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WATER UPTAKE AND GERMINATION OF RED OAK ACORNS

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ABSTRACT

When pericarps were intact, water was absorbed by Nuttall, pin, cherrybark, and northern red oak acorns, mainly through the vascular openings of the cup scar. Uptake through the pericarp was greater for acorns with a thin waxy coating on the pericarp than for acorns with a heavy waxy coating. Splitting or removing the pericarp greatly speeded uptake. Osmotically induced water stresses decreased germination of pin oak acorns, but germination was still 62% at 10 atm.

This paper reports rates of water uptake by acorns of four species of red oak and effects of moisture stress on germination of one species.

Material and methods

WATER UPTAKE.—Acorns of Nuttall (*Quercus nuttallii* Palmer), pin (*Q. palustris* Muenchh.), cherrybark (*Q. falcata* var. *pagodaefolia* Ell.), and northern red oak (*Q. rubra* L.) were stratified in moist peat moss at 40 C for 60 days. Fifteen acorns of each species were then given one of the following treatments: (1) no treatment (control), (2) sealing of cup scar, (3) splitting of pericarp, (4) removal of pericarp, (5) killing the embryo but leaving pericarp intact, and (6) sealing the large micropyles on Nuttall acorns.

Removal of pericarp wax with organic solvents was planned as a seventh treatment, but none of the solvents removed the wax without harming the acorns.

Cup scar areas and micropyles were sealed with wax. Acorns were killed by autoclaving for 5 min with 15 psi steam at 250 F; the acorns were cooled gradually to avoid splitting the pericarps.

All acorns were weighed to the nearest 0.01 g, immersed in distilled water in 25-ml Erlenmeyer flasks, and reweighed after 10, 24, 48, 72, 96, 144, 192, and 240 hr at 19 C. Water adhering to the acorns was removed with cheesecloth before weighing, and all added weight was considered to be uptake. The water was changed in the flasks at each weighing.

After 240 hr, dry weights were obtained by drying the acorns for 36 hr at 75 C. Water contents after the various periods of immersion were then calculated as percentages of acorn dry weight.

OSMOTIC INHIBITION OF GERMINATION.—Stratified pin oak acorns with the pericarps removed were placed in sucrose solutions in petri dishes at 28 C, and germination was observed for 250 hr. The solutions had osmotic stresses of 0, 2.5, 5.0, 10.0, 15.0, and 20.0 atm. There were three replications of each solution, each replication with 20 acorns.

An acorn was considered germinated when embryo development separated the cotyledons. Germinated acorns were removed from the dishes, weighed, dried, and reweighed to determine moisture content. Initial moisture content was determined from a random sample of acorns.

Results

WATER UPTAKE.—Original moisture contents averaged 30% for cherrybark oak acorns and 40%–50% for acorns of other species.

After a large initial uptake, live acorns slowly and steadily absorbed more water (fig. 1). Dead acorns, with the exception of pin oak, absorbed practically no water after initial uptake. Acorns with pericarps

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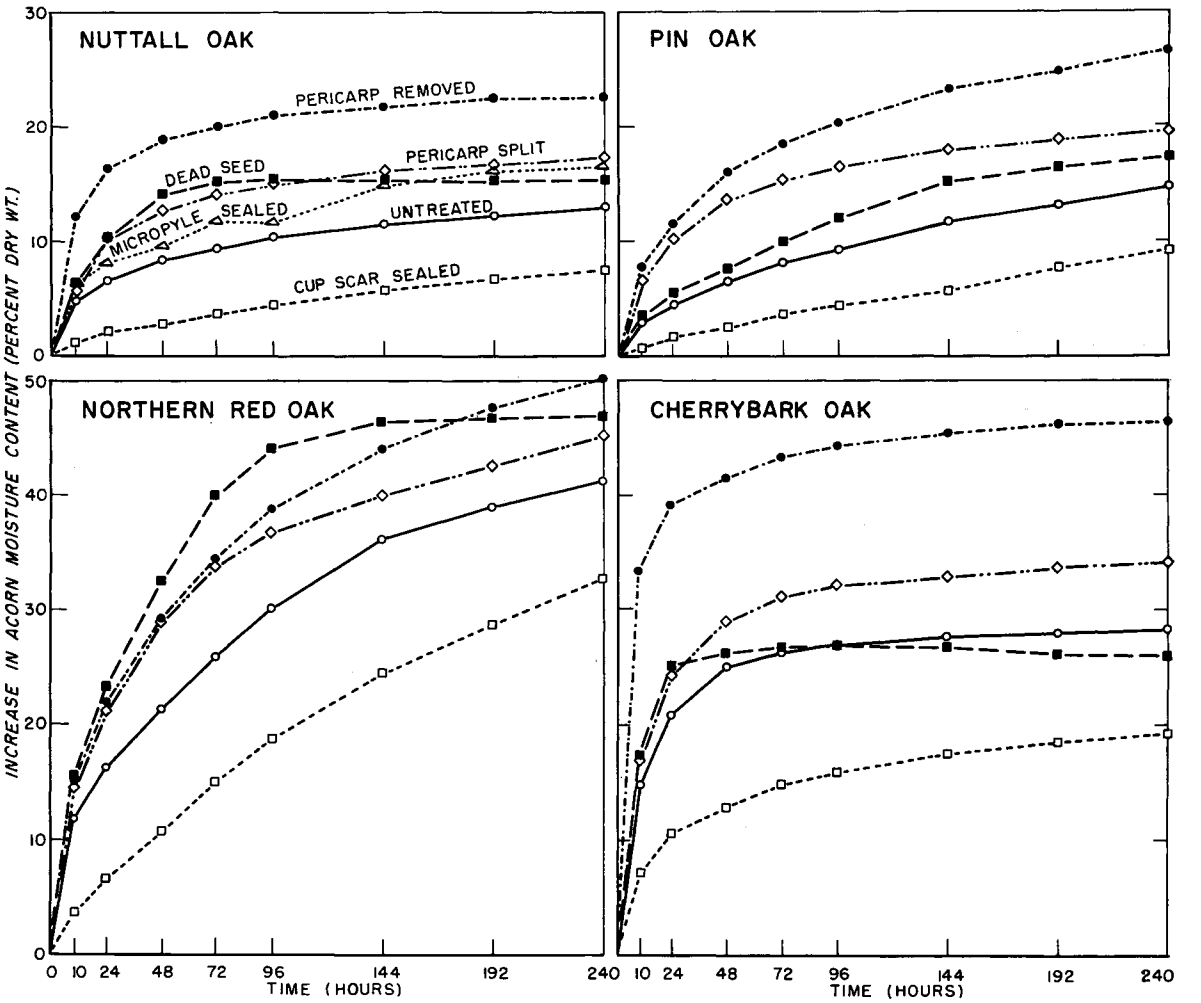

