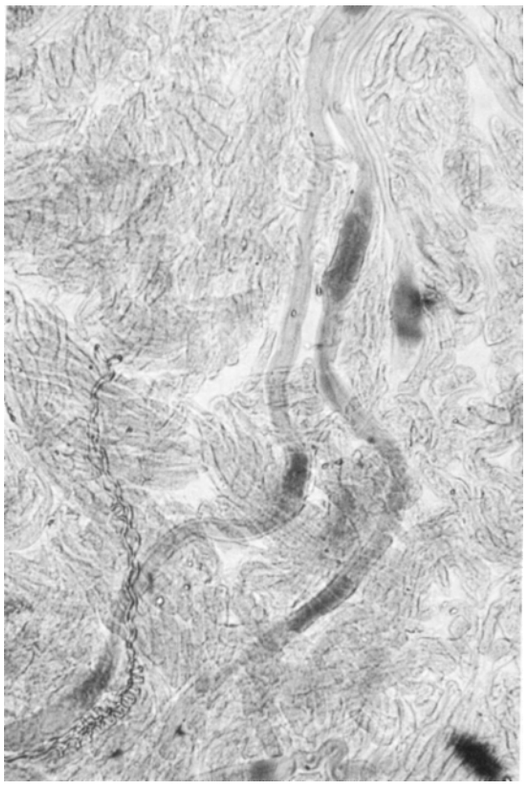
POLLEN GROWTH ALM FLOW

W. H. GRIGGS



Part of a Jordanolo almond pollen tube growing through stylar tissue of Texas. The dark stained regions are heavy deposits of callose on the pollen tube wall (600 times actual size).

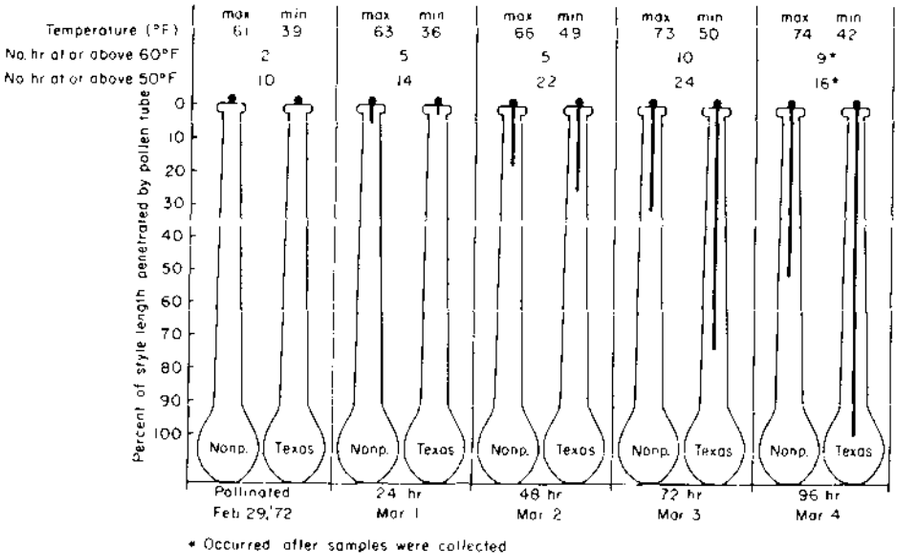
A two-year study indicated that, under orchard conditions, it takes 96 to 120 hours for pollen tubes to grow through the styles of almond flowers. In view of a rapid decline in receptivity, probably the result of embryo sac degeneration, it is assumed that the sooner the flower is cross-pollinated after opening, the greater the chance of fertilization and fruit-set.

ALL ALMOND CULTIVARS commercially grown in California require cross-pollination by honeybees to produce a crop. A previous study at Davis indicated that under weather conditions favorable for natural cross-pollination, almond flowers are most receptive to effective cross-pollination for a day or two after they open, and remain receptive for only 3 or 4 days (see *California Agriculture*, January 1964). The reason for the rapid decline in receptiveness in almond has not been determined. However, G. W. Eaton reported that 80% of the embryo sacs in sweet cherry degenerated within four days after anthesis. Assuming that the rate of degeneration is similar in a close relative, the almond, an obvious question is how long after pollination does it take for the pollen tube to penetrate the style and to reach the embryo sac so that fertilization may occur. Studies designed to answer this question were conducted in the Department of Pomology orchard at Davis in 1972 and 1973.

