MECHANICAL SHAKING IMPROVES SHUMARD OAK ACORN GERMINATION

Mechanical shaking of Shumard oak acorns appeared to increase germination percentage and energy.

G. A. Tuskan and C. A. Blanche[1]

Graduate Students, Department of Forestry, Mississippi State University, Starkville

Because of embryo dormancy in Shumard oak acorns (*Quercus shumardii* Buckl.), natural or artificial stratification is required for germination (*3*). Artificial stratification requires the acorns to be placed on moist, well-drained sand for 30 to 90 days at temperatures between 0° and 9° C (*1*). Even under optimum stratification conditions, germination is often erratic and inconsistent. In addition to embryo dormancy, delays in germination in Shumard oak acorns may also be attributed to the thick, hard pericarp, which retards entry of water and oxygen. Everett and Meeuwig (*2*) were able to penetrate the hard pericarp of bitterbrush seed (*Purshia tridentata* DC.) through mechanical shaking. They found that the application of peroxide through mechanical shaking enhanced the percent and rate of germination.

This study reports on the effects of mechanical shaking and soaking on Shumard oak acorn germination. In comparison, mechanical shaking appeared to increase germination percentage and energy significantly.

Methods

The Shumard oak acorns used in this study were collected from November 2 through 15, 1978, from local sources within a 50 mile radius of Starkville, Mississippi. These acorns were then stored in a freezer at a temperature of 0° C and a moisture content between 30 and 40 percent for 3 months. At the end of this time, the acorns were upgraded by flotation in distilled water and by an ocular test (*3*). Any acorns with damage to the pericarp were discarded. Only sound, filled acorns were examined and compared in this study. Other than cold storage and flotation upgrading, the acorns were untreated in any manner prior to the initiation of the study.

Each treatment was replicated twice with 25 acorns per replicate. The two treatments were compared on the basis of germination energy, percent real germination, and rate of germination. Germination was defined as the emergence of the radicle equal to the length of the acorn. Germination counts were made twice weekly, beginning 7 days after the experimental treatment. The germination counts were completed after 28 days.

Treatment A included the acorns being mechanically shaken in distilled water for 6 hours (fig. 1). The acorns were then placed in germination trays

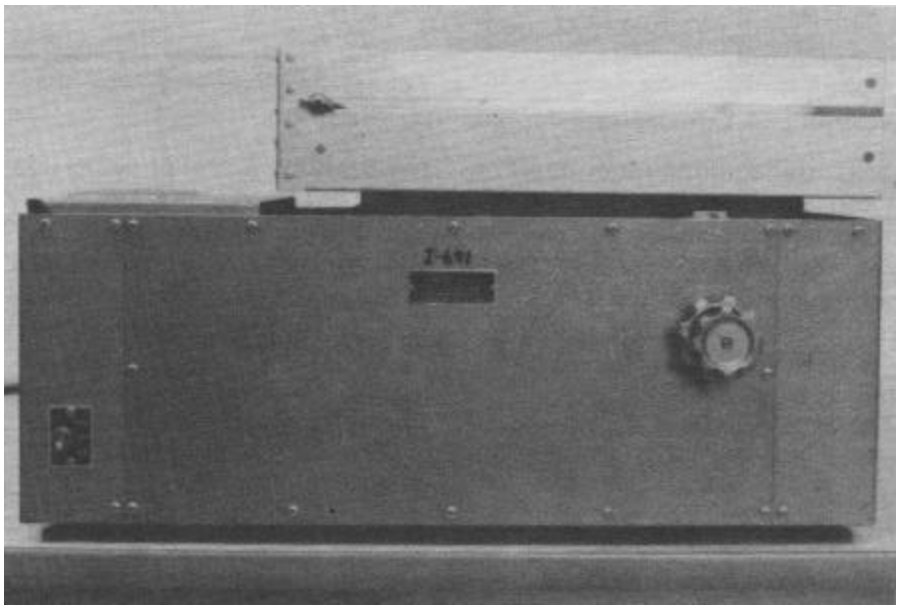

Figure 1.—*A photograph of the two-speed shaker used in this study.*

[1]The authors wish to thank Dr. William Elam for his advice during the study and his review of the article.

lined with moistened filter paper. Treatment B involved the same procedures as treatment A except the acorns were soaked for 6 hours in distilled water and then placed in the germination trays. Several additional treatments were designed to provide an explanation for treatment A and B's results. These additional treatments were: (1) shaking in distilled water then germinating in their leachate, (2) bubbling in distilled water then germinating in distilled water, (3) shaking without water then germinating in distilled water, and (4) shaking with paraffin coating in distilled water then germinating in distilled water.

Finally, all experimental treatments and germination counts were conducted at room temperature.

