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Final Report

METHODS AND SEASON OF DIRECT SEEDING WESTERN YELLOW PINE (Pinus ponderosa)

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In the early years of reforestation work in District 6, a large number of tests were made of direct seeding with western yellow pine, to determine whether this method of reforestation could be used for restocking denuded areas in the pine region. A few of these were initiated by men from the District Office, but the greater number were installed and later examined by local Forest officers in accordance with more or less general instructions issued by the District Office.

The tests were fairly well distributed throughout the whole of the yellow pine region. They covered a wide range of sites all the way from those quite favorable to the species, down to those whose suitability for yellow pine is somewhat questionable, and quite a variety of methods of sowing and ways of treating the seed. A part was initiated in the fall, the remainder in the spring. Many of the experiments were so planned as to afford direct comparisons of methods, treatments, and seasons under the same conditions of site; others comprised single tests only.

Examinations of the plots after establishment were made by local Forest officers as frequently as possible. Because of the press of other duties these were not ordinarily as numerous as later development indicated were necessary to record all that transpired upon the plots. This was particularly true as regards the first season's examinations, which, in the majority of cases, were not made until the end of the summer. It was of course a simple matter to ascertain the condition of the plots at the time of the examination, but it often was next to impossible to determine what had taken place previously and thus name the factors most responsible for success or failure. While the tests, therefore, show definitely what may be expected from direct seeding methods under the conditions prevailing on the various plots, they do not always indicate with clearness the reasons for the results secured, nor afford a sufficient basis for drawing final conclusions as regards the relative worth of various methods and treatments.

Table I contains a complete list of the tests, together with pertinent data on locations, method of treatment, and results.

TABLE #1 – WESTERN YELLOW PINE SEEDING TESTS

Ref. No.	Forest and Designation	Plot or Strip No.	Date Estab.	Method of Seeding	Special Features of Method	Amt. Seed Per A. or Plot	Survival at Various Periods				Remarks
							End of 1st Season	End of 2nd Season	End of 3rd Season	Later Years	
1	Chelan #1-Lower Entiat	1	Spr. 1910	Broadcast	None	6 lbs.	0				Failure attributed to drought and seed not covered.
2		2	Spr. 1910	Seedspot	Spade, covered lightly – spacing 5x5	7 sd.	0				Drought
3		3	Spr. 1910	Bdct. strps.	Raked prior & after sding-strips 14" spaced 5'	2 lbs	0				Drought
4		x1	Spr. 1909	Seedspot	Soil up turned with spade	10-15 sd.	0				
5		x2	Spr. 1909	Seedspot	Seed covered lightly	10-15 sd.	0				
6	Colville #1 – San Poil	1	Fall 1909	Broadcast	New burn.	3 lbs.	0				Attributed to drought
7	#2 – Contention Hill		Fall 1909	Bdct. & s. sp.	Spots made with stick	5.5 lbs.	0				Attributed to drought
8	Crater #1		Spr. 1909	Broadcast	On snow.	3.5 lbs.	0				Attributed to drought
9	#2		Spr. 1909	Broadcast	On bare ground	3.5 lbs	0				Attributed to drought
10	#3		Spr. 1909	Seedspots	Hoe-seed covered – 4'x4'	4 sd.	0				Burned over in 1910
11	#4 – Cat Hill	1	Fall 1909	Broadcast	On 8" of snow	3.3 lbs.	0				Burned over in 1910
12		2	Fall 1909	Seedspots	Coated with coal tar, spacing 10x10	10-12 sd.	0				Burned over in 1910
13	Deschutes #1 – Walker Basin	1	Spr. 1909	Broadcast	Coated with red lead; harrowed after sowing.	?	0				500 beginning 1st season Failure due to drought.
14		2	Spr. 1909	Seedspot	Red lead; sown with corn planter	?	0				Shallow planting, lack of moisture.
15		3	Spr. 1909	Seedspot	Red lead, sown with hoe.	?	200 per A.				Drought
16		5	Fall 1909	Seedspot	Sown with corn planter	?	0				Drought & destruction of seed
17		6	Fall 1909	Broadcast	Harrowed after sowing	?	0				Drought & destruction of seed
18		7	Fall 1909	Seedspot	Sown with hoe	?	40 per A.				Drought & destruction of seed
19		9	Spr. 1910	Seedspots	Sown with corn planter	?	0				Drought & destruction of seed
20		10	Spr. 1910	Seedspots	Sown with hoe	?	40 per A.				Drought & destruction of seed
21		11	Spr. 1910	Broadcast	Harrowed after sowing	?	0				Drought & destruction of seed
22		Ia-If	Spr. 1911	Seedspots	Area poisoned; seed pregerminated.	?	0				Some trees mid season; signs then of rodent work.
23	#2-Walker Basin	1	Spr.1909	Broadcast	Coated with red lead, harrowed after sowing.	?	0				Drought
24		2	Spr. 1909	Seedspot	Red lead-corn planter	?	0				Shallow planting – drought
25		3	Spr. 1909	Seedspot	Red lead-sown with hoe	?	275 per A.	--	0		Drought
26		4	Spr. 1909	Seedspot	Seed pregerminated	?	525 per A.	--	0		No reason given for mortality
27		5	Fall 1909	Seedspot	Sown with corn planter	?	20 per A.	--	0		Drought, sdlgs only in shade lodgepole pine trees
28		6	Fall 1909	Seedspot	Seed pregerminated	?	40 per A.	--	0		Drought, sldgs only in shade lodgepole pine trees
29	Deschutes (cont.)	7	Fall 1909	Seedspot	Sown with hoe	?	12 per A.	--	0		Drought, sdlgs only in shade

