than 15 inches precipitation. This area has a mild moderate climate, little frost, and a long growing season.

Table 2.--Tentative southern California reseeding zones^{1/}

Reseeding zone	Climatic influence	Average precipitation	Elevational range
		<u>Inches</u>	<u>Feet</u>
1	Coastal	10-15	Below 1,500
2	Coastal	15-25	Below 3,500
3	Inland mountain	10-15	500-3,500
4	Inland mountain	15-25	500-3,500
5	Inland mountain	15-25	3,500-6,500
6	Inland mountain	25-35	2,000-3,500
7	Inland mountain	25-35	3,500-5,000
8	Inland mountain	25-45	5,000-8,000
9	Desert	15-25	3,000-9,000
10	Desert	10-15	2,500-8,000

^{1/} From Edmunson, "Climatic zones for reseeding grasses on southern California Fuel-breaks." U.S. Forest Serv., Pacific Southwest Forest and Range Experiment Station. (File report.)

The inland valleys and mountains include six zones, five with more than 15 inches of precipitation, one with less. The three inland zones with 15 to 25 inches rainfall are too dry for all but drought-tolerant grasses, but those with 25 inches or more are considered adequate for several additional species. Elevations below 3,500 are considered suitable for low elevation grasses, those between 3,500 to 5,000 feet for medium elevation grasses, and those above 5,000 feet for high elevation species. Daily and yearly temperatures fluctuate considerably in these inland zones. Frost occurs occasionally at lower elevations in the winter and frequently at medium elevations along with occasional snowfall. At higher elevations snow frequently remains on the soil winterlong.

The area bordering the desert and in the rainshadows of high mountains has been separated into two zones, one with more and one with less than 15 inches of precipitation. The climate in this area is desert-like--dry and desiccating--and temperatures fluctuate considerably.

SEEDING METHODS

Drilling and broadcasting were compared for each of 16 grass species, in 7 of 11 fuel-break study areas. Three areas could not be drilled, and on one drilling was the only planting method used. A small grain drill, 3 feet wide and with rows 7 inches apart, was pulled behind a pickup truck on most seeding plots. The rangeland drill, 10 feet wide and with rows 1 foot apart, was pulled by track-type tractors for drilling experiments when it was available. The single disk coulters with depth bands provided a desirable depth and covering for the seed. Broadcasting of seed on the experimental plots was by hand to give results comparable to seeding from a plane or helicopter normally used on large scale seedings.

DATA COLLECTION

Plant counts were made on square-foot quadrats, to determine emergence the first year and survival the second year after sowing. Plant vigor and stand densities were noted. Table 3 summarizes plant counts at four representative study areas.

PERFORMANCE RATINGS

The performance of species was evaluated on the basis of emergence, survival, and plant vigor during the 2-year period. These evaluations are the basis for current fuel-break recommendations; they will be reviewed and revised if necessary after additional observation.

Table 3.--Average number of plants per square foot after seeding at
four fuel-break study areas

Species	El Cariso		Paradise		Reservoir		Monrovia	
	Zone 2		Zone 4		Summit		Zone 6	
	1st yr.	2d yr.	1st yr.	2d yr.	1st yr.	2d yr.	1st yr.	2d yr.

Perennials

Blue wild rye	4.3	0.5	4.8	0.5	17.7	2.1	4.8	0.5
Big bluegrass	6.0	.1	9.3	.1	3.7	.5	1.5	.2
Goar fescue	2.7	.0	9.3	.8	2.7	.9	.7	.1
Hardinggrass	3.3	.2	5.3	1.7	3.7	.1	.3	.2
Nodding stipa	2.7	.8	6.3	3.2	3.0	1.2	1.7	.5
Orchard								
(Commercial)	6.3	.2	4.0	.4	11.7	.7	4.0	.4
Orchard								
(Palestine)	4.7	.2	1.8	.2	9.0	1.2	1.8	.2
Smilo	.7	.0	1.0	.4	1.7	.4	.8	.0
Veldt grass	3.0	.0	12.7	.2	1.3	.0	1.8	.2
Crested								
wheatgrass	3.0	.0	7.7	.5	8.3	3.2	1.5	.2
Intermediate								
wheatgrass	2.7	.0	3.3	1.0	1.3	(1/)	1.7	.2
Pubescent								
wheatgrass	1.3	.1	6.7	.8	1.0	(1/)	1.0	.2
Tall wheat-								
grass	2.3	.2	4.3	1.1	2.7	1.4	2.2	.5

Annuals

Annual rye-								
grass	10.0+	8.9+	9.7+	10.0+	2.7	(1/)	7.2	10.0+
Blando brome	4.0	7.7	9.0	10.0+	10.0+	(1/)	3.7	4.1+
Cereal rye	1.3	1.4	3.7	.7	1.3	.1	1.0	1.4

1/ Plants injured by tractor.

