Light fruit set and leaf injury from

Boron Deficiency in Vineyards

readily corrected when identified

James A. Cook, Bruce E. Bearden, C. Verner Carlson, and Carl J. Hansen

Excess boron in the soil of some grape growing regions of California has caused vine injury in many vineyards and the possibility of boron deficiency has received little attention until recently.

In the summer of 1956 a Carignane vineyard on a hilltop near Hopland in Mendocino County was inspected because the grower had complained of light crops from poor set although vigor of growth was about normal. When inspected in mid-July, the terminal leaves of affected vines showed a chlorotic pattern, frequently the terminal growing point had died, and poor berry set was common.

The death of growing points—a classical symptom of boron deficiency in many plants—suggested the possibility of low boron as the cause of the disorder in spite of many occurrences of boron toxicity in the general area. Samples of normal and of chlorotic shoot tips, 6″ to 10″ long—including the leaves, petioles, and tendrils—were collected in mid-July about six weeks after bloom. Analysis showed a boron level of 21 ppm—parts per million—for the normal tips and 4.0 ppm for the affected ones. The low value is much lower than those associated with boron deficiency in other grape growing areas of the world. In Germany, for instance, response to borax applications is obtained when leaf values are about 10 ppm.

Observational plots were set up in November. After the rainy season began, a two-ounce-per-vine rate of a material containing 44% boric oxide was broadcast within a 3′ radius of each treated vine. At the end of bloomtime—early in the following June—the foliage of both treated and control vines appeared normal. However, in mid-August and again in August a year later, many terminal shoots on the controls showed the characteristic chlorosis while the boron-treated vines appeared normal. Analysis of mature, mid-cane leaves plus petioles—leaves older and farther down the shoot than those showing chlorosis—collected in mid-August after treatment gave boron levels of 11 ppm and 14 ppm for the untreated rows compared with 27 ppm and 35 ppm for the treated rows. A random sample composed entirely of chlorotic tip leaves showed a leaf-plus-petiole value of 8.0 ppm boron.

The leaf symptoms were similar to those shown by several problem vineyards in Merced County from which leaf blade samples had been taken in September, 1955. One of the Merced samples was analyzed for boron content and found to be 8.0 ppm. Therefore, in February, 1957, a one-row, 33-vine plot in this Thompson Seedless vineyard was treated by applying one ounce of fertilizer grade borax—36% boric oxide—per vine in the irrigation furrow and irrigating it into the sandy soil.

Results were apparent by bloomtime and continued to be strikingly apparent for several weeks until secondary growth developed to partly conceal the primary, affected shoots on the non-treated vines. Mid-cane leaves plus petioles—including the oldest one or two chlorotic leaves on the deficient vines—in mid-June showed 121 ppm boron for the treated and 5.0 ppm for the controls. The yield record in September showed a tenfold increase —35 pounds from the 33 control vines as against 350 pounds from the boron-treated row.

Boron deficiency causes leaf symptoms that resemble Pierce's disease or Spanish Measles. But Pierce's disease affects the basal leaves first, whereas boron deficiency first appears in the terminal leaves of primary shoots. When the growing point dies before water shortage limits new growth, vigorous lateral growth, usually showing no symptoms, may hide the chlorotic leaves or may cause the casual observer to overlook the terminal characteristic of the by-passed chlorotic leaves. Measles usually causes a characteristic speckling of the fruit, whereas lack of boron—depending on grape variety and conditions—may result in a light set with many flower clusters burning off entirely; or a set with a high per-

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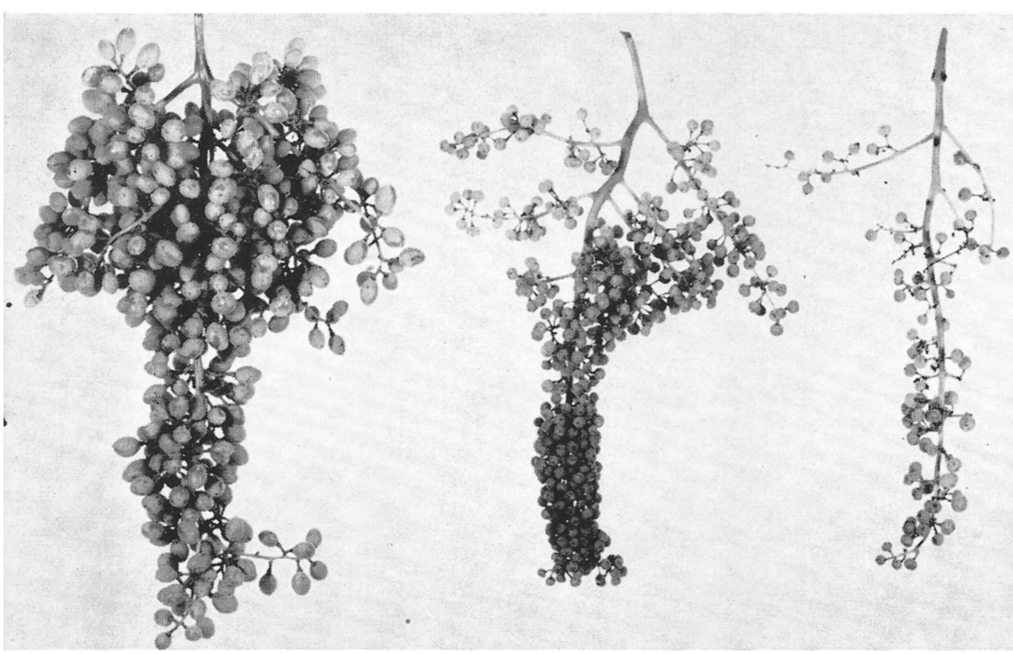

Thompson seedless grapes. Cluster at left is from boron treated row. Center and right clusters are from boron deficient vines.

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-

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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