The bloom periods of Nonpareil and Texas (Mission) almond trees overlapped enough in 1972 so that flowers of both cultivars could be emasculated the same day, February 28. On February 29, between 9 and 11 a.m., 200 emasculated flowers (pistils) on each cultivar were hand pollinated with Jordanolo pollen collected February 22, and stored at 0°F (–17.8°C). The weather was cloudy and cool (51°F, 10.6°C). Temperature records were obtained from a thermograph situated near the block. A sample consisting of 20 pistils was collected from each cultivar at 6, 24, 48, 72, and 96 hours after pollination. The pistils were immediately placed in a fixative solution (3:1 v/v 95% ethyl alcohol and glacial acetic acid) and stored at 36°F (2.2°C).

Five pistils from each sample were studied to determine the general extent of pollen tube growth at each time of collection. The length of each pistil and its style, and the diameter of its ovary, were measured under magnification. The style was then severed from the pistil and subjected to a squash technique, using 50% hydrochloric acid to separate and clear away many of the cells around pollen tubes to improve their visibility. Lacmoid, a stain specific for callose (a cell

TABLE 1. POLLEN TNBE DFVELOPMENT IN NONPAREIL AND TEXAS (MISSION) ALMOND PISTILS AT 24-HOUR INTERVALS FOLLCWING CROSS-POLLINATION (DAVIS, 1973)

