Wildlife Depredations on Broadcast Seedings of Burned Brushlands

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Introduction

In California, dense stands of undesirable woody vegetation or "brush" are being removed by burning, followed by seeding of forage grasses or legumes where natural reseeding of herbaceous vegetation will not occur. This is part of a range improvement program to convert some of the 10 or more millions of acres of brushland in California into more productive grasslands (Love and Jones, 1947). Depredations by seed-eating rodents, birds, and harvester ants may prevent a broadcast seeding from being successful. Such failures frequently have been wrongfully ascribed to unfavorable weather, adverse site conditions or poor germination, since these factors are the more obvious causes of failures and loss of seed is not easily observed.

All tests included in this report were made in Madera County while the author was stationed at the San Joaquin Experimental Range; field observations were made in other parts of California also. Acknowledgments are due many ranchers and county, state, and federal personnel for their assistance and comments on the depredations by wildlife in their respective localities. The material used in Table 2 and some of the field trials were done in cooperation with Jay R. Bentley of the California Forest and Range Experiment Station. Assistance on methods of treating seeds was provided by the Wildlife Research Laboratory of the U. S. Fish and Wildlife Service, California Department of Agriculture, and County Agricultural Commissioners. Milton A. Miller and other Farm Advisors of the University of California Agricultural Extension Service provided valuable information to this study, and individuals of the U. S. Forest Service and the California Division of Forestry gave frequent help.

Seed Treatment

A satisfactory repellent is needed to protect broadcasted seeds from rodents, birds, and harvester ants. Since no effective repellent is now known, dyes and rodenticides are being employed as a temporary expedient for protecting seeds.

Birds are extremely hesitant to eat seeds that are abnormally colored. During the nineteenth century, brilliant dyes were applied to seed grain in Europe to prevent its being "pulled" by rooks, jackdaws, and other species. More recently, Kalmbach (1943), Glading, Enderlin, and Hjersman (1945), and Kalmbach and Welch (1946) have studied the coloring of cereal baits for rodent control to deter beneficial birds from eating the poisoned materials. A yellow aniline dye named National Brilliant Yellow S.P. has proven most satisfactory. Hard, waxy-coated seeds are difficult to dye. The dye is used to protect the seeds from birds when seeding ranges, whereas in rodent control, the dye is used to protect birds from the poisoned seeds. Presumably, birds can learn to eat colored seeds, but an adult song sparrow and crown sparrow did not become accustomed to eating yellow ryegrass seeds after being offered a mixture of dyed and plain seeds for three and four weeks, respectively. Both birds died of starvation when the uncolored ryegrass seeds were removed, even though yellow seeds covered the entire floor of the cage.

rodents in control operations but, mainly, to protect the seeds in range seeding. Not all small rodents are poisoned, but those not killed are largely repelled.

Compound "1080" (sodium fluoroacetate) has proven more effective than

TABLE 1

Germination of seeds, in percent, treated with dye, poisons, and a lecithin-mineral oil spreader, as determined by tests with petri dishes (P), sand (S), and 5 months after storage (5).[1]

SPECIES TESTED	LENGTH OF TEST IN DAYS	TYPE OF TEST	CONTROL	STRYCHNINE AND DYE	"1080" AND DYE	DDT AND DYE	DYE
Harding grass	28	S	46.50	42.50			
Phalaris tuberosa		5	47.50	32.25			
Rhodes grass	14	P	73.00	68.25	65.75		
Chloris gayana		5	67.50	62.25	65.00		
Orchard grass	18	S	72.00	73.00	66.50		
Dactylis glomerata		5	70.00	67.25	68.50		
Ryegrass	14	P	96.25	[2]93.25	[2]93.50	96.00	93.75
Lolium sp		5	95.25	79.50	85.25	88.50	94.25
Subterranean clover	14	S	[3]66.00	[3]53.50	[3]57.50		
Trifolium subterraneum		5	65.75	57.50	57.25		
Yellow sweetclover	7	S	[3]94.50	[3]90.50			
Melilotus officinalis		5	95.25	89.00			
Bur clover	14	S	[3]51.00	[3]42.00			
Medicago hispida		5	55.00	45.75			
Alfalfa	7	S	[3]92.50		[3]91.50		
Medicago sativa		5	92.00		86.50		
Purple and common vetches	10	S	96.00	95.00			
Vicia spp.		5	96.00	93.00			

[1] The seeds were treated by H. T. McLean, Agricultural Commissioner of Madera County and tested by the Seed Laboratory of the California Department of Agriculture.
[2] Roots very short. In petri dish tests, the poison accumulates around the roots.
[3] Percentage of legumenous seeds having unusually hard seed coats and abnormal sprouts are not included.

