FIGURE 3. Burned plots in 1955. Dark-colored bushy plants are rabbit brush.

Figure 1, however, that the cover density of the burned area is still far less than that of the unburned. A notable feature of the burned plots is the complete loss of bitterbrush. This species occupies 91 percent of the vegetated area on the unburned plots and supplies a very large part of the available forage. The palatable grasses on the burned plots 6 years after the fire had only about 30 percent of the basal area of those on the unburned plots. Between 1953 and 1955 the number and basal area of the perennial grasses decreased about 40 percent on the burned plots. Because of this reduction and the complete loss of bitterbrush, after 6 years the grazing capacity of the burned range is far below that of the unburned area. The reduction in perennial grasses appeared to be largely the result of changes in the microclimate and the closer grazing resulted from the removal of the brush cover by fire. It seems probable that much of the area formerly in bitterbrush will be taken over, temporarily at least, by low value species such as yarrow (*Achillea millefolium*), rabbit brush (*Chrysothamnus bloomeri*), cheatgrass, and annual weeds.

BITTERBRUSH SEED DORMANCY BROKEN WITH THIOUREA[1]

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Bitterbrush (*Purshia tridentata*) is one of the most important western browse species on winter ranges used by deer. On some ranges severe reduction of bitterbrush stands has resulted from fire, overbrowsing, and insect defoliation. Restoration through natural seeding is slow and uncertain, especially if the seed-producing plants are few, are low in vigor, or if browsing continues. Artificial seeding under these conditions offers more promise for restoration of bitterbrush.

Planting is made difficult, however, by the dormancy of bitterbrush seed. Fall planting usually ensures the proper temperature and moisture conditions during the winter to break dormancy. However, rodents may destroy much of the over-wintering seed, and frost damage is often great. These hazards can be overcome by spring planting of seed that has been stratified 4 to 6 weeks (Hormay, 1943) to break dormancy. In several trials, spring planting of stratified seed has resulted in higher emergence and survival than fall planting. These trials were hand planted. When mechanical seed equipment was tried, the soft, moist stratified seed proved difficult to handle. Furthermore, stratified seed had to be planted soon after stratification ended. For practical purposes, then, spring planting requires a method of breaking dormancy that yields dry seed fit for use in mechanical equipment.

Treatment with thiourea seemed to offer such a method. Deuber (1932) reported that thiourea shortened the rest period of black oak and red oak acorns. Thompson and Kosar (1939) found that thiourea-treated lettuce seed germinated at temperatures above 68 degrees F., which normally inhibit germination. Johnson (1946) found thiourea a promising substitute for cold treatment on some forest tree seeds. Tukey and Carlson (1945) found that thiourea broke the dormancy of Lovell peach seed and reduced mold and common seed-borne fungi.

Methods

To determine the applicability of thiourea treatment for bitterbrush seed, a series of studies was conducted in 1954 and 1955. For germination tests, replicated lots of 100 bitterbrush seed were soaked for different lengths of time in thiourea solutions of different concentrations. After soaking, the seed was allowed to become air dry

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Table 1. Germination of bitterbrush seed treated with various thiourea solutions for different periods.

Concentration (percent)	Germination when soaking time in minutes was—								Germination when soaking time in hours was—				
	1	3	4	5	10	15	20	30	1	2	3	4	5
	Percent												
3.0	65	87	89	—	—	—	—	—	—	—	—	—	—
2.5	29	78	80	88	—	—	—	—	—	—	—	—	—
2.0	33	52	—	86	—	—	—	—	—	—	—	—	—
1.5	2	—	—	54	82	87	—	—	—	—	—	—	—
1.0	2	2	2	3	—	—	81	87	—	—	—	—	—
0.5	—	—	—	1	—	7	8	—	38	67	57	—	—
0.4	—	—	—	—	—	—	6	11	22	37	59	44	22
0.3	—	—	—	—	—	0	—	6	—	30	48	72	10
0.0	2	—	—	—	1	—	—	—	2	3	0	—	2

and then placed on moist filter paper in petri dishes.

Germination tests were limited to a 15-day period, and seed was considered germinated when a one-half inch radical had developed. During the testing period room temperatures ranged from 65 degrees F. to 75 degrees F. After the germination tests in 1954, spring field plantings were made with treated seed in 1954 and 1955. Some seed was hand planted, some drilled.

Effect of Thiourea

High germination, 85 percent or more, resulted from soaking bitterbrush seed in a 3.0 percent solution of thiourea for 3 to 5 minutes (Table 1). Weaker solutions and longer soaking, down to 1 percent and up to 30 minutes, gave similar results. Germination was generally less than 60 percent with solutions below 0.5 percent even though the seed was soaked until saturated (4 to 5 hours). Germination of seed soaked only in water was 5 percent or less. Throughout the tests the seed with high germination had little or no mold, whereas fungal growth was heavy on seed that had relatively low germination.

Thiourea-treated seed compared favorably with excised embryos in both speed and amount of germination. In two typical treatments giving high germination, 81 and 83 percent of the treated seed and 85 percent of the excised embryos germinated during the first 5 days. Total germination for the treated seed was 87 and 89 percent; for excised embryos, 92 percent (Table 2).

Seedling emergence and survival in field trials were erratic. The thiourea treatment for these tests was 5 minutes soaking in a 3 percent solution. In these field trials some spring plantings failed because seed was sown when soil moisture was at the wilting point. Other plantings had poor survival for unknown reasons. Nevertheless, pilot plantings made on deer winter ranges resulted in stands of 8,000 and 9,000 seedlings per acre at the end of the first growing season. These stands represent 10 percent of the viable seed planted and are considered satisfactory under present knowledge of seedbed preparation and planting techniques.

Summary and Conclusion

Spring planting of bitterbrush seed is desirable because it avoids the hazards of frost and long exposure to seed-eating rodents. Unless treated to break its dormancy, however, spring-planted seed will not germinate in sufficient amounts to produce a satisfactory seedling stand. Thiourea-treated seed, on the other hand, germinated promptly under suitable moisture and temperature conditions. Furthermore, thiourea-treated seed, unlike stratified seed, could be planted any time after the treatment. Seed was treated for field tests well in advance of planting time, air dried, then handled and planted like any other dry seed. This method of pre-treating and drying eliminated the difficulty of handling wet seed while planting, removed the danger of injuring tender stratified seed when drilling, and provided greater flexibility in planting to suit local weather conditions. Yet this treatment, at best, resulted in survival equivalent to only 10 percent of the viable seed planted. Before recommending spring-planted thiourea treated seed for large scale plantings, we need to determine the causes of the relatively low survival and develop methods that will result in a higher survival rate.

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Table 2. Germination of thiourea-treated bitterbrush seed and excised embryos by 5-day periods

Period	Seed in 3 percent thiourea for 4 minutes	Seed in 1 percent thiourea for 30 minutes	Excised embryos
		Percent	
First 5 days	83	81	85
Second 5 days	4	4	5
Third 5 days	2	2	2
Total	89	87	92