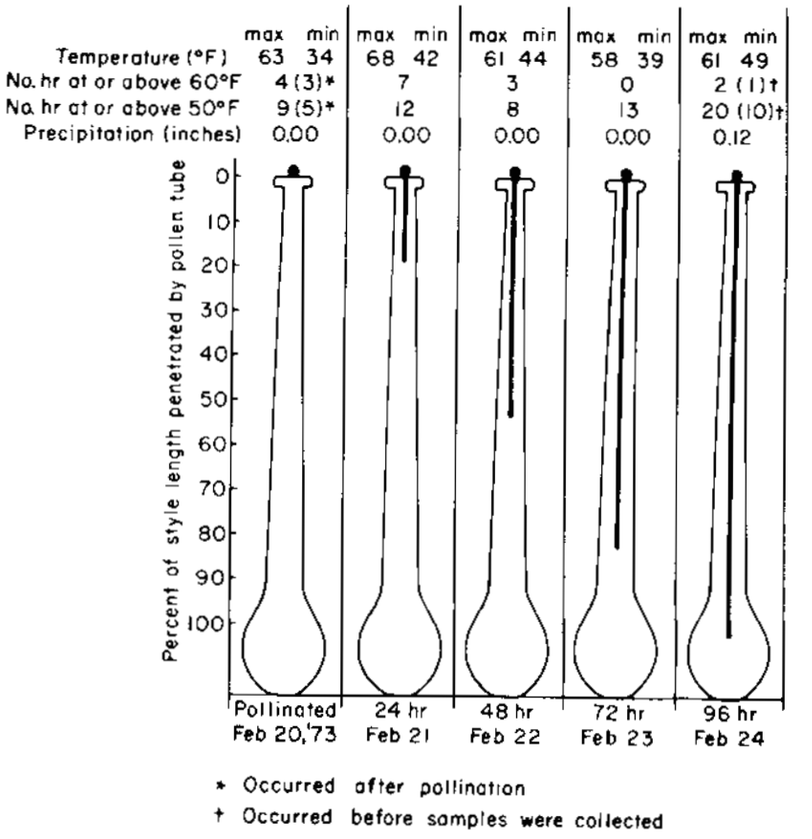


* Occurred after samples were collected

TUBE IN OND ERS

BEN T. IWAKIRI

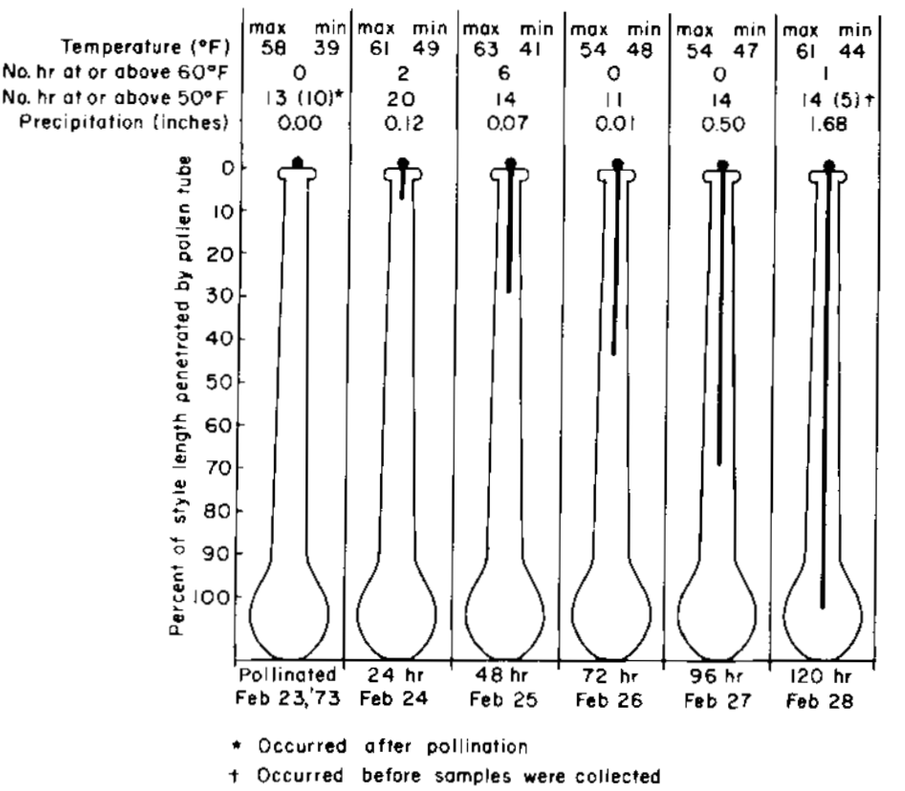
TABLE 2. POLLEN TUBE DEVELOPMENT IN NONPAREIL ALMOND PISTILS AT 24-HOUR INTERVALS FOLLOWING CROSS-POLLINATION (DAVIS, 1973)



wall component of pollen tubes), was used to stain the pollen tubes so that they could be detected readily. The progress of the pollen tubes down the style was determined microscopically by measuring the distance from the stigma to the tip of the longest pollen tube in each pistil. If a tube had grown through the entire style, the corresponding ovary was subjected to the same squash technique and examined for the remainder of that pollen tube.

The styles of both cultivars increased in length during the course of the experiment. On February 29, the styles of Nonpareil flowers averaged 10.9 mm in length, and those of Texas 10.1 mm. On March 4, the styles of the two cultivars averaged 12.3 and 11.9 mm, respectively. Laboratory tests of pollen germination emphasize the relatively great length the pollen tube must extend in order to penetrate the style and reach the embryo sac. An almond pollen grain is approximately 0.05 mm in diameter. Freshly collected Jordanolo pollen placed on an aqueous medium containing 15% cane sugar and