Ref. No.	Forest and Designation	Plot or Strip No.	Date Estab.	Method of Seeding	Special Features of Method	Amt. Seed Per A. or Plot	Survival at Various Periods				Remarks
							End of 1st Season	End of 2nd Season	End of 3rd Season	Later Years	
											lodgepole pine trees.
30		8	Fall 1909	Broadcast	Harrowed after sowing.	?	0				Drought
31	#2-Wal.Bas.-Ad.#1	1	Spr. 1910	Broadcast	Harrowed after sowing	?	0				Drought
32		2	Spr. 1910	Seedspot	Sown with corn planter	?	15 per A.				Drought, sldgs only in shade lodgepole pine trees.
33		3	Spr. 1910	Seedspot	Sown with hoe	?	25 per A.				Drought, sdlgs only in shade lodgepole pine trees
34		4	Spr. 1910	Seedspot	Seed pregerminated	?	10 per A.	--	0		Drought, sdlgs only in shade lodgepole pine trees
35	#2-Wal.Bas.-Ad.#2	3	Spr. 1911	Seedspot	Seed pregerminated	?	7 per A.				Destruction of seed
36		4	Spr. 1911	Seedspot	Sown with hoe	?	9 per A.				Destruction of seed
37	#3-Walker Basin	1	Spr. 1909	Broadcast	Red lead; harrowed after sowing	?	0				Drought
38		2	Spr. 1909	Seedspot	Red lead; corn planter	?	0				Shallow planting, drought
39		3	Spr. 1909	Seedspot	Red lead; hoe	?	0				Shallow planting, drought
40		7	Spr. 1910	Seedspot	Corn planter	?	0				Drought & destruction of seed
41		8	Spr. 1910	Seedspot	Hoe	?	0				Drought & destruction of seed
42		9	Spr. 1910	Broadcast	Harrowed after sowing	?	0				Drought & destruction of seed
43	#4-Long Prairie	-	Spr. 1913	Seedspot	Dpth ½"-3"-vary. degr. firming soil; covered with screen	?	46% in June	0			Germ. slower dpth incr. pking better to 1" then poorer. Dr.
44	Long Pr.-Depth Ts.		Fall 1910	Seedspot	Various depths & degrees of compacting soil.	?	0 to 14 July	--	--	4th season-0	No germ. over 3", 2" best. Much seed eaten. Degree firming soil no apprec. effect. Many dead drght. by mid. 1st yr.
45	Long Pr.-Depth Ts.		Spr. 191	Seedspot	Various depths & degrees of compacting soil.	?	0 to 92 exam	--	--	4th season-0	
46	Fremont #1-Lake		Spr. 1909	Broadcast	Coated with red lead	1.5 lbs.	10 per A.				Sd.into soil by heaving for sprouted sd. found 1 to 1 ½" below.
47	#2-Bald Hill	1	Spr. 1909	Broadcast	Sown on snow. Treated with red lead.	1.5 lbs.	6 per A.				Attributed to destruction of seed.
48		2	Fall 1909	Seedspot	No red lead		0				
49	#5-Sears Flat	a	Fall 1910	Seedspot	6x6, covered 1" deep	10-15 sd.	0				Germ. abunt. in spr., all dead early June. Probably frost.
50	#7-Silver Lake		Fall 1912	Seedspot	7x7 spacing	6 lbs.	0				Germ. abunt. in spr., all dead early June. probably frost.
51	Malheur Little Bear Creek	J	Fall 1911	Seedspot	Grub hoe, covered ½"-6x6	2 lbs	53 per A.	11 per A			Destruction of seed, drought
52	Minam Jeldnes & Perry	1	Spr. 1909	Broadcast	Coated with red lead	?					Drought
53	Jeldnes & Perry	2	Spr. 1909	Broadcast	On snow, red lead.	?					Drought
54		3	Spr. 1909	Seedspot	Grub hoe, red lead, 3'x3'	?					Drought
	Olympic										

