

tention if the mixes had been allowed to dry down in excess of 50 cb soil suction. Water release was calculated from successive weighings and corresponding tensiometer readings and plotted into curves as shown in the graph. The value of water release for 50 cb of soil suction was then extrapolated from the curve and expressed as a volume fraction. For a container 6 inches high, there would be approximately 5 inches of soil mix. To calculate the amount of water to apply, one of the following equations may be used: (1) Irrigation water volume = $\omega' \times$ soil volume; or (2) Irrigation water depth = $\omega' \times$ soil depth.

Average value

An average value of water release (ω') for the mixes of .20 would be multiplied by the 5 inches to obtain 1 surface inch of water required to replenish the water used during the drying cycle. In the first trial, the average value of water release (ω), for 0-50 cb soil suction, was .17 for soil, .18 for calcined clay, and .23 for redwood shavings, indicating the shavings have increased the water storage capacity. It is significant to note the steepness of the water release curve at low suction values. For soil mixes, which have relatively lower densities and correspondingly higher water conductivities than the soil, the curve is even steeper: 60-80% of the 0-50 cb water available was released to the plants by 10 cb. Therefore, it is important to begin irrigations before reaching 50 cb soil suction. The water stored in most mixes generally exceeds 1 surface inch (water release $> .20$). If the soil mix is dried to a suction of 50 cb, it will require a double irrigation to replenish the water used. The improvement of water stored under low soil suction in the container is a disadvantage when the plant and mix are placed in contact with the soil.

Under field conditions an average soil suction of 5-10 cb exists after drainage has stopped. Therefore, most of the water stored in the mix would drain down through the profile, and water available to the plant would be $\omega' - \omega'' \times$ soil depth (graph). It is important to be aware of this condition when plants are set out so that frequent irrigations will be made until the roots are established in the surrounding soil.

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IMPROVED

Pistacia

SEED

GERMINATION

Scarification with sulphuric acid speeded up—and increased the percentage of Pistacia seeds germinating

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THE PISTACHIO NUT TREE (*Pistacia vera*) is propagated by T-budding on seedling rootstocks of *P. atlantica* and *P. terebinthus*. These species are preferred over *P. vera* mainly because they are more resistant to nematodes. Other species of *Pistacia*, such as *P. chinensis* and *P. intergerrima*, have attracted attention from time to time as possible rootstocks for pistachio.

Rapid expansion

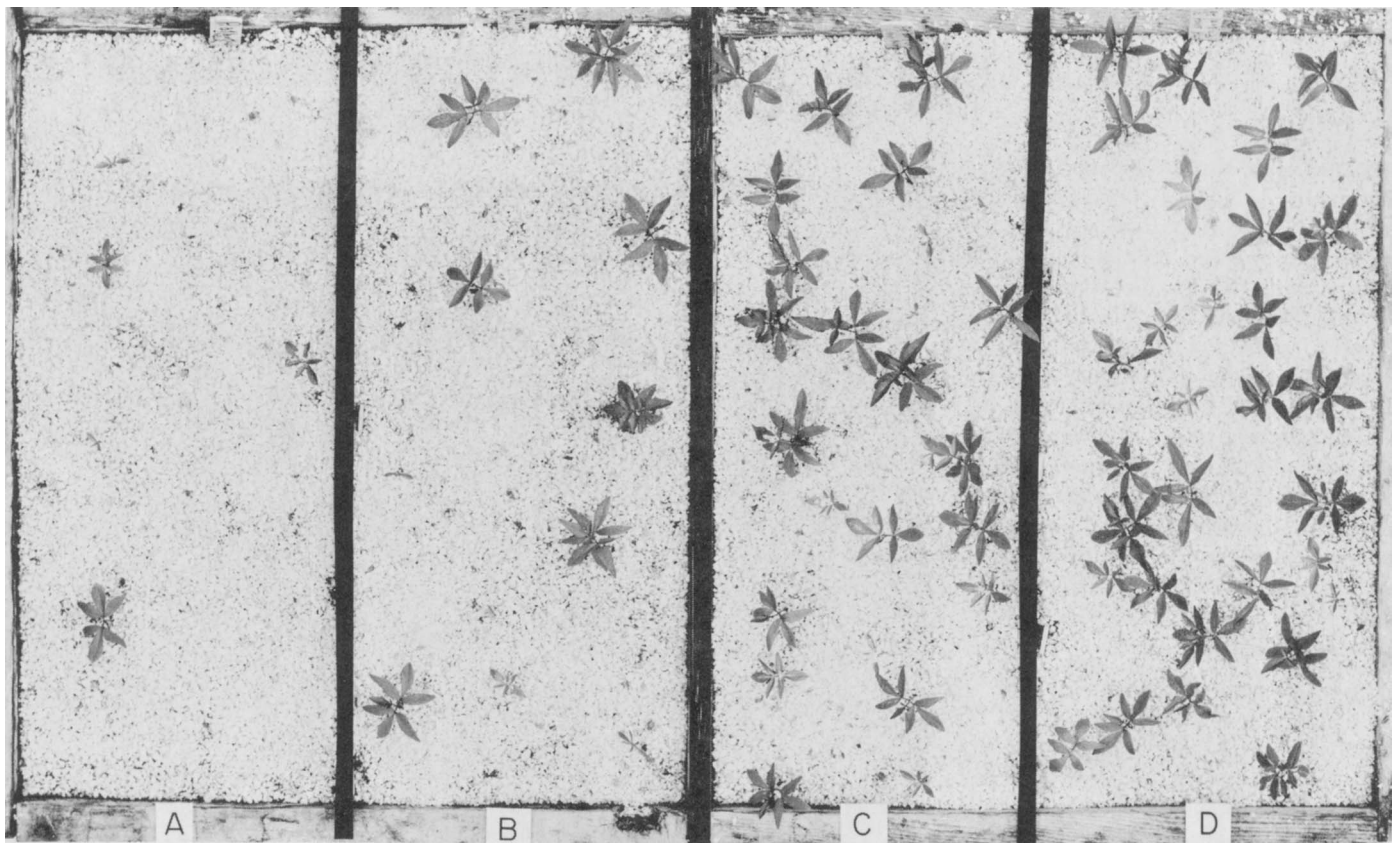
Rapid expansion of the pistachio industry in California has brought with it an unprecedented demand for seedling rootstocks. The research described here was undertaken in response to nurserymen and others experiencing difficulty in obtaining rapid germination of high percentages of *Pistacia* seeds, and who requested specific information concerning this aspect of pistachio culture.