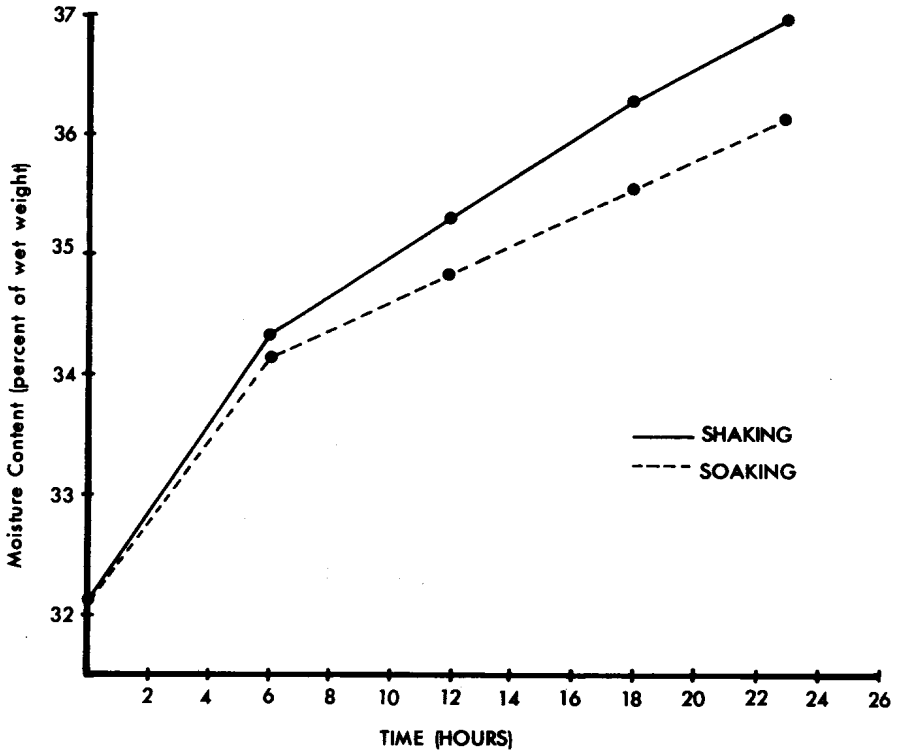

Figure 2.—*Changes in moisture contents as affected by shaking and soaking.*

Results and Conclusions

The initial moisture content of a subsample of 25 acorns was 32.09 percent. (All moisture contents are presented as a percentage of wet weight.) Figure 2 represents the change in moisture content versus time as affected by mechanical shaking and soaking. The final moisture content of the soaked acorns was 36.17 percent, yet the shaken acorns had a final moisture content of 36.98 percent. This larger increase in moisture content over time seemed to indicate that the permeability of the pericarp was increased by shaking.

In comparing germination energy, the shaken acorns had a 35 percent better value than did the soaked acorns (table 1, fig. 3). This larger value indicated that the peak rate of germination during the 28-day test period came at an earlier time and was greater for the shaken acorns than that of the soaked acorns. Figure 4 denotes the differences in percent real germination, with the final percentage of sound acorns that did germinate nearly 30 percent greater for the shaken acorns (table 1). Finally, in comparing the rate of germination for both the shaken and soaked acorns, there appeared an abrupt difference after the 7th day of germination (fig. 5). The rate of germination for the shaken acorns was continually greater than that of the soaked acorns. After 14 days, the increased rate of germination leveled off nearly parallel to the rate of germination for the soaked acorns.

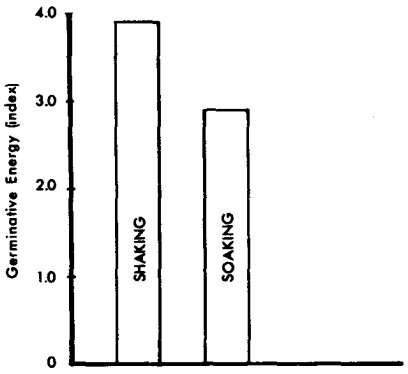

Figure 3.—*Germination energy as influenced by shaking and soaking.*

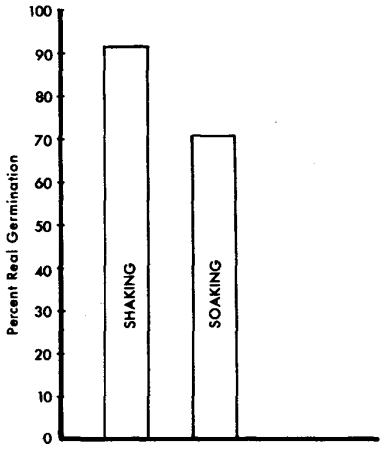

Figure 4.—*Effects of shaking and soaking on percent real germination.*

Mechanical shaking of Shumard oak acorns had beneficial effects on the percent real germination, germination energy, and rate of germination. Three possible explanations exist for the germination enhancement. The first is that mechanical shaking may remove and dissipate inhibitors located in the pericarp. The second is that mechanical shaking may allow an increased uptake of water through the availability of