Ref. No.	Forest and Designation	Plot or Strip No.	Date Estab.	Method of Seeding	Special Features of Method	Amt. Seed Per A. or Plot	Survival at Various Periods				Remarks
							End of 1st Season	End of 2nd Season	End of 3rd Season	Later Years	
55	#4-Solduck	b	Spr. 1910	Seedspot	Grub hoe, 9-15 seed-6'x6'	2 lbs.	0	152 per A	96 per A.	6th yr. Bench 128-Slope 96	No germination until 2nd yr. Erosion and destruction of seed.
56	Siskiyou Briggs Creek	x22	Fall 1912	Seedspot	Poisoned grain after sowing with corn planter	2.5 lbs.	0				Destruction of seed.
57	Cave Creek	x24	Fall 1912	Seedspot	Poisoned grain after sowing with corn planter	2 lbs.	1 per A.	2 per A.	2 per A.		Destruction of seed
58		x24	Fall 1912	Seedspot	47 spots in the above covered with screens		70% had sdlgs.	90% had sdlgs.	90% had sdlgs.		Good results when seed is protected.
59	Umatilla #1-Henry Cr.	2	Spr. 1913	Seedspot	Half covered with screens	1 lb.	0				No sdlgs. protected or unprotected. Drought
60	#2-Kahler Cr.	2	Spr. 1913	Seedspot	Half covered with screens	1 lb.	0				No sdlgs. protected or unprotected. Drought
61	Umpqua #2-Thorn Mt.	1	Fall 1910	Seedspot	Poisoned before sowing. Grub hoe, 6x6-1/2" cover	10-15 sd.	120 per A.	0			Destruction of seed. Drought
62	#4-Williams Cr.	3	Spr. 1911	Seedspot	Poisoned before sowing. Grub hoe.	1.5 lbs.	0				10% germ. then killed by drought. Much seed destroyed.
63	Wallowa #1 – Bear Cr.	1	Spr. 1909	Bdct. & ssp.	2/3 bdct. 1/3 seedspot	7.5 lbs.	B=0 S=many				Many 1st yr. sdlg. died; replaced in part by later germ.
64	#2-Chalk Lick	1	Spr. 1909	Seedspot	Seed coated with red lead	5 lbs.	0				Attributed to drought
65		2	Spr. 1909	Broadcast	Seed coated with red lead	5 lbs.	0				Attributed to drought
66	#4-Hurricane	1	Spr. 1909	Bdct. & Ssp.	Coated with red lead.	18 lbs.	5000 per A.		1000 per A.	1000 per A.	Stand attributed use of excessive amount seed.
67	#7-Falls Cr.	1	Spr. 1910	Broadcast	Coated with red lead	6 lbs.	0				Attributed to destruction of seed
68	Wenatchee #2-Nehahum	1	Fall 1909	Broadcast	None	7 lbs.	0				Tramping by stock.
69		2	Fall 1909	Seedspot	Hoe, ½"-1" deep	4 lbs.	0				Tramping by stock
70		3	Fall 1909	Drills	8 seed per ft. Drills 5' apart	6.5 lbs.	0				Tramping by stock
71	#1-Cougar	1	Spr. 1909	Seedspot	Treated with red lead 3'x4'	5 sd.	25 (?) per A.	300 per A.	0		Drought & tramping by stock
72		3	Spr. 1910	Seedspot	Treated with coal tar 8'x8'	12-18 sd.	0				Drought & tramping by stock
73		4	Spr. 1911	Seedspot	Treated with coal tar 8'x8'	12-18 sd.	0				Drought & tramping by stock
74	Whitman #2-Columbia	1	Spr. 1909	Broadcast	Red lead-seed raked in.	5 lbs.	100 per A.	120 per A.	--	10 per A.	Most where soil is moist – destruction of seed & drought
75	Whitman (cont.)	3	Spr. 1909	Broadcast	Red lead-not raked in.	5 lbs.	75 per A.	50 per A.	--	11 per A.	Attributed to drought & destruction of seed
76		2	Spr. 1909	Seedspot	Red lead-5'x5'-1/4" deep	1 lb.	300 per A.	600 per A.	--	14th yr. 500	Only success of many tests here. Mostly 1 tree per spot.
77		4	Fall 1909	Broadcast	Red lead-seed raked in.	3 lbs.	0				Destruction of seed by