Artificially colored seeds are not protected from rodents for these animals are color-blind, but when also treated with rodenticides, in the same manner as in preparing cereal rodent baits, they are less likely to be destroyed by rodents. Seeds are treated with poisons to kill

strychnine in protecting seeds from rodents and ants, and it is much cheaper. Unfortunately "1080" is extremely poisonous and there is no known antidote. No one should treat forage seeds with any rodent poison without first consulting his local rodent control official. He is authorized to handle rodent poisons and may be able to control the rodents and harvester ants either before the brush is burned or just before the area is seeded. Use of "1080" for protecting seeds is justified only until a cheaper and less-toxic repellent for rodents, ants, and possibly birds can be found.

Since it is important that neither dye nor poison impair the viability of seeds used for range improvement, germination tests were made immediately after applying the dye and poison and again after five months of storage on nine species (Table 1). Dye was used at the rate of two ounces per 100 pounds of seed; the poisons were 10 ounces of strychnine, two ounces of "1080," or 10 ounces of DDT per 100 pounds of seed. There was no appreciable difference in germination as a result of the treatments or of five months of storage.

Wildlife Depredations on Seedings

Treatment with a yellow dye and either strychnine or "1080" materially reduced the rate which birds, rodents, and harvester ants took seeds broadcasted on burns in Madera County during 1948–50. About 400 pounds of forage seeds treated with dye, poison, or both, were exposed in comparison with larger amounts of untreated seeds on 20 plots varying in size from a few square yards to about ten acres, and at elevations of 1,000 to 3,000 feet. In all instances properly treated seeds received marked benefit; however, some of these seedings still were not successful because of drought or frost upheaval (Fig. 1).

FIG. 1. Destruction of seedlings by frost heaving. Occurs during certain years in some localities, where insulation provided by the canopy or litter has been removed by fire.

The rate which broadcasted seeds are removed by wildlife is variable. Many areas do not have harvester ants. Dense stands of a single species of brush, particularly chamise (*Adenostoma fasciculatum*), support but a sparse population of birds and rodents and in such regions loss of seeds may not be excessive. In the proximity of cover for birds, rodent burrows, or ant colonies, seeds may disappear rapidly. One of the better patches of ryegrass that occurred on the seeding plots put out in 1949 was from untreated seeds on digger pine (*Pinus sabiniana*) ash; however, the ryegrass seeds near brush and oaks on the remainder of this plot largely disappeared and most of the bur clover was lost on the entire plot.

On one plot with seeds treated by yellow dye and "1080," very few were missing 111 days after sowing. There was no rain during the interval and seeds remained in place where they fell, even on top of rocks and other exposed places. On a control area planted at the same time, most of the untreated seeds were gone when next examined 44 days later, although a few ryegrass seeds still were present after 111 days.

In another test about 150 pounds of six species of annual and perennial range-plant seeds were broadcast on 30 acres of ash: 10 pounds of this seed were treated with yellow dye and strychnine and were sowed on a one-acre plot. Forty-five days later only the treated seeds could be found, even in deep ash, except for some untreated seeds adjacent to the one-acre plot of treated seeds. Some of these one-acre plots lacking visible seeds had received as much as 16 pounds. Three months after the seeding only treated seeds could be found, but even most of them, which had been treated with strychnine, were missing also. Several rains had occurred but it had been too cold for germination. Among the seed-eating animals living on the plots were pocket mice, kangaroo rats, white-footed mice, a covey of quail, and harvester ants. The day after the treated seeds were put out one dead kangaroo rat was found; its cheek pouches were full of broadcasted seeds but the strychnine had acted before the animal could cache them.

One of the most successful seedings of a small brush burn was on a ranch near North Fork, California. A good burn furnished deep ash, and rain two or three days after sowing afforded the seeds considerable protection from wildlife. The rancher protected the perennials after they germinated by having his son regularly shoot rabbits and rodents. That portion of the seeding which was not successful the first year was reseeded the following year and this seed covered by trampling with livestock. In the second year after the burn the remaining dead brush and trees were cut, piled and burned, and the ash spots were seeded. There was a rather rapid and complete disappearance of the seeds because rains were late, thus enabling birds and rodents to take them. The rancher reseeded the area again, in the snow, and the following spring many plants had germinated.

Seeds treated with strychnine are more vulnerable to harvester ants than those poisoned with "1080." Of six plots where seeds treated with strychnine and yellow dye were broadcasted on thick ash, two were devoid of seeds when examined one and one-half months later. Near each of these plots was a colony of harvester ants having colored hulls and seeds in their nests. On a three and one-half acre plot broadcasted with "1080"-coated seeds, all nearby ant colonies were inactive when next examined a month and a half later. Several thousand dead ants were counted on one ant hill. On another area that received "1080" seeds, and that was examined the next day, there were hundreds of dead and dying harvester ants at each colony.