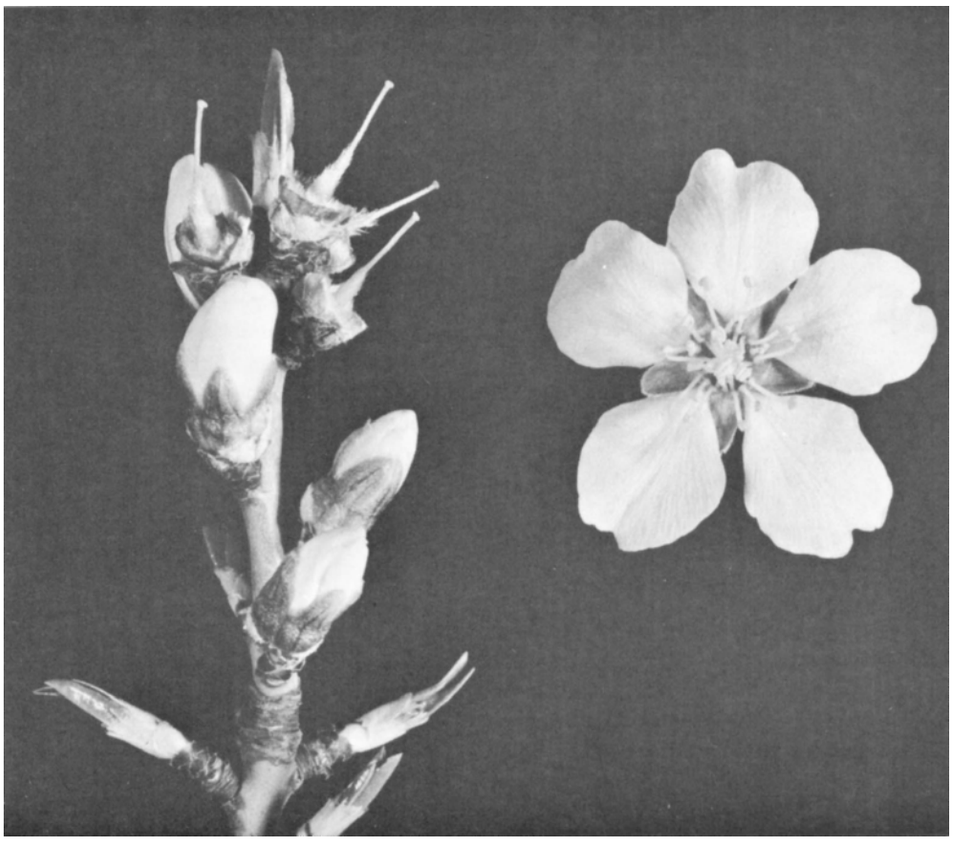
TABLE 3. POLLEN TUBE DEVELOPMENT IN TEXAS (MISSION) ALMOND PISTILS AT 24-HOUR INTERVALS CROSS-POLLINATION (DAVIS, 1973)



2% agar started germinating within an hour. Growth was relatively rapid at first, and by the end of 1½, 3, 5, and 7 hours the tubes averaged, respectively, 0.42, 0.64, 0.77, and 0.79 mm in length. At 12, 24, and 48 hours, they averaged 0.82, 0.93, and 0.96 mm. Thus after two days on the artificial medium, the length of the pollen tubes was less than $\frac{1}{10}$ the length of the Nonpareil or Texas styles.

The weather was favorable for pollen tube development following the 1972 pollinations (table 1). Maximum temperature each day was above 60°F (15.6°C) and the minimum temperature was above freezing. Past studies with other deciduous tree fruit species have revealed that satisfactory pollen germination and tube growth occur at 60°F to 70°F (15.6°C to 21.1°C), some germination occurs at 40°F to 50°F (4.4°C to 10.0°C), but temperatures below 40°F (4.4°C) either hinder or prevent pollen germination.

No pollen tube growth was discerned in styles collected 6 hours after pollination, and after 24 hours the tubes had penetrated only 5.4% of the length of Nonpareil styles and 3.5% of the length of Texas styles (table 1). The daily increments of growth increased after the first 24 hours (under the higher temperatures), and by March 4, 96 hours after pollination, the pollen tubes had penetrated 50.4% of the length of Nonpareil styles and 100% of the length of Texas styles. Because of this difference in the percentage of the styles penetrated, it seems reasonable to assume that the stylar tissue of Texas flowers might be more compatible with Jordanolo pollen than the stylar tissue of Nonpareil flowers, or that an inherent difference exists between the two cultivars in their ability to set fruit. However, pollination records of H. P. Olmo and W. H. Griggs do not substantiate these assumptions. Hand pollination of Nonpareil and Texas pistils with Jordanolo pollen over a five-year period gave fruit-sets ranging from 14.4% to 43.8%, with an average of 32.7% for Nonpareil, and from 15.4% to 41.4%, with an average of 26.7% for Texas. The records also show the percentages of fruit-set resulting from open pollination over a six-year period. The sets ranged from 24.0% to 37.1%, and averaged 30.4% for Nonpareil, and from 21.7% to 45.0%, with an average of 34.0% for Texas.



Flowering shoot of the almond, left, shows four emasculated flowers with exposed pistils and three blossoming buds, the uppermost being in the "popcorn" stage and ideal for emasculating. Flower at right has just expanded and is receptive to cross-pollination.

