GERMINANT REFORESTATION: A PROMISING NEW TECHNIQUE[1]

Robert L. DeVelice and Bruce A. Buchanan
Graduate Assistant and Assistant Professor of Forest Soils, Department of Agronomy, New Mexico State University, Las Cruces, N. M.

Advantages of germinant.…over conventional methods include: faster planting ratio, greater suitability for planting in shallow soils, and a much shorter lead time needed to initiate germinant reforestation operations.

Reforestation of ponderosa pine (*Pinus ponderosa* Laws.) in the southwest is challenging because of extensive nonstocked areas and low seedling survival. Burned and cutover commercial ponderosa pine lands needing reforestation exceed 150,000 hectares (*7*). Seedling survival varies greatly but averages less than 30 percent (*2*). Since ponderosa pine is important for timber production and for a variety of recreational uses, economical reforestation techniques must be devised to overcome the difficulties. A new development that may aid in achieving this goal is the use of germinated seeds, hereafter referred to as "germinants."

Germinants have been tested in California using Coulter pine (*Pinus coulteri* D. Don) seed (*1*), and in New Mexico using ponderosa pine seed (*4*). In both studies, the highest survival rates were obtained when the germinants were protected with screen caps following planting. The New Mexico study also showed that variable radicle lengths (.25 to 4.75 cm) and configurations (straight or bent) had no apparent effect on survival 5 weeks after planting.

The following is a report of the New Mexico study based on survival records taken 1 year after planting.

[1]Journal article No. 644, New Mexico Agricultural Experiment Station, Las Cruces, N. M.

Materials and Methods

This study was conducted within the Sacramento Mountains of south-central New Mexico. Eight plots (each 10 x 10 m square) were positioned in burned areas dominated by shrubs and grasses. These plots were located within the elevational range of 2,000 to 2,450 m and were separated by a maximum distance of 10 km.

The ponderosa pine seeds utilized were extracted from cones collected from squirrel caches in the Sacramento Mountains. These seeds were germinated in moist vermiculite beneath sheets of paper at a temperature of about 20°C. The germinants were field planted when they were 9 days old (early July 1974) and had radicle lengths varying from .25 to 4.75 cm (fig. 1).

Thirty-two seedspots (50 x 50 cm scarified patches) were prepared within each study plot. One germinant was placed in each of two 2.5 cm diameter holes about 10 cm apart in each seedspot and gently covered with about 1 mm of soil.

Cone-shaped caps (30 cm tall), fashioned from fine (1/16 in) mesh window screen, were placed over 16 of the planted seedspots on each plot. Each cap was secured to the ground by four 3.5 cm long nails. Eight of these covered seedspots were mulched with

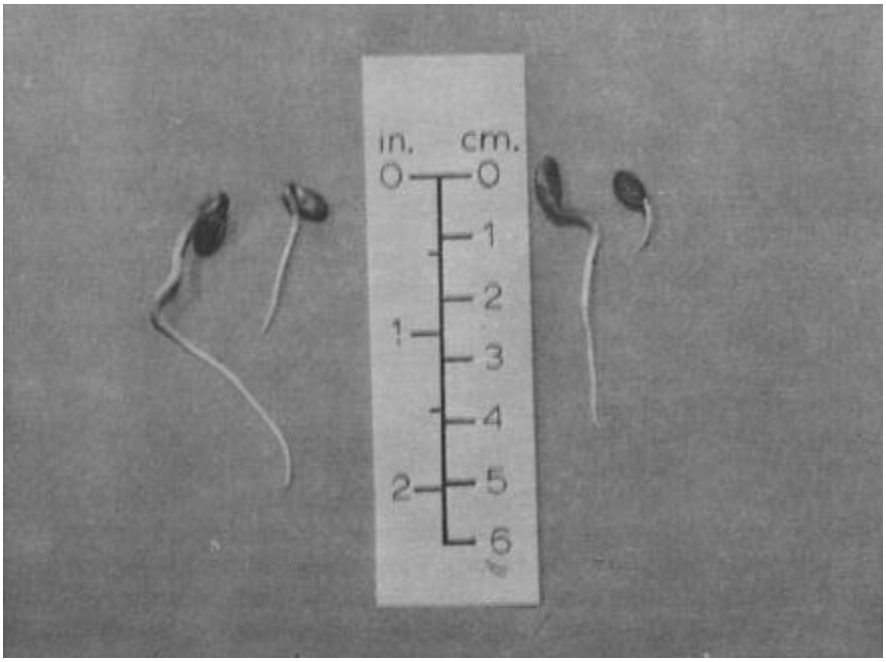

Figure 1. *–Ponderosa pine germinants as they appeared at planting time, 9 days after germination.*

wood debris collected at the planting site. Of the 16 uncovered seedspots in each plot, eight were mulched and eight were left untreated (control).

