TECHNICAL PAPERS

Control of Cracking of Fruit by Rain

W. L. Powers and W. B. Bollen

Oregon Agricultural Experiment Station, Corvallis

In submergence trials a very dilute solution of copper sulfate has given full control of cracking of cherries. Preliminary tests indicate that 0.1 per cent anhydrous copper sulfate can be included in the spray or dust for cherry fruit fly control to check cracking after rains. A pretreatment with 0.1 per cent lime hydrate checks cracking but is less effective than copper sulfate. Borax applied as a fertilizer at the rate of 1 pound/tree has reduced the cracking to one-third the amount observed on untreated adjacent areas. Similar beneficial results have been obtained with prunes.

Borax was freely applied for weed control under a back yard Bing cherry tree early in the spring of 1940, and the subsequent fruit crop was remarkably free from cracks.

Early rains the following September caused over half of the prune crop from trees in fertilizer test plots on Melbourne clay loam to fall to the ground. A count of 200 prunes still on trees of an untreated plot showed 25 per cent to be cracked. Where 30 pounds/acre of borax had been broadcast on the soil of an adjacent area, the cracking was reduced to 9 per cent.

Bing cherries on Amity silty clay loam and Salkum gravelly clay loam showed improved color of foliage and decreased cracking where borax had been applied. Available boron is low in the Salkum soil. These observations led to a study of the value of this and other treatments for reducing cracking of cherries, prunes, carrots, beets, and tomatoes. It was supposed that borax might increase elasticity or toughness of the plant cell wall of fruit skin.

Cherry orchards in eight locations, all on humid soils, were used in cooperative field tests to determine the value of borax for decreasing the splitting of nearly ripe fruits after rains. The trials included several soil types, three varieties of cherries, and different rates and methods of application. Treatments were made early in February of 1942. Counts were usually made of 300 to 2,000 fruits/plot and by two or three persons to determine the percentage of cracked fruit at harvest time. Lack of fruit or damaging rain delayed these trials.

Data for 1942 and 1944 indicated some 25–50 per cent decrease in cracking where borax was applied. Two of the larger orchards with 24–30 trees/plot were re-treated, and observations in 1945 and 1946 showed one-half to one-third as much cracked fruit where borax had been applied. Chemical analyses of soil, leaf, and fruit samples revealed some definite increase in boron content of leaf and slight increase in fruit and available soil boron.

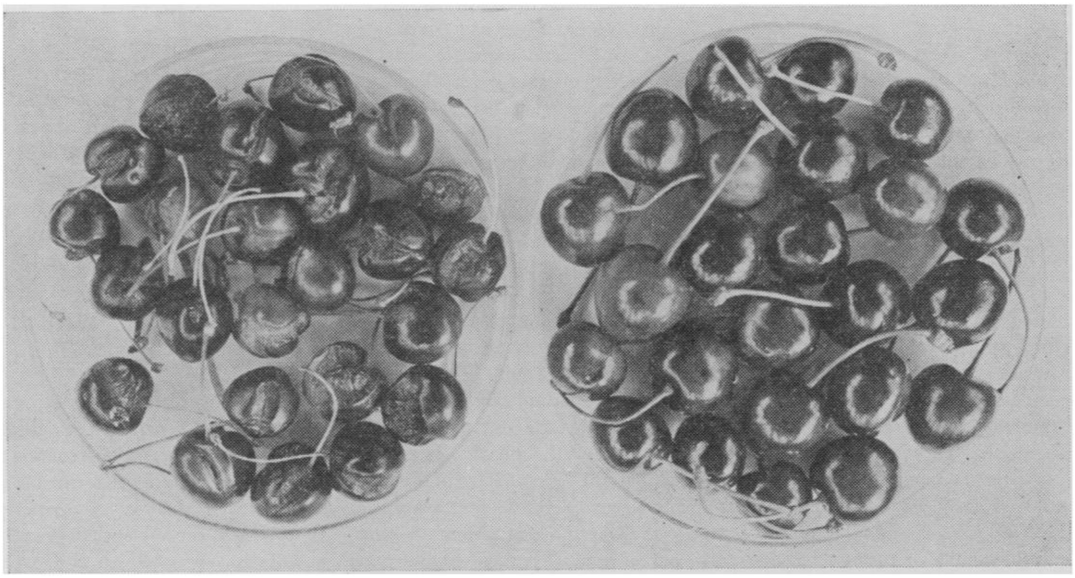

Fig. 1. Left: Bing cherries after 64 hours immersion in distilled water— 24 out of 25 cracked. Right: Bing cherries after immersion in .05 per cent copper sulfate—only 1 in 25 cracked.

Growers noted improved color of foliage, and one of the cooperators made a commercial application to his whole orchard except for the test rows.

Immersion trials. When a rain of 1.6 inches failed to crack ripe and slightly withered prunes in September 1945, immersion tests were resorted to, using 25 fruits/test. Submergence in water caused all the fruits to crack in 48 hours. A solution containing 0.25 per cent borax delayed and decreased cracking, with the result that some 50 per cent of the fruits were still sound after 48 hours.