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							End of 1st Season	End of 2nd Season	End of 3rd Season	Later Years	
											rodents – many hulls found
78		5	Fall 1909	Seedspot	Red lead – ¼-1/2" deep	5 sd.	300 per A.	0			Reason for loss after partial germination not stated.
79		6	Fall 1909	Broadcast	Red lead on snow & covered by new snow	5 lbs.	0				Attributed to destruction of seed
80		7	Spr. 1910	Seedspot	Red lead	1 lb.	0				Attributed to destruction of seed
81		8	Spr. 1910	Broadcast	Red lead-in strips 5' apart, raked in	2 lbs.	0				Attributed to destruction of seed
82		9	Spr. 1910	Broadcast	Red lead-not raked in	3 lbs.	0				Attributed to destruction of seed
83		11	Fall 1910	Seedspots	Treated with coal tar	1 lb.	--	0			
84		14	Spr. 1911	Seedspots	Treated with coal tar	7 sd.	--	0			Attributed to destruction of seed
85		15	Spr. 1911	Seedspots	Treated with red lead	7 sd.	--	0			Attributed to destruction of seed
86		17	Spr. 1911	Seedspots	Treated with red lead	12 sd.	--	0			Attributed to destruction of seed
87	#3-Wildcat	1	Spr. 1909	Broadcast	Red lead	4.5 lbs.	0				Attributed drought & destruction of seed
88		2	Spr. 1909	Broadcast	Raked in red lead.	4.5 lbs.	0				Attributed to drought
89		3	Spr. 1909	Seedspot	Red lead	1 lb.	0				Attributed to drought
90		4	Fall 1909	Broadcast	On Snow	3 lbs.	0				Attributed to drought
91		5	Spr. 1910	Seedspot			0				Attributed to drought
92	#4-Old Burn	1	Fall 1910	Seedspot	Treated with coal tar	1 lb.	90 per A.	--	7		Many died 1st yr. drought. No signs seed molested.
93		2	Spr. 1911	Seedspot	Untreated	1 lb.	0				A few germinated, then died of drought
94		6	Fall 1911	Seedspot	Untreated	¾ lb.					Rodents and drought
95	#5-Woodrat	2	Fall 1910	Seedspot	Treated with coal tar	1 lb.					Probably rodents
96		7	Spr. 1911	Seedspot	Not treated	1 lb.	0	70 per a.	300 ? per A.	11th 25 per A.	Thot sd. eaten. 3rd yr. report questionable accuracy
97		9	Fall 1911	Seedspot	Not treated	¾ lb.	--	--	50	7th 3 per A.	Compet. lodg. p. & questionable adapt. to site
98	#10-Switchback	3a	Fall 1912	Seedspot	Spots unprotected	30 sd.	0			0	Destruction of seed by animals
99		3b	Fall 1912	Seedspot	Spots protected with screens	30 sd	90% had sdlgs	80% had sdlgs	80% had sdlgs	6th-70% sdlgs	13% loss dr. 1st yr., incr. to 50% later, partly sheep
100		4a	Spr. 1913	Seedspot	Spots unprotected	30 sd.				6th 0	Destruction of seed by animals
101		4b	Spr. 1913	Seedspot	Spots protected with screen	30 sd.	100% had sdlgs.	100% had sdlgs	100% had sdlgs	6th 0	By 3rd yr., total no. decr. 26% dr. Final loss sheep.
102	#13-Crawford Md.	1a	Fall 1912	Seedspot	Spots unprotected	30 sd.	20% had sdlgs	20% had sdlgs	20% had sdlgs	6th 0	1 seedling in one spot; seed destroyed by animals
103		1b	Fall 1912	Seedspot	Spots protected	30 sd.	80% had sdlgs.	80% had sdlgs.	80% had sdlgs.	6th-40% sdlgs	Only 5% loss in no. sdlgs. in 3 yrs., then 45% loss sheep.
104		2a	Spr. 1913	Seedspot	Spots unprotected	30 sd.	11% had	22% had	22% had		2 spots, 1 sdlg. each.

