Studies on self- and cross-

Pollination of Olives

under varying temperature conditions

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Investigations with Ascolano, Manzanillo, and Sevillano olive varieties show that chances of fertilization and fruit set are much greater after cross-pollination than after self-pollination. Pollen tube growth usually is faster following cross-pollination than after self-pollination and more pollen tubes can reach embryo sacs before the sacs degenerate.

Contradictory views regarding the benefits of mixed varieties in olive orchards have long been held in the Mediterranean countries and in California but studies at Davis and at Winters have shown that cross-pollination of varieties does increase fruit set in some years. In certain districts of California the olive crop is poor in certain years, even when conditions seem favorable for pollination and fruit set.

Temperature is a possible factor in olive fruit set because individual varieties have particular temperature requirements and high or low temperatures affect pollen tube growth.

To gain specific information concerning the rate of pollen tube growth, the olive varieties Ascolano, Manzanillo and Sevillano were used in pollination studies under different temperature conditions in two greenhouses. The warm greenhouse was held at a minimum of 60°F, and the ventilators were not opened until the interior temperature reached 90°F. The cool greenhouse was not heated, and the ventilators were kept open in an attempt to maintain day temperatures below 80°F. Thermographs were operated in both houses. The difference in minimum temperatures of the two houses was consistently around 8°F.

The first year of the studies, experiments were made with two self-pollinated varieties—Ascolano and Manzanillo—and with one of the cross-pollination combinations—Ascolano flowers with Manzanillo pollen—and were repeated the following year. As the prevailing tem-

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BORON

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centage of shot berries; or an apparently normal set that may shatter severely about midsummer.

Positive identification of boron deficiency symptoms led to the quick remedy of several problem vineyards in Mendocino County and in Merced County and to the location of additional, small, boron-deficient areas within vineyards. In general, in Merced County, the small areas are on the east side of the county in sandy soil where extreme leaching occurs, as near pipeline valves or flood gates in irrigation ditches.

In Mendocino County, and other coastal counties, the trouble areas are usually at the higher elevations, well above the valley streams that sometimes contain toxic levels of boron. The largest general region is Redwood Valley, a few miles north of Ukiah, where about one-fourth of the vineyard acreage has shown reduced yields or leaf symptoms.

Typical boron values of various foliage tissues are listed in the table in the next column. All samples were collected from vines which showed, sometime during the season's growth, visual symptoms. Extensive petiole analyses on a survey basis have been in progress for several years. Using the boron values tabulated as tentative reference levels, the survey has revealed additional suspect regions in the sandy soils of other areas in San Joaquin Valley—southeast San Joaquin, Stanislaus, and eastern Fresno counties.

Fertilizer trials on a relatively large scale are established and analyses are being intensified in the suspect regions. Information concerning seasonal fluctuations and the boron levels of various parts of the foliage—tips, petioles, and leaf blades—is being accumulated in an attempt to be able to determine definitely the deficiency level and the best tissue and sampling time for measuring the boron needs of grapes.

Boron Levels of Foliage Tissues of Grapevines Showing Symptoms of Boron Deficiency
Parts per million dry weight

County	Variety	Boron
	Petioles adjacent to clusters	ppm
Fresno	Thompson Seedless	24
Fresno	Thompson Seedless	26
Stanislaus	Thompson Seedless	25
Stanislaus	Carignane	26
Merced	Thompson Seedless	22
Mendocino	Carignane	28
Mendocino	Carignane	27
Mendocino	Carignane	26
Mendocino	Carignane	20
Mendocino	Carignane	24
Mendocino	Carignane	26
Mendocino	Zinfandel	28
Mendocino	Alicante	25
	Terminal leaves plus petioles	
Merced	Thompson Seedless	5
Mendocino	Carignane	9
Mendocino	Carignane	17
Mendocino	Carignane	5
Mendocino	Carignane	7
Mendocino	Carignane	8
Mendocino	Carignane	11
Sonoma	Carignane	8
Napa	Gamay	5
Santa Clara	Sylvaner	12
	Terminal chlorotic blades	
Mendocino	Carignane	8
Mendocino	Palomino	10
Merced	Grenache	8
San Joaquin	Carignane	10

Boron deficiency results in extreme crop losses, but it can be easily and cheaply corrected once the symptoms are identified. However, as with most trace elements, toxic effects from overdoses are a danger. Many boron materials are available, and they vary in strength from about 35% to about 65% boric oxide—B_2O_3. One ounce per vine of any of the lesser concentrated boron fertilizers or one-half ounce of stronger materials should provide sufficient boron for several years. Applications in excess of these very low rates may result in toxicity, particularly in vineyards on sandy soils.