Discussion

If seeds can be covered by use of drill, drag, or harrow, or by trampling of livestock, they will be less exposed to removal by rodents, birds, and ants; often, however, none of these methods is practicable in rugged terrain. Seeds broadcasted into soft ash immediately after burning acquired partial immunity from wildlife, but only until the more exposed seeds were taken. Seedings delayed until the first fall rains were more successful than seedings made immediately after the fire because they were available to seed-eating wildlife for a shorter time before germinating. The earlier that seedings are made during the summer the longer the seeds are exposed to the ravages of wildlife. When unfavorable weather delays germination until the following spring, seeds may be exposed to wildlife for many months, seven months being the longest interval observed by the author.

Rodents, birds, and harvester ants were found still living in the same general areas following controlled burns. Apparently most rodents and ants are able to escape the fires by going below ground, while birds are able to fly out and return after the ash cools or escape to islands missed by the fires. Burned areas which require seeding are those that would otherwise be largely devoid of herbaceous vegetation; thus, in such instances, the seed-eating animals survive the fires but their food supply does not. Birds and harvester ants have been observed eating broadcasted seeds; rodents have had them in their pouches when trapped or poisoned.

Ground squirrels, although sometimes most in evidence, usually are not as important as seed eaters as the less conspicuous and more abundant white-footed mice, pocket mice, kangaroo rats, kangaroo mice, and grasshopper mice. Woodrats, chipmunks, and tree squirrels when present will take seeds. The larger rodents, like squirrels, do not appear to feed on small seeds as readily as do mice. Little is known regarding the rate which rodents gather seeds. A family of about twelve deermice (*Peromyscus maniculatus*) living in a Michigan grassland cached, in less than one month, 1,050 cc. of small weed seeds and 565 acorns, all in one nest. Each acorn was carried at least 120 feet, the distance from the nearest branch of an oak tree to the nest (Howard, 1949). Rodents not only remove seeds from sowings on range lands but they often are an important obstacle to reforestation for the same reasons (Bramble, et al, 1949; Horn, 1938).

Birds must eat seeds one by one, thus individually remove them at a slower rate than rodents which are able to transport seeds in their pouches and cache them. However, in many localities there may be present, at some seasons of the year, flocks of crowned sparrows (*Zonotrichia*), other sparrow-sized birds, mourning doves, valley quail, or towhees to pick up seeds.

The number of harvester ants (*Veromessor andrei*) present in any of the burned areas has not been determined but colonies often are only fifty feet or less apart. More than 2,000 dead ants were near the entrance of one colony that had gathered seeds treated with the rodenticide "1080". Ant hills, which actually are not much of a hill, can readily be located from more than one hundred feet away a short time after seeding by the presence of seed hulls around the entrance of the colonies (Fig. 2). The hills become most conspicuous when dyed seeds are broadcasted, for the colony entrances then become yellow.

In some areas rodents require controlling at the time seeds germinate, if the animals have not been effectively reduced in numbers by earlier operations (also mentioned by Bridges, 1942). Where perennials have been seeded, control of both rodents and rabbits may be necessary, especially later in the year after the annual forage becomes dry. Control of pocket gophers often is needed before

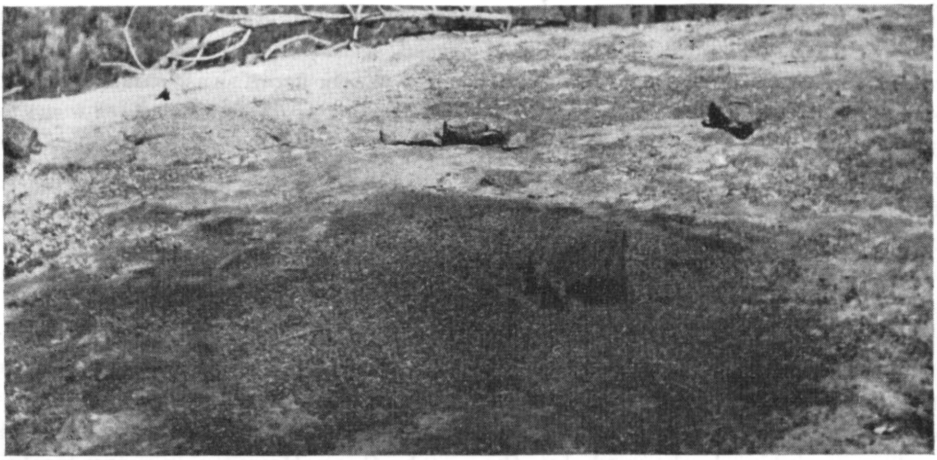

FIG. 2. Harvester ant mound, surrounded by hulls and seeds (dark area) gathered by the ants from broadcast seeding on a controlled burn above O'Neals, California.

