3-ha field site selected to evaluate the salt tolerance of corn on Delta organic soil. It is located on the Marian Fry farm on Terminous Tract, San Joaquin County. The soil, about 2 meters deep, is typical of the Delta soils in composition and uniformity. The experimental design, shown schematically in figure 2, consists of 5 sprinkler-irrigated treatments replicated 6 times and 4 subirrigation treatments replicated 4 times. The sprinkler treatments are irrigated with low-level sprinklers to provide uniform water applications with ample leaching. The resultant soil salinity profiles should simulate those in standard salt tolerance trials so that the results can be compared with those from trials of other crops. The subirrigation treatments are similar to the commonly accepted irrigation practices for corn in the Delta. Comparison of the two systems provides the means to evaluate any differences in salt tolerance because of the irrigation method.

The salinity levels of the water used in the 5 sprinkler treatments are 0.2, 0.6,1.0, 2.0, 3.0 dS/m. The levels for the 4 subirrigation treatments are the same except that the 3.0 dS/m treatment is omitted. Water for the least saline treatment is taken directly from the south fork of the Mokelumne River. During the growing season, the river water has an average electrical conductivity of about 0.2 dS/m and a chloride concentration of nearly 10 mg/l. The remaining water treatments are prepared by mixing the river water with saline well water. The well, drilled near the experiment, delivers water having an EC of 8.1 dS/m and a chloride concentration of 2200 mg/l.

Irrigation treatments

The sprinklered plots are irrigated weekly to meet the evapotranspirational demand of the crop plus about 50 percent additional water for leaching. This maintains fairly uniform soil salinity throughout the root zone. Leaching is possible in the sprinkler plots because we installed subsurface drains on a 15-m spacing at a depth of 2 m. The subirrigation treatments are irrigated 3 times during the season to raise the water table to within about 0.1 m of the soil surface.

Land preparation, planting, fertilization, and cultivation are performed by the farmer and they match those for corn grown in the area. One of the typical corn varieties, DeKalb XL 75, is being grown. Yields will be determined by hand harvesting the center portion of each plot. In addition to grain yield, plant density, plant height, and stover weight will be determined and correlated with soil salinity measurements.

This three-year study, supported in part by the California State Water Resources Control Board and the California Department of Water Resources, is in its initial year. It will be finished, however, before the water quality standards in the Delta are reevaluated in 1982.

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Caprification:

A unique relationship between plant and insect

Marvin Gerdts ☐ Jack Kelly Clark

By transferring pollen from inedible caprifigs to edible Smyrna-types, a tiny wasp helps create an important commercial crop.

In California, the fig, like many other fruits, was introduced when the mission at San Diego was established in 1769. Commercial culture started in 1885 and dried Adriatic figs were shipped east in 1889; but these were inferior in eating quality to imported Smyrna-type figs. Smyrna figs, which require pollination to set fruit, were introduced into California in 1881-1882, but it was not until about 1900—through the efforts of George Roeding of Fresno and L. O. Howard and Walter Swingle of the USDA—that the fig wasp, *Blastophaga psenes* L., was established and used successfully to transfer caprifig pollen to Smyrna-type figs to obtain fruit-set (a process called "caprification"). This success stimulated interest in commercial production of Calimyrna (Sari Lop, California Smyrna) figs in California, and acreage expanded in the early 1900s.

Pollination of Calimyrna figs involves complex symbiotic relationships between caprifigs and the fig wasp. Over the years, University of California researchers have investigated and described these relationships. They have also studied methods of using fig wasps in the commercial production of Calimyrna figs, while insuring that the crop is protected from fruit diseases that can be transmitted by *Blastophaga*. Gustav Eisen described the fig wasp life cycle and its relationship to caprifigs in 1901. Ira Condit, U.C. Subtropical Horticulturist, added further descriptions in 1918 and 1920. Their descriptions of caprification, a horticultural word used to describe the pollination process in figs, illuminated the complex relationships of plant and insect.