Immersion trials were conducted with Bing cherries early in July 1946. In water, 80 per cent cracked in 16 hours and 100 per cent in 64 hours; with stems or only the leaves dipped in water, none cracked. Therefore, water absorption is through the skin. This caused gain in volume and weight. At the red stage of ripening, 100 per cent cracked in 16 hours. When fully ripe, 80 per cent of the nearly black fruits were cracked by immersion for 64 hours.

Solutions of 0.25–0.01 per cent anhydrous copper sulfate completely prevented cracking for four days, while those containing 0.25 per cent fructose, table sugar, sodium chloride, sodium oxalate, zinc sulfate, aerosol, or pretreatment with aerosol or calcium propionate, had little effect.

Pretreatment for 30 minutes with sulfur or calcium hydroxide, followed by immersion in water, decreased cracking somewhat. In two days immersion after the pretreatment with sulfur, 88 per cent were cracked. Pretreatment for 30 minutes with 0.1 per cent calcium hydrate reduced cracking to 16 per cent; that with 0.1 per cent copper sulfate, to 2 per cent. Continuous submergence of ripe Royal Ann cherries in the lime solution resulted in cracking of 16 per cent of the fruit in three days and 24 per cent in four days, while in the same strength of copper sulfate there were no cracked fruits at the end of four days.

Microorganisms in relation to cherry crack. Cracked cherries were removed from the solution after 24 hours; sound fruit and additional cherries developing cracks were withdrawn at 48 hours. Bacteria, yeasts, and molds were determined on 1 per cent dextrose agar. In the case of cracked fruit the cracks and adjacent skin were swabbed with a loop and streaked on poured plates. Sound fruit was rolled directly on the agar surface. In most cases the number of colonies was sufficiently restricted to permit counting, but with the Royal Anns confluent growth in many cases permitted only a rough estimate. Colony characteristics and confirmatory microscopic examination were used to differentiate spore formers (*Bacillus* sp.), micrococci, flavobacteria, and yeast. While the results are not rigidly quantitative, they present an index of the relative abundance of the various groups determined.

Numbers and kinds of microorganisms apparently are not related to cracking; flora of cracked fruit was found to be quantitatively and qualitatively similar to that of the sound cherries.

No molds developed on cracked fruit after removal from the solutions and maintenance at room temperature (25° C.) until shriveled (four or five days); neither was there any macroscopic development of bacteria or yeast.

After three to five days mold and bacterial growth appeared on all solutions except $CuSO_4$ above 0.01 per cent concentration. Bacteria but no molds developed on the 0.01 per cent $CuSO_4$ solution. Sound cherries left in the solutions after 48 hours remained sound at the close of the five-day observation period.

Trials with protective sprays. Pretreatment of very ripe Royal Ann cherries with 0.1 per cent copper sulfate spray and then repeated spraying caused only 1 per cent cracking in fruit; the water spray without pretreatment caused 6 per cent. Further copper tests with prunes and related pressure tests indicate bearing strength increased. It appears probable that 0.1 or 0.05 per cent anhydrous copper sulfate can be included in the cherry fruit fly spray or 3 per cent with the sulfur-containing dust for prunes and applied early in the morning.

Microscopic examination. Examination of skins of fruits after 48 hours submergence indicates that water increased turgidity of cells compared to that from lime, while plasmolysis was more in evidence after the copper treatment. In all cases there was a gain in weight during immersion.

Discussion and conclusion. Copper sulfate has given control of cracking of fruit in immersion tests, and preliminary spraying tests indicate that its use as a spray or dust will check cracking of fruit due to rains. The benefit reported from use of Bordeau spray (*3*) appears to be due more to the copper than the calcium contained. Bordeau reportedly increases transpiration (*1*) and may decrease fruit size.

How copper sulfate solution functions to prevent cracking of fruit is not fully determined. Cracking after rain has been related to osmotic concentration of the fruit juice, turgor of fruit, temperature, and skin permeability (*4*). Possibly the fruit cells are affected so less water is absorbed or held. The copper sulfate is effective at too low a concentration to have any appreciable osmotic effect. No specific fungi or other causative organism was found. It now appears more probable that the copper sulfate has a toughening effect (*2*) on the fruit skin comparable to that of tannin on leather.

It appears that the solution or spray, to be effective and noninjurious, should have a concentration of 0.1 to .01 per cent. Perhaps this material can be included in the cherry fruit fly spray or early morning dusting trials. Dilution of anhydrous copper sulfate with diatomite or other fine inert powder is suggested.

References

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Methionine Metabolism and A-Aminobutyric Acid

CHARLES E. DENT[1]

University College Hospital, London

A-amino-n-butyric acid has been identified by paper chromatography in the urine of a case of Fanconi syndrome (*1*).

It also occurs in appreciable amounts in normal blood and urine and has been found in a dilute acetic acid extract of yeast. It would appear to be very generally distributed in tissue nonprotein nitrogen.

On giving methionine (10 grams) by mouth, an increased output of α-aminobutyric acid and of methionine sulfoxide, as well as of methionine, can be detected in the urine, the overflow of all three following a similar course. This has been seen in a normal subject but was much more obvious in a case of Fanconi syndrome, in which "renal" aminoaciduria occurs.

[1] Visiting Rockefeller Fellow in the Department of Pathology, School of Medicine and Dentistry, University of Rochester, Rochester, New York.