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							End of 1st Season	End of 2nd Season	End of 3rd Season	Later Years	
							sdlgs	sdlgs	sdlgs		Destruction of seed.
105		2b	Spr. 1913	Seedspot	Spots protected	30 sd.	20% had sdlgs.	20% had sdlgs	20% had sdlgs	6th 0	6 sdlgs. only; screens dislodged; final loss from sheep

(End of Table 1.)

Results

General Averages

Results on the whole were very poor. Only 41 plots, or 39% of the total of 105 were reported as containing seedlings at any time during the first season, and by the end of the third season (in a few instances a longer period) the number had dropped to 12. This was only 11% of the whole. Drought, destruction of the seed, tramping by stock, frost, and erosion, were the various agencies named as responsible for failure. Of these, drought and destruction of the seed were cited by far the greater number of times. Whatever the causes of failure may have been, these experiments indicate clearly that direct seeding is not a reliable method for use with western yellow pine.

Absence of trees at the time of the first examinations may have been due either to lack of germination or to mortality of the trees soon thereafter. Since many of the plots were not examined for the first time until near the end of the first season, data on germination is far from complete, yet it is believed significant that at least some trees were reported on 41% of the plots in which the seed was covered, as against only 20% for the plots where the seed was left uncovered. It is readily conceivable that moisture conditions would be more conducive to germination under the former than under the latter condition. Also the seed might be somewhat protected from molestation by birds. On the other hand, covering the seed would not be of much aid in preventing injury from rodents, since their powers of scent enable them to detect the presence of seed beneath the soil.

Destruction of Seed

Destruction of the seed was given as the reason for failure on a great many plots, and concrete evidence that this was a contributing cause was presented in seven instances. One of these is No. 77, where it was reported that many empty hulls were found. The other six comprise tests in which the spots were covered with cones made of wire screening of sufficiently small mesh to exclude birds and rodents but not, it is believed, so fine as appreciably to affect moisture or other conditions. A summary of results on these protected plots and on adjoining uncovered check plots is as follows:

Protected Spots	Unprotected Spots
#58 – 70% had seedlings	#57 - .08% had seedlings
#99 – 90% had seedlings	#98 – 0% had seedlings
#101 – 100% had seedlings	#100 – 0% had seedlings
#103 – 80% had seedlings	#102 – 20% had seedlings
#105 – 20% had seedlings (Not an accurate test, as part of screens became dislodged)	#104 – 11% had seedlings
#43 – At rate of 1,000 seedlings per acre	No directly comparable check but numerous other tests with unprotected spots in same general region failed to yield anywhere near as many seedlings.

The number of seedlings obtained in these screened spots was so greatly superior to the almost negligible number found in the exposed spots that there can be no question that destruction of the seed was the controlling factor. Since these plots were situated in the Blue Mountain region, the pumice soil region of central Oregon, and the Siskiyou Mountains region of southern Oregon, they are fairly representative of much of the yellow pine country, and it is permissible to assume that similar destruction of the seed takes place elsewhere. Birds are universally present on deforested lands, and various kinds of rodents almost equally so. Moreover, numerous similar tests have demonstrated that

destruction of seed is a very frequent cause of failure in direct seeding operations with other species. That it was a major factor in a great majority of these tests with yellow pine is a safe conclusion.

Methods to protect seed.

Several methods were employed in an attempt to prevent or lessen destruction of the seed. These consisted of coating the seed prior to sowing with red lead, and with coal tar, and in scattering poisoned grain over the area prior to sowing. The majority of the plots in each treatment were entire failures, yet the percentage of the red lead and poisoned grain plots containing at least some seedlings was higher than that of the plots receiving no treatment at all. The actual figures were 33% for red lead, 40% for poisoned grain, and only 28% where there was no treatment. Apparently, therefore, these two treatments were of some benefit in protecting the seed, though by no means to an extent sufficient to make direct seeding a dependable method of reforestation. Only one of the seven plots on which the seed was coated with coal tar contained any seedlings.