The covering of a *Pistacia* seed presents a formidable barrier to growth of the embryo. The seed is surrounded by a bony, indehiscent (except *P. vera*) endocarp which is extremely hard and

somewhat resistant to the passage of water. This structure, which is commonly termed "shell" in the pistachio, is known as the "pit" in fruits such as apricot and cherry. With prolonged exposure to moisture, the layer cementing the two halves of the shell softens, permitting their separation. This, in turn, permits the embryo to grow and develop. However, such exposure frequently brings about deterioration and rotting of the seed, which results in a disappointingly low germination percentage and seedling survival rate from a given lot of seed.

With many species, reducing the thickness of the hard seed coverings or otherwise modifying them by mechanical or acid scarification, has improved germination. However, preliminary testing of *Pistacia* seeds in a conventional abrasive scarifier produced disappointing results. Lining the scarifier with two different types of abrasive paper failed to appreciably reduce the thickness of the shells after several hours of operation.

In contrast, the use of sulfuric acid gave highly satisfactory results. Dry *Pistacia* seeds were placed in a glass



P. atlantica seedlings from (A) untreated seeds, and from seeds that were soaked in sulfuric acid for (B) ½ hour, (C) 1 hour and (D) 1½ hours. All seeds were soaked in water for 24 hours before being planted on April 19. Before photographing on May 19, 1972, 50 seedlings were removed from each treatment.

container and covered with concentrated sulfuric acid in a ratio of about 1 part seed to 2 parts acid. The mixture was stirred at about 10-minute intervals to facilitate removal of the dark, digested material from the shells and to separate seeds that had stuck together. Groups of at least 100 seeds were removed from the acid at various intervals and thoroughly washed with water to stop the reaction. The seeds were soaked in water for 24 hours before being planted in vermiculite in a greenhouse maintained at 65° to 80°F.

Acid scarification speeded germination, and increased the percentage of seeds that germinated. The effectiveness of the treatment was particularly pronounced with seeds of *P. terebinthus*, which are notoriously more difficult to germinate than those of *P. atlantica*. Scarification for 1½ hours resulted in 53% germination about two weeks after planting, at which time none of the untreated seeds had germinated. When the experiment was terminated on June 15, several times more scarified seeds had germinated than unscarified control seeds. The shells of seeds scarified for 2 hours were practically digested by the acid, and some seeds apparently were

injured, as indicated by a total germination of only 15%.

The viability of *Pistacia* seeds rapidly decreases with time. Storing seeds at 36°F for about a year decreased the germination percentage by more than 50%. Although an attempt was made in 1972 to duplicate the experimental conditions of 1971, apparently some variation occurred. The fact that severe seed injury occurred in the 2-hour treatment in 1971, but not in 1972, suggests that frequency of stirring the seeds in the acid or temperature conditions, or both, were different between years.

Since *P. atlantica* seeds normally germinate much better than *P. terebinthus* seeds, their response to scarification was not expected to be as dramatic. However, by the second week after planting, the germination percentage of *P. atlantica* was 46% after a 1½ hour acid treatment, as compared with 26% for the untreated seeds (see photo). As with *P. terebinthus*, acid treatment of *P. atlantica* seeds for 1½ hours resulted in the highest germination percentage, which reached 80% by the fourth week after planting.

Acid scarification is an effective means of increasing germination, but it must be used with caution. Acid re-

acts with water to create high temperatures, and with metals to bring about rapid corrosion. Therefore, only dry seeds should be acid scarified, and then only in a glass or earthenware container. The mixture of acid and seeds should be stirred slowly to avoid heat buildup and to ensure uniform scarification. Small lots of seeds may be used to determine the approximate time they should be in the acid. The time will vary with temperature, species, and even between trees of the same species. Tests with the various species of *Pistacia* which may be used as rootstocks have indicated that a treatment time of 1 to 2 hours is sufficient at 75°F. The extent of scarification may be determined by withdrawing samples at intervals and checking the thickness of the shells. When they are paper thin, the acid (which may be reused) should be poured off and the seeds washed with copious amounts of water. The seeds may be planted wet, or they may be dried for planting later.

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