+ Indicates there were more than 10 plants in one or more quadrats and that the counts did not go beyond 10.

RESULTS

THE WHEATGRASSES

Five years ago, the potential of the wheatgrasses in southern California was not generally recognized, but they have done surprisingly well in recent years and are recommended for most mixtures in upper elevations. They also are included in some lower elevation seeding mixtures.

Tall wheatgrass.--Tall wheatgrass has been outstanding among wheatgrasses. It rated good to excellent in all zones where perennial grasses were considered adaptable (table 4). It has done best with 15 to 35 inches of rainfall at elevations above 3,500 to 6,500 feet. In Zone 5 it formed a better ground cover than any other grass. In Zone 7, it was second only to intermediate wheatgrass. Tall wheatgrass is a long-lived, drought-tolerant introduced bunchgrass. It stays green, or partially green, late in the season--an important consideration in fire control. It is also stemmy and coarse leaved. Seed is commercially available at moderate price.

Intermediate wheatgrass.--This grass has done best at medium and higher elevations, 4,000 to 8,000 feet, and with rainfall of 20 to 40 inches. In Zone 8 it was rated the best grass. In somewhat drier and lower Zones 4 and 5, intermediate wheatgrass did well on good deep soil, but was inferior to other grasses on dry sites. Intermediate wheatgrass is a long-lived, introduced perennial grass which is capable of slow spread by rhizomes. It stays green later in the season than most perennials but not as late as tall wheatgrass. Seed is commercially available.

Pubescent wheatgrass.--This grass has grown well over a wide range of elevation and rainfall, but it usually was not as vigorous as either tall or intermediate wheatgrasses where they are adapted. In Zone 9 on the desert side of the mountains, however, it grew better than either, and better than any other grass. It has not grown satisfactorily below 2,000 feet elevation, or with less than about 15 inches of rainfall. Pubescent wheatgrass is another drought-tolerant, introduced perennial. It grows on somewhat less fertile sites than tall or intermediate wheatgrasses, which it resembles. It tends to fill in bare soil with new plants from rhizomes. Seed is commercially available.

Crested wheatgrass.--Crested wheatgrass, better known among the wheatgrasses for drought resistance, has done well in our tests at elevations between 3,500 and 6,500 feet, and with rainfall between 15 and 25 inches. Although not most outstanding in any zone, it looked good in Zones 5, 7, 8, and 9. It has not grown well at low elevations in the coastal or inland mountain climatic influences. Crested wheatgrass has a shorter growth period and less height than the other wheatgrasses and has not provided as good a ground cover. Seed is usually abundant.

Table 4.--Ratings of grasses, based on comparative growth in southern California, 1958-1960

Species	Performance in reseeding zones ^{1/}						
	2	4	6	7	5	8	9

PERENNIAL GRASSES

Long-lived grasses

Tall wheatgrass	G	E	G	E	E	G	E
Intermediate wheatgrass	F	G	F	E	G	E	E
Pubescent wheatgrass	F	G	F	G	G	G	E
Crested wheatgrass	F	F	F	E	E	G	G
Nodding stipa	E	E	E	G	G	F	P
Blue wild rye	E	F	E	G	G	F	F
Hardinggrass	G	E	G	F	P	P	P
Smilo	F	F	F	P	G	P	P
Goar fescue	F	F	G	G	G	F	P

Short-lived grasses

Veldt grass	F	P	P	P	P	P	P
Orchardgrass (Commercial)	F	P	F	F	F	F	P
Orchardgrass (Palestine)	F	P	F	F	F+	F	P
Big bluegrass	F	P	F	F	F	G	G

ANNUAL GRASSES

Soft chess (Blando brome)	E	E	G	F	G	P	P
Annual ryegrass	E	E	E	G	F	F	P
Cereal rye	G	G	G	G	G	G	G

^{1/} Species were not rated in zones 1, 3, and 10, where yearly precipitation is only 10-15 inches and where most of the perennials may not be adapted.

Ratings: E = Excellent, G = Good
F = Fair, and P = Poor

OTHER LONG-LIVED PERENNIAL GRASSES

Three introduced, and two native range grasses were tested in this group. All have been used in reseeding rangeland in California.

