Modification of Seed Covering Material Yields More and Larger Pine Seedlings

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Ponderosa pine (Pinus ponderosa Dougl. ex Laws.) seed, sown in a soil with a high composition of calcium carbonate that tends to crust, was covered with either soil, soil treated with phosphoric acid, light colored sand, or dark volcanic cinder. After two seasons, seedling density and size were greatest with cinder covering, second best with sand, and poorest with soil. Phosphoric acid was ineffective. Tree Planters' Notes 38(1):11-13; 1987

When dry, the soil in many places at the Albuquerque Tree Nursery, Albuquerque, NM, forms a strong crust that can impede seedling emergence (5, 7). One answer to the crusting problem is frequent, light irrigation to prevent the crust from forming; this is standard practice at the nursery. Two other methods were tested. Treatment of the soil immediately covering the seed with phosphoric acid would convert calcium carbonate, the main cause of the crust, to calcium phosphate, which forms a softer, more crumbly crust when it dries (5, 7). A second method, sometimes used in nurseries with heavy soil, is to cover the seed with a material that does not crust, such as sand. Using a grit or sand mulch is common nursery practice, but usually to reduce surface evaporation and frost heaving (1, 3, 6, 8). However, sand covering has been shown to increase seedling emergence of many species in hardwood nurseries with soil that crusts (9).

Such a covering can modify soil surface temperatures, depending on the material's albedo. Southwestern sources of ponderosa pine germinate poorly at cool temperatures (4); therefore, a dark-colored material that would warm up more than the surrounding soil might speed germination, especially for spring sowings.

Materials and Methods

On May 23, 1983, one bed on one of the poorer soils at the Albuquerque Tree Nursery, Albuquerque, NM, was marked off in 1.5-meter sections. It was then sown to ponderosa pine with an Øyjord drill, which was lifted by the front end so that the discs and rear roller did not cover the seed. The seed in each 1.5-meter plot was covered by hand to a 20-millimeter depth with one of the following:

1. Soil, simulating standard nursery practice.
2. Soil, followed by application of 100 milliliters of 7.5 per cent H_3P0_4 per 1.5 meters of drill row.
3. Sand, 0.5- to 2-millimeter particles, light tan in color, mostly quartz and granite.
4. Volcanic cinder, 1- to 4-millimeter particles, almost black.

The four treatments were randomized within each of eight blocks within the one bed. (Confining research plots to a small portion of the nursery is not statistically optimum, but is often a practical necessity. In this case, soil analyses indicated sufficient calcium carbonate throughout the nursery to cause crusting, and I have observed crusting in many parts of the nursery.)

The seedlings were grown to full size in two growing seasons using the same practices of irrigation, fertilization, weeding, etc., as used routinely throughout the nursery. At the end of the first and second growing seasons, a 30-centimeter strip across the bed was selected at random near the middle of each plot. All of the seedlings in the strip were lifted and the following observations were made per plot:

1. Number of seedlings, from which seedling bed density was calculated.
2. Mean fresh weight per seedling.
3. Mean epicotyl height.
4. Median foliage color.

Foliage color varied from dark green to yellow, and was measured by an index keyed to the following Munsell standard colors *(2):*

Index/color	*Munsell code*
4/dark green	7.5G 4/4 to 2/4
3/light green	7.5GY 5/6 to 5/8
2/yellow green	5.0GY 6/6
1/yellow	2.5GY 7/6 to 7/8

Data were analyzed by one-way analysis of variance. Significant differences in treatrnent means were determined by Duncan's multiple range test. Median color per plot was treated as a continuous variable.

Table 1—*Effect of seed covering on stand establishment and seedling characteristics*

Parameter	Growing season	Seed covering[1] Soil (control)	Soil plus phosphonic acid	Sand	Black cinder
Density (no./m²)	2-0	181 b	162 b	308 a	273 a
	1-0	222 b	194 b	295 a	224 b
Fresh weight (g)	2-0	2.56 c	2.55 c	4.07 b	6.68 a
	1-0	0.78 b	0.78 b	1.05 a	1.06 a
Epicotyl height (mm)	2-0	41.6 c	42.0 c	60.0 b	75.2 a
	1-0	23.2 b	22.9 b	33.0 a	32.7 a
Color index	2-0	2.43 c	2.51 c	2.99 b	3.38 a
	1-0	2.85 b	2.70 c	3.32 a	3.33 a

[1]Within rows, numbers followed by the same letter are not significantly different at P = 0.05.