Mortality after germination

Mortality after germination was largely caused by drought. As already stated, the percentage of plots with trees decreased from 39% during the first season to only 11% at the time of the last examinations, which were made usually at the end of the third season, but in a few instances at a later period. In five of the plots on which there were seedlings originally, tramping by sheep was listed as a contributing factor; in one case frost heaving was mentioned, and in two instances competition with a natural growth of lodgepole pine. These comprise only 20% of the total number, leaving 80% on which drought alone was held responsible. On plots 27, 28, 29, 32, 33, and 34, the only seedlings found at the end of the first season were in the shade of lodgepole pine, where there was a partial mulch of needles. While even these disappeared later, it is probably that their presence there the first year when all other parts of the plots were bare of seedlings, is an indication of more favorable moisture conditions. On several plots, notably #98 and #101, which were examined more frequently than was ordinarily the case, numerous dead seedlings were found, which in the judgment of the examiner, based upon the appearance of the seedlings and the parched condition of the soil, had clearly succumbed to drought.

Effect of Method of Seeding.

The various methods tried were as follows:

Broadcasting on bare ground, and on snow in early spring.

Broadcasting followed by harrowing or raking to get seed into ground.

Seedspots made with hoe, seed covered to various depths up to 6", and various degrees of compacting soil.

Seed planted in spots with cornplanter.

Seed sown in drills.

Results at the time of the first examination, usually at the end of the first season, are given below summarized for each method:

Method	% of plots with seedlings	Seedlings per acre
Broadcast without covering	20	6 to 5,000
Broadcast followed by harrowing or raking in seed	15	100 to 500
Seedspots with hoe	50	10 to 525
Seedspots with cornplanter	30	1 to 20
Drills	0	0

Results were very poor for all methods. None produced seedlings in more than 50% of the plots and from this, the percentage ranged down to zero. Furthermore, in only a few plots were the seedlings sufficient in amount to give promise of adequate restocking.

Although the percentages of plots with seedlings given in this summary would seem to indicate the relative worth of the various methods, it is hardly permissible to conclude that they do so with any degree of exactness, because of the many different combinations of site conditions existing on the various plots. A more exact indication of the relative worth of the various methods is afforded by those tests where different methods were tried under the same conditions of site, time, etc. Many of these were complete failures, but a few specific comparisons are available as follows:

Plot No.	Method	Seedlings per acre
63	Broadcast with covering	0
63	Seedspot with hoe	Plentiful
79	Broadcast on snow in fall, seed covered by snow	0
77	Broadcast; raked in	0
78	Seedspot with hoe	300
13	Broadcast; covered by harrow	500 early in season
14	Seedspot with cornplanter	0
15	Seedspot with hoe	200
23	Broadcast; covered by harrow	0
24	Seedspot with cornplanter	0
25	Seedspot with hoe	275
31	Broadcast; covered by harrow	0
32	Seedspot with cornplanter	15
33	Seedspot with hoe	25
30	Broadcast; covered by harrow	0
27	Seedspot with cornplanter	20
29	Seedspot with hoe	12
21	Broadcast; covered by harrow	0
19	Seedspot with cornplanter	0
20	Seedspot with hoe	40
17	Broadcast; covered by harrow	0
16	Seedspot with cornplanter	0
18	Seedspot with hoe	40

The greater effectiveness of the seedspot method is clearly indicated by these comparisons. In only one of the eight sets of tests was a larger number of seedlings obtained by broadcasting than from spotting, and in this case the heavier stand is attributed to the much larger quantity of seed used.

In plots #44 and #45, in which various depths of cover and degrees of compacting soil were tested, it was demonstrated that a covering greater than three inches practically prevented germination and that a depth of about two inches gave the best results. The degree of compactness of the soil had no appreciable effect. These tests were located in a loose pumice soil and the results can hardly be considered applicable to soils of other character. In plot #43 a somewhat similar test was made, the seed being covered to depths varying from one-half to three inches. All spots were covered with screens so that destruction of seed was prevented. An examination made six weeks after sowing, while germination was in progress, indicated that it was progressively slower as the depth of covering increased, none having then taken place at a depth greater than two inches. Since no further examination was made that season, nothing is known as to final germination. When examined the second season all seedlings were dead and their mortality was ascribed to drought.

Pregermination of Seed.