Because of the difference in rate of pollen tube growth in the two cultivars in 1972, we repeated the experiments in 1973, but the pistils were sampled over a longer period of time following pollination. Nonpareil flowers were emasculated February 19 and pollinated during the afternoon of February 20 with Jordanolo pollen collected February 12. Weather at the time was clear, excellent for pollen germination and development, with temperatures in the low 60s F (approximately 17°C). Since the Texas trees bloomed later than Nonpareil in 1973, the Texas flowers were emasculated February 22 and pollinated with Jordanolo pollen in the early afternoon of February 23, when temperatures were near 58°F (14.4°C).

Approximately 300 flowers were pollinated on each cultivar, and a sample consisting of 15 pistils was collected from each cultivar at 24, 48, 72, 96, 120, 144 and 168 hours after pollination. The samples were processed and studied as described for the 1972 samples.

In 1973, the styles of nonpareil had averaged lengths of 10.7 mm on February 21 and 12.2 mm on February 25. Texas styles averaged 10.8 mm on the first date of sampling, February 23, and 11.9 mm on February 28.

The Jordanolo pollen tubes penetrated the Nonpareil styles faster in 1973 than they did in 1972, growing through them in 96 hours (table 2). They penetrated a greater percentage of style length (53.9%) in 48 hours after pollination than they did in 96 hours (50.4%) the previous year. In 1973, the temperatures were somewhat higher the first 24 hours after pollination of Nonpareil than they were in 1972. However, from 24 to 96 hours after pollination (February 22–24, 1973), the temperatures were lower than in 1972 (March 2–4, 1972), with fewer hours above 50°F and 60°F (10.0°C and 15.6°C).

In 1973 120 hours were required for the pollen tubes to extend through the Texas styles (table 3), compared to 96 hours in 1972. Because Texas bloomed later than Nonpareil in 1973, its flowers were subjected to lower temperatures following pollination. The weather was particularly cool during the first 24 hours, and between 48 and 120 hours after pollination of the Texas flowers. There were only 9 hours of temperatures of 60°F (15.6°C) and above, between pollination on February 23 and the time the Texas styles were penetrated by the pollen tubes (February 28, 1973), compared to 22 hours in 1972 (table 1).

The reason for the contrasting responses of Nonpareil and Texas to cooler temperatures is not clear. However, the increased rate of pollen tube growth in Nonpareil in 1973, relative to that in 1972, and the decreased rate in Texas, indicate that some factor other than temperature may have a significant role in determining the rate of pollen tube penetration through the stylar tissue.

The 1973 results with both Nonpareil and Texas flowers indicate that pollen germination and tube growth may be satisfactory, even though somewhat inhibited, at temperatures between 50°F and 60°F (10.0°C and 15.6°C). This is not surprising, as the important almond cultivars usually start blooming during warm weather in February, and the bloom period is often interrupted and prolonged by intervals of cool, inclement weather. The salient point is that, even under relatively favorable weather conditions, four or five days are required for pollen tubes to grow through almond styles. Certainly, the earlier an almond flower is cross-pollinated after opening, the more likely fertilization and fruit-set will result. It is essential that the grower maintain adequate combinations of cross-compatible cultivars and that he provide an abundant supply of honeybees to facilitate early pollination.

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Picnic Day, Davis, 1975

AGRICULTURAL RESEARCH PHOTO FEATURES

PICNIC DAY visitors at Davis were given an opportunity to observe many phases of agricultural research being conducted in laboratories, field plots, and livestock feed yards. Included were the activities pictured here, and on the cover of this issue.

Right photo shows "fingerprints" of genetic traits produced by a research process called electrophoresis-- contributing to the search for pest-resistant varieties of tomato plants. U.C. Davis graduate student Jon Fobes studies the distinctive patterns produced by plant enzymes that have been subjected to high voltages of electricity. Among the objectives of his research project is the checking of hundreds of varieties of wild tomatoes to find those with a natural resistance to nematodes, which are tiny organisms that attack plants roots.

Photo below shows U.C. Davis researcher Mary Ferguson adding sulphuric acid to samples of lamb fat as part of a process in testing for the presence of hexachlorobenzene. This is part of an ongoing project to determine safe levels of use for this fungicide. Photos by Tracy Borland.