Results and Discussion

The soil was observed to form a crust whenever the surface was dry. The sand and cinder did not. The sand was nearly the same color as the soil, and therefore, soil and sand surface temperature of the dark cinder was undoubtedly warmer that either soil or sand. Thus, although there are some other factors that cannot be ruled out, differences in seedling performance between soil and sand covering are probably attributable to presence or absence of a crust, and differences between sand and cinder are probably attributable to difference in surface daytime temperatures.

Compared to the soil covering, covering seed with sand or dark cinder increased 1-0 seedling fresh weight an average of 36 percent, epicotyl height and average of 42 percent, and foliage color was significantly greener (table 1). Seedling bed density was 33 percent greater with the sand covering.

At the end of the 2-0 year, the superiority of the sand or cinder seed covering was even more apparent, and the cinder covering was significantly better than the sand. Compared to soil covering 2-0 bed density was 70 percent and 51 percent greater with sand or cinder covering, respectively; fresh weight was 59 percent and 161 percent greater, respectively; epicotyl height was 44 percent and 81 percent greater, respectively; and foliage color was greener with cinder than sand, which, in turn, was greener than with soil covering (table 1).

By the end of the second season, the surface of the sand-covered plots was almost indistinguishable visibly from soil-only plots. Cinder-covered plots were distinguishable by surface color, although the cinder was by then mixed with the surface soil. Second-year differences in growth probably are a carryover effect from the first growing season.

The prolonged beneficial effects of the sand and cinder may have included better percolation of the irrigation water into the soil. Volcanic cinder tend to be highly fertile and may have contributed some nutrients, particularly potassium and sulfur, to the soil. However, because nursery nutrient levels were adequate, it is unlikely that mineral nutrition could account for the observed differences between the plots.

treated with sand and with cinder. More likely, the dark cinder raised soil surface temperatures in the spring and fall enough to prolong the effective growing season.

The favorable effect of the dark cinder compared to light-colored sand is at variance with usual nursery recommendations where the objective is to minimize daily fluctuation in soil surface temperatures (1.3). However, these recommendations apply more to nurseries in cool, humid climates, which are very different from the hot, dry climate at Albuquerque.

Depth of recommended seed covering also varies between nurseries in different climates. May (6) recommended 0 to 3 millimeters of soil covering over southern pine seed. Armson and Sadreika (3) recommended 3 to 6 millimeters over boreal conifer seed in Ontario. Stoeckeler and Slabaugh (8) recommended 6 to 12 millimeters over ponderosa pine seed in the Great Plains and commented that more covering is needed in drier climates. Fore the dry climate at Albuquerque Tree Nursery, a target sowing depth of 20 millimeters for ponderosa pine seems reasonable.

Soil covering treated with phosphoric acid failed to increase seedling numbers or growth, or to improve foliage color (table 1). However, the soil Was very dry when the phosphoric acid was applied. It effervesced and rolled off the drill rows, which may explain lack of positive results. The day after the seedbeds had been irrigated, a simple unreplicated plot was treated with phosphoric acid. Growth response was similar to sand covering, but there was no increase in number of seedlings.

Conclusions and Recommendations

1. Sand or cinder seed coverings were used effectively to increase stand establishment and growth in soils were crusting can be a problem.
2. Because of variation in soils, climate, and the different reactions of species to soil crusting, nurseries considering such mulching should test it on a small scale on their problem soils first. Over an entire nursery, the cost of applying substantial volumes of sand or cinder might outweigh any gain. In addition, if the composition and color of materials available locally is different from the ones used in this experiment, their use may give quite different results.

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