Caprification

The fig fruit is a hollow peduncle bearing numerous pistillate (female) flowers on the inner wall. For Calimyrna fruits to mature,

Inside the nonedible caprifig, male fig wasps emerge from the many gall flowers lining the hollow interior. Males begin emerging first and fertilize females that are still inside their gall flowers (20x life-size).

Fertilized female wasp emerges from a gall flower in the caprifig (17.6x life-size).

Female picks up a coating of pollen as she struggles through flowers to reach the eye of the caprifig, through which she will escape to the outside (18.2x life-size).

Caprifig section showing the route traveled by the female wasp (3x life-size).

these flowers must be pollinated from an external source, and nature has provided the very specialized fig wasp to transfer pollen from the male caprifig to Calimyrna fruits. Without caprification, Calimyrna figs grow to ½ to ¾ inch in diameter and then turn yellow, shrivel, and drop before maturing.

The caprification process occurs from the end of May into June. Adult female wasps emerge from caprifigs and enter Calimyrna figs, seeking egg-laying sites. In the process, pollen carried on the wasp bodies is spread to female flowers and results in fertilization and the production of viable seeds. Eggs are not laid in female flowers of Calimyrna figs because the flower structure is not suited to oviposition by the wasp.

The fig wasp relies on caprifigs to reproduce and complete its life cycle. It completes three life cycles per year, coinciding with the three caprifig crops: profichi (spring) crop; mammoni (summer) crop; and mamme (winter) crop. Female adults emerge from maturing caprifigs seeking egg-laying sites in the succeeding overlapping crop. They proceed by seeking caprifigs, which they enter to deposit eggs on modified female flowers (gall flowers) suited to fig-wasp egg laying. In the ovaries of these flowers, the larvae hatch and develop. Adult male wasps emerge from the gall flowers first and fertilize the females before they leave the galls. After mating, adult female wasps migrate in search of the succeeding caprifig crop and the cycle continues.

Further studies

U.C. Plant Pathologist P. D. Caldis described an internal fig rot problem in 1925 and 1927. He suggested the name endosepsis for the fungus disease caused by *Fusarium moniliforme* (Sheld.) Snyder and Han-

Female wasp emerges from the eye of a caprifig. She will then fly to another fig to lay her eggs (15x life-size).

Caprifigs are placed in slotted paper bags in Calimyrna orchards. Female wasps that emerge from these figs will enter the edible Calimyrna figs in search of suitable egg-laying sites.

Female wasp enters the eye of a Calimyrna fig (17x life-size).

Section of a Calimyrna fig showing the many long-styled ovaries lining its interior (3x life-size).

sen. Caldis found the fungus in caprifigs and showed that it was transmitted to Calimyrna figs by the fig wasp.

Treatment to control endosepsis was developed by H. N. Hansen, another U.C. Plant Pathologist. In a series of investigations beginning in 1926 he developed a caprifig dipping technique which is still used by the fig industry.

From 1944 through 1946 Simmons and Fisher (USDA), Condit and Hansen (U.C.), and Tyler (California Fig Institute) researched caprification procedures. They determined the number of wasp-egg laden caprifigs needed per Calimyrna tree, the best distribution pattern of caprifigs within a Calimyrna orchard, the frequency of caprifig distribution, and the number of times caprifigs should be distributed during the caprification season. The studies resulted in standardization of caprification schedules and provided guidelines that insured crop-set while minimizing disease and fruit-split.

By 1950, Robert Warner (California Fig Institute and U.C.) described refinements of Hansen's endosepsis clean-up program. As mercuric fungicides had to be replaced, other fungicides were tested and recommended by U.C. Food Technologist M. W. Miller and Gerdts and Obenauf of U.C. Cooperative Extension in the late 1960s and early 1970s. Fungicide studies were again resumed in 1977 by Obenauf and U.C. Plant Pathologist J. M. Ogawa as additional disease problems were encountered.

U.C. researchers continue the search for ways to best utilize the fig wasp to enable California growers to produce abundant, high-quality figs.

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Female wasps try to lay their eggs in female flowers inside the Calimyrna fig but fail because the styles are too long. While struggling to lay their eggs, the wasps transfer pollen to the flowers, thus ensuring fruit-set (14x life-size).