Hardinggrass.--This grass is planted more widely than any other on low elevation rangeland in California. In southern California it rated good to excellent in the lower zones and poor above 3,500 feet. Hardinggrass grew best in Zone 4, but also did well in Zones 2 and 6. Hardinggrass is a long-lived introduced bunchgrass. It grows 3- to 4-feet high on fuel-breaks, and matures after nodding stipa but before the later-maturing intermediate and tall wheatgrasses. After maturing, stems are frequently green near the base. Seed is available but expensive.

Smilo.--This has been a tough long-lived grass on a variety of sites. Although rarely recommended alone it has been a standard component in seed mixtures for low-elevation brushland seeding for several years. It serves a purpose in mixtures because of its superior ability to establish on hard soil where coverage of seed is difficult. Seedlings develop slowly in winter because smilo grows best during warm weather. In our tests smilo has done best at medium or low elevations with 15 to 35 inches of rainfall, but it has not excelled over other grasses. Although stands at the study areas have been erratic and generally poor in the past two years, smilo is included in some of the recommended grass mixtures because of its good growth and persistence in earlier trials.

Nodding stipa.--The grass with the best growth record below 3,500 feet and with 15 to 25 inches of rainfall was nodding stipa. Between 3,500 and 5,000 feet elevation in Zones 5 and 7 it has also done well, but was rated behind the wheatgrasses. At the higher elevations and under the desert climatic influence it grew poorly. Nodding stipa is a long-lived, very drought-tolerant, small bunchgrass native to the coastal mountains and Sierra foothills in California. It survives where most other perennials do not. On this attribute, it would be used considerably on fuel-breaks were seed commercially available.

Blue wildrye.--This is another native species that has given fair to good results at low to medium elevations and moderate rainfall in the mountains, and near the ocean. Within its zone of adaptation seedling stands have been good, and second-year survival better than in most species. Experience elsewhere in California indicates that plants generally remain small. No commercial seed supplies are available, however, so it cannot be recommended for fuel-break seeding.

Goar fescue.--This is an early maturing, vigorous strain of the tall fescue commonly planted in irrigated pasture mixtures. In our tests it has grown moderately well in Zones 5, 6, and 7, or between 2,000 and 5,000 feet elevation with a rainfall of 25 inches or more at the lower elevations. Even where it is best adapted, plants are not as hardy as those of other adapted grasses such as harding or tall wheatgrass.

SHORT-LIVED BUNCHGRASSES

Several short-lived bunchgrasses are being tested. None has been outstanding.

Orchardgrass.--Two strains of orchardgrass, commercial and Palestine, were seeded at each site. Differences between them are small, and we judge them of about equal usefulness on fuel-breaks. Both have produced good seedling stands, but second-year survival has been poor in these dry years. Additional study is necessary before we can recommend orchardgrass.

Veldt grass.--This is a short-lived introduced bunchgrass whose numbers have declined from good seedling stands to a few scattered or no plants in the second year. It has not proved adapted for fuel-break seeding, especially above 2,000 feet.

Big bluegrass.--The Sherman strain of big bluegrass is a small short bunchgrass. It does not appear widely adapted to the dry soils of southern California. It shows greatest promise on north exposures above 25 inches of rain and 5,000 feet elevation. Seed is commercially available.

ANNUAL GRASSES

Annual grasses are tested for fuel-breaks because they produce a quick cover, are more easily established than perennials from broadcast seeding, and may be the only species adapted on poor sites. Annual grasses dry out earlier and usually present more flammable fuel than perennial grasses. These species rely upon self-seeding for perpetuation. Two forage grasses and one cereal have been studied.

Soft chess.--This is a rapid-growing, drought-tolerant annual grass. It matures earlier and is better suited for quick vegetal cover on droughty soils than commercial ryegrass, but it dries early, and has fine stems and leaves through which fire can move rapidly. Soft chess is an excellent annual to seed in light amounts with a perennial mixture because it does not compete strongly and will add to the ground cover. Seed of soft chess is commercially available as "Blando brome." In our tests, soft chess was rated "excellent" at the lower elevations near the coast and also inland. Its growth was fair at medium elevations and poor at high elevations.