In one series of seedspot tests conducted in the pumice soil region of central Oregon, the seed before sowing was soaked in water for five days at room temperature which fluctuated between hot in midday and very cold at night. This was done to stimulate germination by the abundance of moisture thus supplied, and to shorten the period between sowing and germination. By hastening germination, the seed would be exposed for a shorter time to destruction by animals and to injury from drying out of the top layer of soil. When sown, the seed had not swelled perceptibly, but the seed coat had softened somewhat. The test was repeated in the same locality each spring for three consecutive years and once in the fall. At each sowing, a check plot of unsoaked seed was spotted on an adjoining strip for comparative purposes.

The number of seedlings per acre reported found at the end of the first season was as follows, directly comparable data being placed on the same line:

Sown with Pregerminated Seed		Sown with Dry Seed	
Plot No.	Seedlings per acres	Plot No.	Seedlings per acre
26	525	25	275
34	10	33	25
35	7	36	9
28	40	29	12

In only the first year's test were seedlings present in any considerable numbers. In this series, the plot sown with pregerminated seed lead by almost two to one. In the remaining tests, the pregerminated seed showed up the better in one series and was inferior in two, but the number of seedlings was too small for the results to carry much weight. Obviously any effect the treatment may have had in stimulating germination and shortening its period, was not sufficient to offset the action of unfavorable factors. The most significant feature of two of these series was the fact that the only seedlings found were located in the shade of lodgepole trees among a litter of pine needles. Apparently a moisture relationship was the important factor here. This condition, however, had nothing to do with the question of pregermination since it was common to both.

Season of Sowing.

In all, 33 tests were made of fall sowing and 69 of spring sowing. At the end of the first season, seedlings were found in 48% of the fall sown plots, and in only 35% of those initiated in the spring. Exact comparison of the two seasons under similar conditions of site, source of seed, method, etc. are afforded in 15 instances. Seven of these were entirely bare of seedlings at the end of the first year in each season's plots, and in two instances, #18-#20 and #102-#104, results were practically the same. In the remaining six, fall seeding proved superior 4 times and spring seeding twice. The data for these six are as follows, those on the same line being directly comparable. In each case the seed-spot method was employed.

Fall		Spring	
Plot No.		Plot No.	
78	300 seedlings per acre	80	0 seedlings per acre
27	20 seedlings per acre	32	15 seedlings per acre
28	40 seedlings per acre	34	10 seedlings per acre
29	12 seedlings per acre	36	9 seedlings per acre
44	Variable; from 0 to 14 seedlings per acre	45	Variable; from 0 to 92 seedlings per acre.
99	Avg. of 9.5 seedlings in 90% of spots	101	Avg. of 15.6 seedlings in 100% of spots

The preponderance of evidence thus appears to favor fall seeding slightly, yet so many of the tests were entirely barren of results because of destruction of the seed, that a definite conclusion to this effect is hardly warranted. In only one set of tests, #99 and #101, was the seed protected by wire screens, and here results were about equal, for the spring plot had a higher average number of seedlings per spot, but a slightly less number of spots with seedlings.

Sowing on snow

Three trials, plots #8, #47, and #53, were made of broadcast sowing in the spring on the surface of the snow, to determine whether some benefit might be derived from the seed being carried by the melting snow into closer contact with the soil than occurs when it is sown on bare ground. In only one instance, #47, were any seedlings found at the end of the first season, and in this case only six per acre. The other plots were total failures. Direct comparisons with broadcasting on the bare ground were afforded in two instances, but in each case the check plot was equally barren of seedlings at the end of the first season. So far as these tests are concerned, therefore, broadcasting on the surface of the snow apparently offers no gain in ultimate results over the same method on the bare ground. Whether germination was increased by sowing on the snow, the seedlings then dying before the first examination, is not determinable from the data; neither is it known to what extent the seed may have been destroyed by birds and rodents.

Seeding vs. planting

It is interesting to compare the results secured from seeding tests with those obtained on areas planted with nursery stock. Eight comparisons are available where both methods were tried on the same areas, though not always at the same time. Data for these are given in Table 2. It will be noted that survival on the planted areas was so greatly superior to that on the direct seeding plots that there is no question of the relative effectiveness of these two methods under the conditions pertaining in these tests. Trees were reported for only three seeded areas after the second year, and in no case did the number reach an appreciable amount. On the other hand, planting gave results on each area, and survival in some instances was as high as 50% to 90% after several years. None of the planting

was a total failure, except where in later years stock grazing and land clearing destroyed the stand. From these tests, it is obvious that the almost complete failure of direct seeding cannot be attributed to non-adaptability of western yellow pine to the site. It must be ascribed to deficiencies inherent to the method such as susceptibility to drought and destruction of seed.