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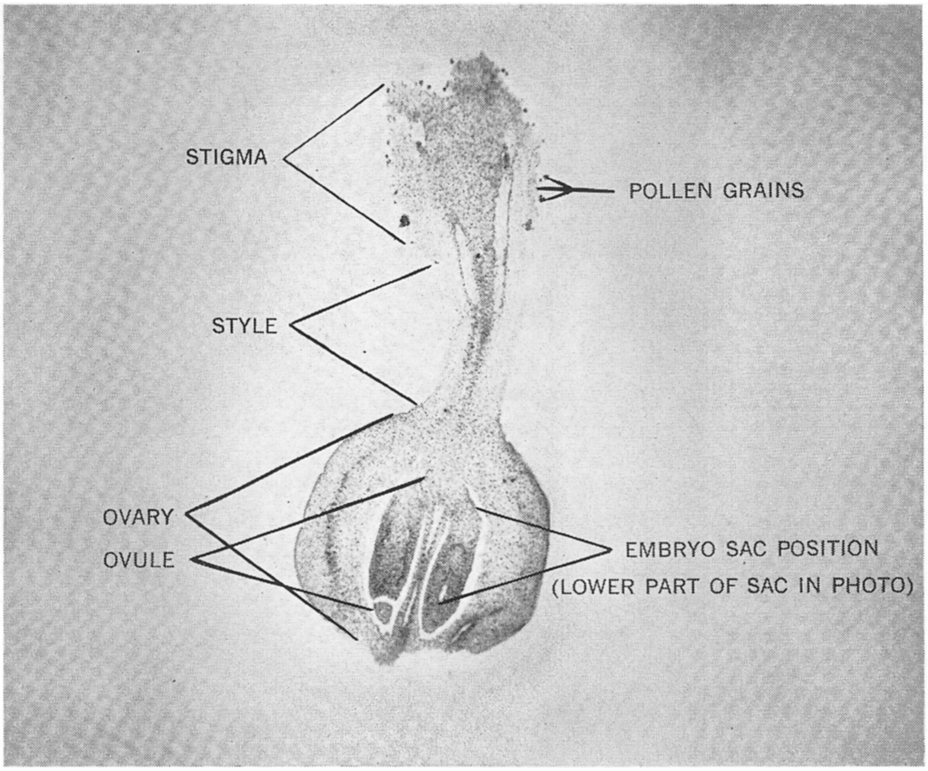

Longitudinal section of olive pistil.
27 times actual size.

peratures during the time of pollen tube growth were less extreme in the second series than in the first tests, those pollinations were actually subjected to four sets of temperature conditions.

Several young trees of each variety were taken into the greenhouses a few weeks before flowering. For self-pollination experiments, trees of a single variety were isolated in individual compartments of nylon cloth. For cross-pollination experiments, trees of different varieties were put in the same compartments.

For all experiments, the flowers were hand-pollinated after they opened but before the anthers shed pollen. All but one of the possible cross-pollinations among the varieties was made. Samples of pollinated flowers—10 from each tree—were collected at one- or two-day intervals until 10 or more days after pollination. The pistils were sectioned and stained to show the pollen tubes, and were studied under the microscope. A record was made of the longest pollen tube in each pistil, whether it had stopped growth in the stigma, the style, or the ovary, or had reached the embryo sac.

Except in Manzanillo flowers with Sevillano pollen, the pollen tubes grew faster in the warm than in the cool greenhouse. In Ascolano pistils with Sevillano pollen, the tubes grew almost as fast in the cool as in the warm greenhouse. In self-pollinated Sevillano, the pollen tubes grew through the style as rapidly in the cool as in the warm greenhouse, but growth through the ovary and into the embryo sac was slower in the cool house.

In self-pollinated Ascolano, pollen tubes were severely retarded in the cold temperatures. The tubes required 10 or 12 days to reach the style, and none reached the embryo sac even after 17 days. In the warmest compartments, some pollen tubes of Ascolano appeared in embryo sacs three days after pollination.

Of the varieties self-pollinated, Manzanillo was the most sensitive to temperature. In only one of the four temperature experiments—the moderately warm—were pollen tubes found beyond the stigmas, and none reached the embryo sacs until 13 days after pollination. However, in the warmest temperatures, pollen tubes grew on the surface but not into the stigmas.

With one exception, pollen tubes grew faster in cross-pollinations than in related self-pollinations under the same temperature conditions. The exception was Manzanillo pollen on Sevillano pistils. In the warm temperature, tube growth was as fast as in self-pollinated Sevillano, but in the cool compartment tube growth was slower. However, the Manzanillo pollen tubes grew much more rapidly in Sevillano flowers than in self-pollinated Manzanillo.

For olive pollen tube growth, genetic incompatibility within a variety and to some extent between varieties may be more important than temperature. If certain identical genes are present in both a pistil and a particular pollen grain, tube growth will be blocked at some point by inhibiting substances that are rapidly formed by the pistil in reaction to the pollen grain or tube. The incompatibility reaction is so strong in these varieties, either self- or cross-pollinated, that it prevents all but one pollen tube from growing below the stigma. The incompatibility effect was particularly noticeable in self-pollinated varieties. The percentages of pistils in which a pollen tube grew beyond the stigma were low in self-pollinations as compared with cross-pollinations and the percentages of pistils in which a pollen tube reached an embryo sac were even lower.

The presence of a pollen tube in an embryo sac did not always insure fertilization. If pollen tube growth was too slow, the sac began to degenerate before the tube reached it. However, the chances of fertilization were greater in cross- than in self-pollinations, as indicated by the higher percentages of pistils in which a pollen tube reached an embryo sac.

Pollen Tube Growth in Olives

Pollinations		Pollen tube growth Percentages	
Pistils	Pollen	Beyond stigma	Into embryo sac
Ascolano	Ascolano*	60.0	40.0
	Manzanillo	89.8	61.2
	Sevillano	94.7	76.3
Manzanillo	Manzanillo* ...	30.8	15.4
	Ascolano	90.0	68.0
	Sevillano	94.2	61.8
Sevillano	Sevillano*	50.0	5.2
	Manzanillo	95.7	11.4

* Self-pollinations.

In most of the pollinations, warm temperatures were favorable for compatibility. However, in the cross-pollinations in which Sevillano pollen was used, cool conditions were more ideal. Higher temperatures increased the incompatibility reactions and pollen tubes more frequently became blocked somewhere between stigmas and embryo sacs.

Of the three varieties tested, Sevillano appeared to be the most self-incompatible and Ascolano the least so.

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