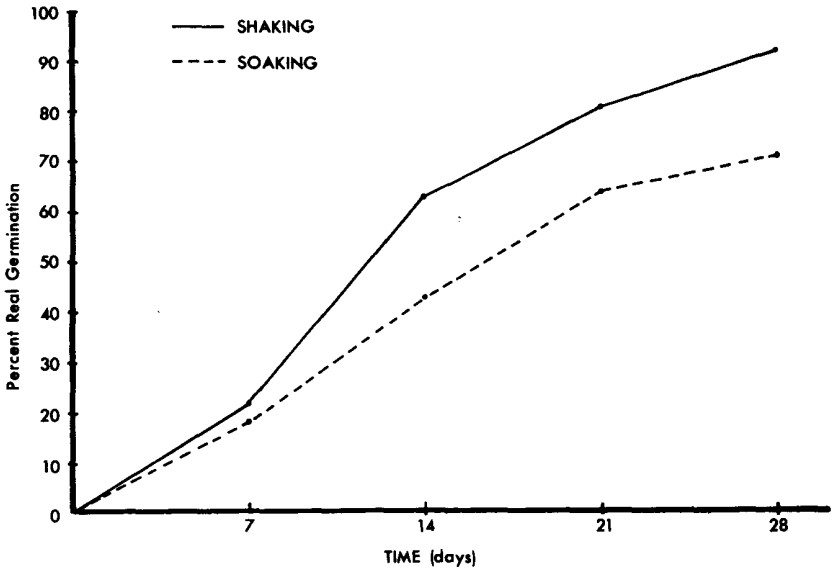

Figure 5.—*Rates of shumard oak germination under shaking and soaking.*

Table 1.—*The effects of mechanical shaking on germination energy, percent real germination, and germination capacity*

Treatment	Germination energy[1]	Percent real germination[2]	Germination capacity[3]
Shaking in distilled water Germinating in distilled water	3.91	91.9	90.0
Soaking in distilled water Germinating in distilled water	2.89	70.8	68.0

[1]Germination energy equals the change in the number of germinated acorns divided by the number of days since the treatment began.

[2]Percent real germination equals the percent of sound acorns that germinate. At the end of 28 days, the acorns were cut open to determine if they were sound.

[3]Germination capacity equals the percentage of total acorns that germinated within the 28-day test period.

water and the abrasive movement of the acorns. The third is that mechanical shaking may increase the availability of oxygen to the embryo.

To determine which of the three possible mechanisms were involved in the germination enhancement, four additional treatments were examined and compared in terms of germination energy (table 2). The first treatment—shaking acorns in distilled water then germinating them in their leachate—did not show any significant difference from that of the control (table 2). This implies that removal of water soluble inhibitors from the pericarp was not a significant mechanism for germination enhancement. The second treatment—bubbling in distilled water then germinating in distilled water—yielded the best germination response followed closely by the third treatment—shaking without water then germinating in distilled water. The results from these two treatments seemed to indicate that shaking improved air permeability, which consequently increased oxygen availability. The fourth treatment-shaking the acorns coated with paraffin in distilled water then removing the paraffin and germinating in distilled water-had the lowest germination energy in comparison to the rest of the treatments. This reinforced the conclusion that mechanical shaking rendered the pericarp of Shumard oak acorns more permeable to oxygen and secondly to water. This conclusion was further confirmed by the observation of an increased evolution of gas as indicated by water vapors condensing on the lids of the germination trays immediately after placing the shaken acorns in the trays.

Table 2.—*The effects of several treatments on germination energy in Shumard oak acorns as an indicator of possible mechanisms of germination enhancement.*

Treatment number	Description	Germination Energy
1	Shaking in distilled water Germinating in leachate	1.3962
2	Bubbling in distilled water Germinating in distilled water	1.9520
3	Shaking wthout water Germinating in distilled water	1.7398
4	Shaking with paraffin in distilled water Germinating in distilled water	.8147
Control	Shaking in distilled water Germinating in distilled water	1.4439

Summary

Mechanical shaking of Shumard oak acorns had a positive effect on germination energy, percent real germination, and rate of germination in comparison to soaking. Considering the tested treatments and the continued increase in moisture content versus time, germination enhancement appeared primarily due to an increased gas exchange. At present, it seems that mechanical shaking could be used in nursery operations to enhance germination by promoting prompt and consistent germination of Shumard oak acorns.

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