FIG. 1.—Water uptake of acorns by species and treatment

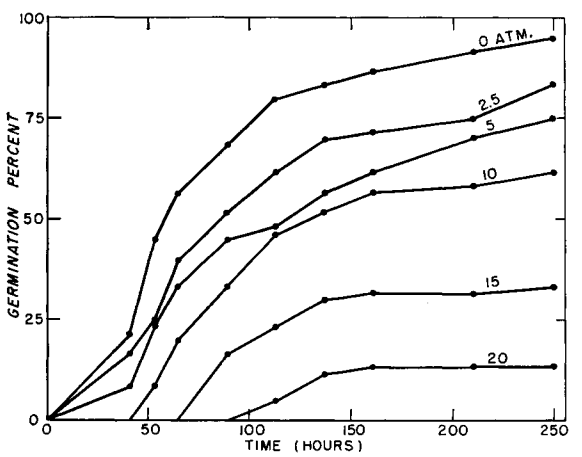

FIG. 2.—Cumulative germination of pin oak acorns in sucrose solutions with various osmotic stresses.

split or removed absorbed the most water in almost every case.

Sealing the cup scar resulted in decreased water uptake in all species, but the greatest decrease—to about 60% of uptake of control acorns—occurred in Nuttall and pin oak acorns, whose pericarps have very thick waxy layers.

Sealing the micropyle on Nuttall acorns did not result in less water uptake.

OSMOTIC INHIBITION OF GERMINATION.—Both total germination and rate of germination of pin oak acorns were decreased by increasing osmotic stress and thereby slowing water uptake. About 60% of the acorns germinated at 10 atm of stress; at higher stresses there was little germination (fig. 2).

When they were placed in the sucrose solutions, the acorns had an average moisture content of about 45%. Those in the solutions with low osmotic

stresses germinated first; their moisture contents were 60%–75%. Those germinating after 100 hr had moisture contents of 50%–60%. The small number of acorns that germinated in the 20-atm solutions had moisture contents of 45%–49%.

Discussion

Several studies (Goo, 1951*a*, 1951*b*, 1956; ASAKAWA, 1956) have shown that water uptake by coniferous tree seed can be divided into three phases: (1) rapid initial uptake, caused mainly by imbibition, (2) a tapering-off period of slow uptake, and (3) distinctly increased uptake resulting from metabolic activity in germination. In this study, phases 1 and 3 were present, but phase 2 was not. Since phase 2 is associated with a period of metabolic inactivity prior to germination, it appears that the stratification prior to submersion was effective and that the acorns began to germinate as soon as they completed initial uptake.

The curves in figure 1 are similar to KORSTIAN's (1927) for scarlet and northern red oak. KORSTIAN concluded that water uptake per se did not normally limit acorn germination.

The thick coating of wax on the pericarps of Nuttall and pin oak acorns may explain the high tolerance to submergence of wet-site red oaks reported by BRISCOE (1961) and LARSEN (1963). Nuttall and pin oak acorns absorbed much less water on a dry-weight basis than did northern red and cherrybark oak acorns, which have a much thinner wax coating. In this study Nuttall and pin oak acorns took up water mainly through the cup scar, whereas northern red and cherrybark acorns took up considerable water through the pericarp as well as the cup scar.

The insignificance of water uptake through the micropylar openings was previously reported for *Quercus pedunculata* and *Q. sessiliflora* (WATT, 1919).

Since osmotic stresses do not necessarily have biological effects equal to those of soil-moisture tensions, the stresses that limited germination indicate only the general trends likely in soil.

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