TABLE 2

Forage seedling survival on plots with and without rodents and rabbits. Plots seeded October 25, 1947.

SPECIES SEEDED	POUNDS PER ACRE SEEDED	NUMBER OF PLANTS OBSERVED SEPT. 17, 1948.	
		No rodents	Rodents
H. ryegrass (*Lolium sp.*)	1	74+	31
Harding grass (*Phalaris tuberosa*)	1	20	5
Smilo (*Oryzopsis miliacea*)	1	17	20
Ladak alfalfa (*Medicago sativa*)	1	12	0
Burnet (*Sanguisorba minor*)	$\frac{1}{16}$	6	0
Others	5	18	3
		[1]147+	[2]63

[1] Nine per cent of the 147+ plants were grazed but only one was grazed to the ground. Two were killed by a pocket gopher that got in the enclosure.

[2] Of the 63 plants, 100 per cent were grazed and 51 of them were grazed to the ground.

a successful stand of perennials can be established (Love and Jones, 1947). Deer, on occasion, will graze heavily on seeded plants.

An example of damage rodents and rabbits may inflict on mature forage was obtained from two adjacent plots where a similar mixture of seeds were broadcasted over each plot (Table 2). Brush was piled and burned on two 12 x 50-foot plots between O'Neals and North Fork, Madera County, California on October 25, 1947. Seeds were broadcast into the soft ash two days later. Livestock were excluded from both plots. Rodents and rabbits were excluded from one of the plots (except for at least one pocket gopher and one ground squirrel that managed to get in). Deer grazed in both of them. The seeds were exposed to birds and ants in both plots, but to rodents only in one plot.

A useful method to learn the fate of seeds that have been broadcast is to construct wire cages of $\frac{1}{4}$-inch hardware cloth and place them over known amounts and kinds of seeds with similar samples adjacent outside the cages (Fig. 3). The resultant growth of grasses is ranker under the cages because of insulation by the wire. The cages had little effect when placed over forage that had already germinated and was about $\frac{1}{2}$-inch high.

Further studies are needed to learn more effective methods for treating seeds to reduce losses by rodents, birds, and ants, especially to obviate use of substances as toxic as "1080". A need for better methods of controlling range rodents, rabbits, and harvester ants with poisons also is indicated.

FIG. 3. Wire cages protect seeds from rodents and birds. Known numbers and kinds of seeds can be placed under wire cages and their survival compared with similar quantities of seed placed on an adjacent, unprotected site. However, wire cages do not protect from ants.

Conclusion

Some brush-covered lands in California are being made more productive by controlled burning followed by broadcast seeding of desirable forage species. Many such efforts have been unsuccessful because rodents, birds, and harvester ants removed most of the seeds before germination. Hard smooth-coated seeds are preferred over chaffy, soft seeds, such as ryegrass. Ryegrass seeds are not likely to be taken if other foods are available. If the seeds are dyed yellow, bird depredations are considerably reduced. If also treated with a rodenticide, such as "1080", harvester ants are killed and rodents are either killed or effectively repelled. An effective and economical repellent to replace the dye and highly toxic poison is needed.

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WORLD FOOD SUPPLIES

Agriculturists have long been trying to bring into cultivation the marginal and waste lands of their time—so that land which two generations ago seemed hopeless is now in cultivation. The zone of cultivation has greatly widened. But what of the land beyond, that seems hopeless to us? Will our children be able to cultivate it if they want to do so?

There are three great difficulties which we have not been able completely to overcome: drought, the uncertainty and variation of yields, and soil erosion. But a good start has been made. It is the combination of soil and climate, and not climate alone, that in many parts of these marginal regions determines the possibility of food production. We may not be able to change the climate, but the soil certainly can be altered by the growth of grass. Experiments with this purpose in mind are in progress in many countries on marginal lands. The world has been ransacked for drought resistant grasses and improvement has begun on the same lines as were used for wheat including choice of promising varieties, selection of most suitable sorts, and cross-breeding to produce better varieties which has not yet got very far. Crested wheatgrass in America, some of the agropyrons in parts of Africa, and other grasses, have already enabled large areas of waste lands to provide far better grazing than before. Erosion has been better brought under control through the use of proper land utilization programs in which adapted grasses figure largely. There is little doubt that when the need arises, more land can be brought into cultivation.

Science can be relied upon to solve the material problems of mankind but we must not think that it can clear up all our difficulties. The hardest and most serious problems of today are essentially moral and spiritual, and with these science can give but little help.

Sir John Russell
from Presidential address to the British
Association for the Advancement of Science,
September, 1949. Prepared for Farm Forum.