Commercial annual ryegrass.--This is a rapid developing moderately drought-tolerant, introduced annual grass. It seeds abundantly and perpetuates itself for a few years on north exposures. Thereafter, vigor and coverage decline, and it fails to persist. On good sites it competes aggressively with perennials, and should not be drilled with them. Annual ryegrass is rather coarse stemmed. Seed is the cheapest of the grasses. Annual ryegrass has grown very well in Zones 2, 4, and 6, up to about 3,500

feet elevation on the coastal side of the mountains where rainfall is between 15 and 30 inches. Growth at higher elevations was less vigorous. On the desert side of the mountains the growth was poor.

Wimmera ryegrass.--This ryegrass has been planted alongside commercial ryegrass on several sites and consistently has grown as well the first year. The second year, on a dry site, wimmera was considerably better than commercial ryegrass. On a site with deeper soil and north exposure there was little difference in growth. On drier, harsher sites in southern California wimmera ryegrass should be substituted for commercial annual ryegrass in fuel-break sowing.

Cereal rye.--Cereal rye rated fair to good on all sites. Because it is tall and stemmy, competes excessively with perennials the first year, and persists poorly, cereal rye is not recommended for fuel-break seeding.

RECOMMENDED SPECIES MIXTURES

Tentative species mixtures recommended for sowing in the various zones are shown in table 5. Results from our trials during only two years, when precipitation each year was about half of the longtime average, have been used to modify previous recommendations. Some species for which seed is not commercially available, or is in short supply, have been omitted.

Species testing, now concentrated on the San Dimas Experimental Forest, also will be continued elsewhere in southern California to refine the species recommendations.

SUMMARY AND CONCLUSIONS

Tests of grasses have been underway for two years under a variety of southern California soil and climatic conditions in coastal and inland mountain areas. The objective is to select species for sowing on southern California fuel-breaks and other areas.

Thirteen perennial and three annual grasses were planted in a total of seven different climatic zones. On most sites they were both drilled and broadcast. Grasses were rated for emergence during first season, survival through the second year, and stand development characteristics.

Wheatgrasses proved to be highly suitable for southern California fuel-break seeding. They are the most important grasses for higher elevations and are also useful components for lower mountain seeding mixtures. Tall wheatgrass appeared most useful and proved to be widely adapted. Hardinggrass grew well below elevation of 3,500 feet on deep soil receiving at least 15 inches average annual rainfall.

Table 5.--Mixtures recommended for 7 different zones in the southernCalifornia fuel-break program

Climatic zones	Grass species	Drilling rate Lbs. per acre ^{1/}
2--Coastal, 15-25 in. precipitation, below 1,500 feet elevation	Hardinggrass	2
	Tall wheatgrass	2
4--Inland mountain, 15-25 in. precipi- tation, below 3,500 feet eleva- tion	Pubescent wheatgrass	1
	Blando brome	1/4
5--Inland mountain, 15-25 in. preci- pitation, 3,500 to 6,500 feet elevation	Tall wheatgrass	2
	Crested wheatgrass	2
	Pubescent wheatgrass	1
	Blando brome	1/4
6--Inland mountain, 25-30 in. preci- pitation, 2,000 to 3,500 feet elevation	Hardinggrass	2
	Tall wheatgrass	2
	Intermediate wheatgrass	1
	Pubescent wheatgrass	1
	Smilo	1
	Blando brome	1/4
7--Inland mountain, 25-30 in. preci- pitation, 3,500 to 5,000 feet elevation	Tall wheatgrass	2
	Intermediate wheatgrass	2
	Pubescent wheatgrass	1
	Blando brome	1/2
8--Inland mountain, 25-45 in. preci- pitation, 5,000 to 8,000 feet elevation	Intermediate wheatgrass	2
	Tall wheatgrass	2
9--Desert-side mountain, 15-25 in. precipitation, 3,000 to 9,000 feet elevation	Pubescent wheatgrass	1
	Crested wheatgrass	1

^{1/} For broadcast seeding, double these rates.

Several species--Goar fescue, orchard grass, veldt grass, smilo, and big bluegrass--produced less satisfactory growth than did wheatgrasses or hardinggrass. Of the native species, nodding stipa and blue wild rye rated highly but seed of these species is not commercially available.

Soft chess (Blando brome) proved suitable for seeding on most sites at medium to low elevations. It may be sown in small amounts with perennials. Commercial annual ryegrass grows aggressively on good sites and provides excellent ground cover for a few years after brushland is burned over. It can compete with perennial grasses severely during the establishment period and is not recommended for sowing with them. Wimmera ryegrass grew as well as commercial ryegrass, and may be substituted for it.

Tentative species mixtures have been recommended for the climatic zones in southern California.