Germinant survival and regeneration success on each plot was recorded 1 year after planting. Regeneration success is a measure of the number of seedspots with at least one living germinant. In contrast, germinant survival is the a number of living germinants, per total planted. Statistical significance of the survival differences between treatments was determined using a paired t-test (*8*).

Based on the mean survival values, by treatment, predictive curves were developed to estimate the number of germinants needed per seedspot to attain various levels of regeneration success. This was accomplished according to the following equation, based on the expansion of the bionomial:

$$G = 1n(1-R)/1nP \quad (1)$$

where G =number of germinants planted per seedspot, R = percent regeneration success (decimal), and P = percent germinant death (decimal).

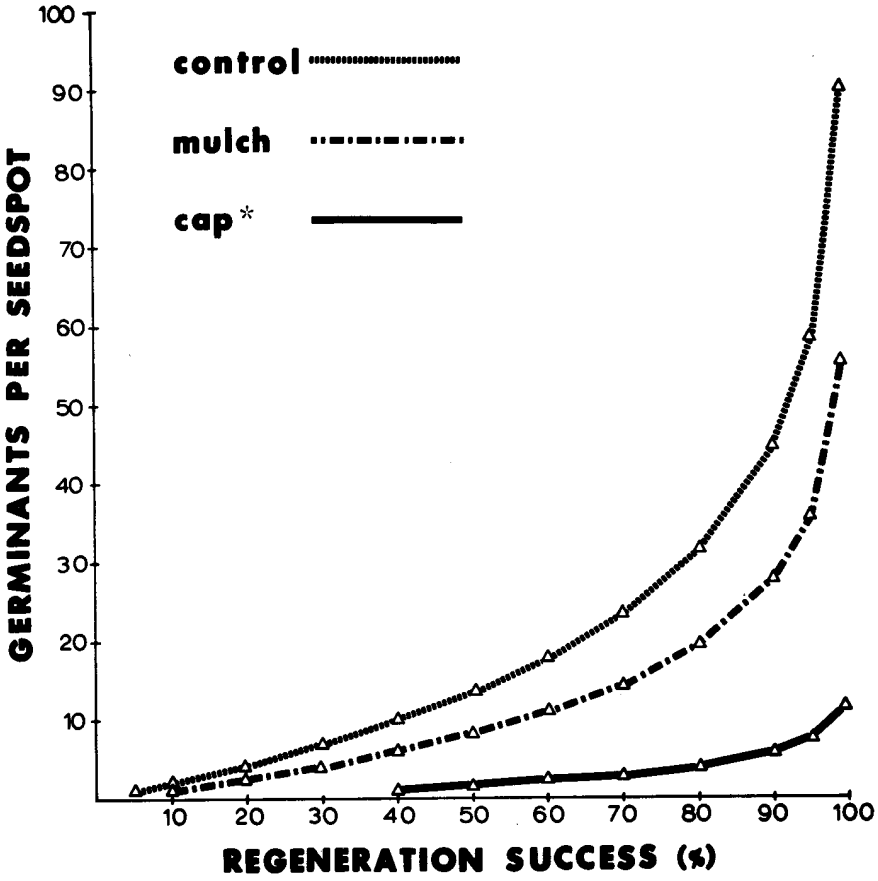

Figure 2.—*Predicted number of germinants needed per seedspot, by treatment, for various levels of regeneration success. * The curves for the cap and cap with mulch treatments are approximately the same.*

Results and Discussion

Wide variation in germinant survival occurred among plots and between treatments (table 1). Caps significantly enhanced survival while mulching showed no apparent benefit. The predicted regeneration success curves (fig. 2) dramatically demonstrate the positive influence of screen caps on germinant survival.

Owing to their small size and succulence, young germinants are extremely vulnerable to animal damage and desiccation. Increased germinant survival under caps may therefore be attributed to protection against one or both of these factors. Shade provided by caps should reduce germinant moisture stress by lowering the vapor pressure gradient between the germinant and the atmosphere. The beneficial effect of shade on ponderosa pine seedling survival was recently noted (3).

The ineffectiveness of mulching in increasing noncapped germinant

survival may be explained by the partial loss of mulch through erosion. However, this does not explain why mulching did not benefit capped germinants. The ineffectiveness of mulching seedlings with wood chips has been documented by (*5*). In fact, it was found that mulching decreased survival in some cases.

Germinant survival beneath screen caps is comparable to the containerized seedling and bareroot stock ,survival rates reported by Buchanan (*2*). However, germinants have the advantage of being suited to planting in soils too shallow for conventional stock, and can be handplanted at a rate of about 100 germinants per hour in comparison to the 20-per-hour planting rate obtained when using bareroot stock (*1*). Further, conventional reforestation methods require up to 2 years of lead time to obtain planting stock, while only 10 to 15 days are needed using germinants. This enables coordinating germinant reforestation operations with periods of desirable environmental conditions for seedling growth and development.