Conclusions

At best, direct seeding is a very unreliable method for restocking denuded areas in the yellow pine region. Actual comparison with results obtained with planting of nursery grown stock indicates it to be greatly inferior.

Destruction of the seed by birds and rodents is one of the major factors responsible for its failure. No practical method is known to protect the seed.

Drought is another major factor, affecting both germination and survival after germination.

Because many plots, largely through the action of these agencies, were entirely bare of seedlings at the time of the first examination, and others had only a small number, the data are not sufficient to permit final conclusions regarding the relative worth of methods, treatments, and seasons. The most that can be deduced regarding these, is as follows:

Methods of seeding in which the seed is covered, such as seedspotting and raking or harrowing after seeding, appear to be superior to simple broadcasting, probably for the reason that moisture conditions are more favorable for germination and the chances for molestation by birds is somewhat reduced.

Soaking seed prior to sowing may increase germination under certain conditions. It does not, however, insure that germination will be sufficiently prompt to decrease losses from animals, nor does it affect later mortality.

Results were not sufficiently conclusive as regards season of sowing to permit choice between fall and spring.

Sowing on surface of snow gave no better results than on the bare ground.

[signed] Julius F. Kummel

TABLE #2 – COMPARISON OF SEEDING AND PLANTING TESTS ON THE SAME AREAS

SEEDING				PLANTING			
Seeding Plot No. from Table I	General Character of Site	Method	Results	Designation	Age of Stock	Season	Results
49	Border between yellow pine and desert.	Seedspots	Early germ. good; then total loss; attributed to frost.	Fremont #5 Sears Flat Strip 14 & 15	1-1 1-2	Spring Spring	82% first season, 35% 3rd. Drought & stock grazing 48% first season, 3% 2nd. Drought & stock grazing
51	Near upper limits of yellow pine type on Blue Mtns.	Seedspots	53 seedlings per acre 1st yr. only 11 in 2nd yr	Malheur-Little Bear Cr. Plot K, N, C, O, R	1-1 1-1 1-1 1-1-1 1-1-1	Spring Spring Fall Fall Spring	76% first season, 50% 6th. Drought & stock grazing. 75% first season, 25% 5th. Drought & stock grazing. 77% first season, 40% 6th. Drought & stock grazing. 35% first season, 1% 4th. Drought & stock & winter killing. 65% first season, 40% 3rd. Drought
13 to 22	Pumic soil of questionable yellow pine suitability	Bdct. & seedspots	Seedlings on only 40% during 1st yr., then total failure, drought & destruction of seed.	Deschutes #1-Walker B Stps. 4-8-12 to 17	1-1 & 2-1	Fall & Spring	First 4 attempts very poor, because of poor stock & frost heaving. The following two years with better stock, 90 to 99% survived first year, with very little mortality second year. By fourth yr. land was settled on and part of trees destroyed by clearing. Those surviving were making fair growth, particularly in shade of brush.
59 & 60	Border yellow pine & grassland types	Seedspot, half screened	No seedling at any time	Umatilla #1-Henry Cr. #2-Kahler			84% 1st yr., 64% 2nd, 6% 3rd yr. Drought & trampling by stock. 80% 1st yr., 50% 2nd yr., 0% 3rd yr. Drought & trampling by stock.
92 to 94	Fir, larch, Doug.fir type where yellow pine occurs sparingly.	Seedspot	23% on 1 plot 1st yr., 1% 3rd yr., nothing on remainder	Whitman #4-Old Burn Stps. 8 to 13	1-1, 1-1-1 & 2 ½	Fall & Spring	47 to 98% living 3rd yr.
95-97	Border line betw. yellow pine & true fir type	Seedspot	A few on two plots after 7th & 11th yr.	Whitman #5-Woodrat #11	1-1	Spring	33% after 8 yrs. Much more than on seeding strips.
56	Good quality yellow pine type in southern Oregon.	Seedspots	O-Destruction of Seed.	Siskiyou-Briggs Cr. Z 2-10-18-19-23	Nursery & Forest grown	Fall & Spring	Rather high loss, but 12% to 50% living 3rd yr. Drought, poor stock, brush competition responsible.
11 & 12	Near upper limits yellow pine west side of Casades.	Broadcast seedspots	0 0	Crater-Cat Hill-Sp. 1912 Plots 1 & 2	1-1	Spring	From 34% to 98% living after 8 yrs.