To maximize reforestation efficiency it is desirable to have at least one surviving germinant on each seedspot, that is, high regeneration success. In this study, percent regeneration success was always higher and often double the percent survival (table 1). Regeneration success is expected to be higher than survival because each seedspot was planted with two germinants. However, planting two, three, or four germinants does not necessarily double, triple, or quadruple regeneration success; rather, regeneration success more closely follows the bionomial distribution described by equation 2 and shown graphically as predictive curves in figure 2.

$$R = 1-(P)G \qquad (2)$$

Schubert and Fowells (*6*) state that many problems exist in predicting regeneration success from the expansion of the binomial —the most serious being that the factors affecting seedling survival may not occur at random as the model implies. Only if the effects of nonrandom events such as animal damage and unfavorable climatic and edaphic conditions are minimized will predicted regeneration success closely model observed regeneration success. Since there is close agreement between the observed and predicted regeneration success means (table 2), random germinant death is indicated when two germinants are planted per seedspot.

Based on the results of this study and the work of Anderson and Williamson (*1*), germinant planting holds promise as a viable reforestation technique. Because of the high regeneration success possible, with little additional planting time, the planting of at least two germinants per capped seedspot is recommended. Further research is needed in such areas as the economics of germinant reforestation, comparisons of germinant with conventional methods, basic studies in

Table 1.—*Average 1-year survival (SU) and regeneration success (RS) of ponderosa pine germinants, by treatment, for eight plots in the Sacramento Mountains, N.M.*

	Control		Mulch		Cap		Cap-Mulch	
Plot	SU	RS	SU	RS	SU	RS	SU	RS
No.	percent							
1	6	12	0	0	44	75	31	50
2	0	0	13	25	81	100	69	75
3	0	0	0	0	0	0	6	12
4	6	12	13	25	31	62	19	38
5	0	0	0	0	6	12	13	25
6	0	0	0	0	13	25	19	25
7	25	38	38	50	56	75	63	75
8	0	0	0	0	31	50	25	50
Mean	5a[1]	8	8a	12	33b	50	31b	44

[1]Survival means followed by different letters are significantly different at the 5 percent level.

germinant physiology, and determining germinant planting and protection techniques that will insure high regeneration success. Only after such research is performed can the true value of the germinant method be accurately assessed.

Table 2.—*Average observed [obs] and predicted [pre] 1-year regeneration success of ponderosa pine germinants, by treatment, planted in Sacramento Mountains, N.M.*

	Control		Mulch		Cap		Cap-Mulch	
	Obs	Pre	Obs	Pre	Obs	Pre	Obs	Pre
	- percent -							
Mean	8	9	12	15	50	55	44	52

Literature Cited

1. Anderson J. M. and R. C. Williamson. 1974. Use of germinated seed to establish Coulter pine plantations in southern California. J. For. 72:90-91.
2. Buchanan, B. A. 1974. Containerized seedlings on the Lincoln National Forest *In* Proc. N. Am. Containerized For. Tree Seedling Symp., Denver, Colo., Great Plains Agric. Coun. Publication No. 68. p. 359-365.
3. Buchanan, B. A., M. F. Davault, and J. T. Fisher. 1977. Influence of artificial shade on water stress of containerized ponderosa pine seedlings. Can. J. For. Res. (In press).
4. DeVelice, R. L. and B. A. Buchanan. 1974. Survival of newly germinated ponderosa pine seed on the Lincoln National Forest. West. Interstate Comm. Higher Ed., Boulder, Colo. 29 p.
5. Reitveld, W. J. and L. J. Heidmann. 1974. Mulching planted ponderosa pine seedlings in Arizona gives mixed results. Dep. Agric., For. Serv., Res. Note RM-257. 3 p.
6. Schubert G. H. and H. A. Fowells. 1964. Sowing rates for reforestation by the seedspotting method. Dep. Agric., For. Serv., Res. Note PSW-44. 9 p.
7. Schubert, G. H., L. J. Heidmann, and M. M. Larson. 1970: Artificial reforestation practices for the Southwest Dep. Agric., Handb. 370, 25 p.
8. Snedecor, G. W. and W. G. Cochran.

A NEW PUBLICATION COMPARTMENTALIZATION OF DECAY IN TREES

Alex L. Shigo and Harold G. Marx

Agriculture Information Bulletin No. 405 Forest Service, U.S. Department of Agriculture; 73 Pages; July 1977

The booklet explains to forest managers how most tree defects develop. It shows how most columns of discolored and decayed wood associated with trunk wounds are compartmentalized. The publication is profusely illustrated with beautiful color paintings by David Carroll. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $1.85. Stock No. 001-000-03671-8.