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Circular of Information No. 283
(Revision of No. 248)

September 1942

USE OF BORON IN CONTROLLING CANKER OF TABLE BEETS

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Importance of Beets as a Vegetable Crop

Oregon is among the leading states of the Union in the production of beets for canning, ranking about fourth in total tonnage, but first of all states in tonnage per acre. Beginning in 1919 with a pack of 3,608 cases, the pack for 1941 was 844,666 cases, out of a total for the entire Northwest of 1,023,651 cases. It has been estimated that between 14,000 and 15,000 tons of beets were canned in 1941, with a total value of approximately a quarter of a million dollars. The Northwest beet pack is conceded to be of unusually high quality.

Beets are also grown widely as a market garden crop for city sales, and likewise extensively in home gardens.

Beet Canker Defined

This trouble has been affecting certain areas of beets in Oregon for several years, being first photographed and described by the junior author of this circular in 1933. The malady appears as a dark spot on the root, usually on the part of the greatest circumference of the beet. Some roots may be very slightly affected with but one small spot of one-half to one inch in size. Other roots may have several spots to a degree where most of the root is blackened. Sometimes the canker or blackening may not be visible on the surface, but when the beet is sectioned the darkened areas are plainly seen extending into the fleshy part of the root from depths varying from one-eighth to one-quarter of an inch. As affected roots increase in size, the black spots frequently develop into growth cracks and large open cankers, extending in extreme cases to a complete girdle of the root.

Prevalence of Canker and Losses Incurred

Beet canker has been identified in plantings growing on Amity, Newberg, Chehalis, Salem, Sauvies, Sifton, Deschutes and peat soils. On these soil types at one time or another beet canker has been prevalent in varying

percentages of roots affected. In some instances the damage has been slight; in extreme cases fields have been so badly affected as to have no beets harvested at all.

There have been evidences, based on field observations, that new land is liable to produce a crop less affected than where beets are grown on the same land year after year, which seemingly results in more severe canker. Both early and late plantings have been affected. Irrigated fields of beets seem to have suffered less than unirrigated areas, although there have been some instances observed where beets were badly cankered in the presence of ample soil moisture, and conversely, no canker appearing sometimes in fields that have dried out badly and in which the beets were small.

Losses to grower and canner on account of blackened beets occur through dockage of tons of marketable beets, wasted material in handling the affected roots, and extra labor involved in the factory in removing cankered areas. Conversely, advices received from canneries packing beets are to the effect that the daily pack of beets is increased considerably because of lessened blackening of the roots due to boron applications and a consequent reduction in hand work in eliminating blackened areas.

Use of Boron in Control of Canker

Greenhouse experiments were started in November 1937 in the collection of Amity and Newberg soils from fields where beet canker had been prevalent. In the greenhouse fertilizer trials some four dozen jars of each soil were used, omitting the major nutritive elements one at a time and then adding trace elements one at a time to a series of jars that had received a general fertilizer containing nitrogen, phosphorus and potash. Low, medium and high supplies of (1) boron, (2) moisture, and (3) potash were provided. All tests were in duplicate.

Canker developed in untreated beets. It was not prevented by a good supply of moisture or of potash. In fact, a high potash fertilizer seemed to increase the percent of canker. Liming increased canker or decreased boron availability.

As little as ten pounds of boric acid an acre under controlled conditions prevented canker.

Field Trials

Field plants were started in 1938. Following control of canker in the plant house tests three rates of application of boric acid were made, as well as treatments with sulfates of other trace elements. The sulfates of copper, manganese, zinc and calcium were ineffective. There is some indication that sulfur increased availability of soil boron slightly and lessened injury. It has been found that liming to bring the soil reaction to a pH of 6.5 or near neutrality may cause symptoms of boron deficiency.

Table I. Effect of Boron and Other Minor Elements in Soil Fertility

Table Beets on Newberg Sandy Loam
Chas. Hart's, Jefferson, Oregon
One-tenth Acre Plots

Treatment & Rate	Lbs./Ac.	Yield			Canker Percent
		14 Rod Row Lbs.	1/10 Acre Lbs.	Per Acre Tons	
None		35	1700	8.50	64
Boric Acid	10	31	1500	7.50	24
Boric Acid	20	24	1200	6.00	12
Boric Acid	30	32	1600	8.00	4
None		39	1950	9.75	80
Copper Sulfate	40	35	1700	8.50	52
Manganese Sulfate	40	24	1200	6.00	32
Zinc Sulfate	40	31	1500	7.50	44
None		21	1050	5.25	76
Calcium Sulfate	40	29	1450	7.25	48
Sulfur	40	24	1200	6.00	28

Fields of beets to which boron has been applied in the form of commercial borax have yielded relatively few cankered beets in comparison with untreated areas.

In the East Farm Experiment Station vegetable gardens at Corvallis five individual plots, treated with 20 pounds of borax per acre, yielded 35 percent of roots free from canker, 10.4 percent of roots with a very slight canker, with 4.5 percent having medium to heavy cankering. One of the five treated areas produced 92 percent roots with no canker and 8 percent with a very mild degree of blackening. Most of the roots that were affected in the treated areas had but a slight degree of canker.

In the untreated areas, a mean of 23 percent of the roots were free from canker, 36.5 had a mild degree, while 40.5 had medium to heavy canker. In two plots 48 percent of each were badly cankered, 24 to 28 percent mildly affected, and 24 to 28 percent were free from injury.

In the treatment of the plots at Corvallis the borax was mixed with 500 pounds per acre of a 4-16-8 fertilizer and broadcasted over the area previous to seeding. The beet plants were watered with a sprinkling system.

In the 1939 field trials 3.2 percent of the beets in all of the treated plots had slight canker, but 15.4 percent of all of the untreated plots were cankered, some severely.

In 1940 the mean percentage of canker of the untreated plots was 22.2 percent, of the treated plots 6.0 percent, with some treated plots as low as 1 percent.

In the 1942 plots there were 28 percent of the beets receiving a light irrigation affected with canker, ten percent of the roots receiving medium irrigation being 10 percent cankered, while beets having heavy irrigation had but 4 percent affected. Twenty-four percent of the unwatered beets were affected with canker.

The probable reason for the lightly watered beets having more canker than the totally unirrigated is that the light irrigations made the beets more succulent and more susceptible to water losses but were insufficient to supply the roots with water needed during critical periods. As stated, the beets having medium irrigation were but half as badly affected with canker as the light irrigation flats.

Maintaining the soil moisture to an optimum level favors availability of boron and definitely reduces incidence of canker.

In recent field trials of seven strains of beets, 60 pounds of borax per acre proved to be superior to 30 pounds in reduction of mild and severe canker, the comparative figures being as follows: 60 pounds of borax, 11.2% mild canker against 14% where 30 pounds were used and 25.6% when no borax was applied. Severe canker occurred in only 2.6% of the beets treated with 60 pounds of borax in contrast with 3.8% of the beets receiving 30 pounds and 21.5% of the beets having no borax. In these trials 52.8% of the beets receiving no borax were free from canker; 82% were free from the trouble in the plots receiving 30 pounds of borax, and 86.1% of the beets were free from canker in the plots having 60 pounds of borax applied.

Availability of boron in soil varies with geological origin and colloidality of soil, its reaction and moisture content, and perhaps with temperature. Liming that increases soil reaction nearly to neutrality (or above pH 6.5) may interfere with boron availability and cause deficiency symptoms. Therefore, boric acid may be more effective on neutral soils. Two pounds of boric acid supplies about as much boron as three pounds of borax but boron is obtained somewhat cheaper in borax. Soils and water from sedimentary rock seem to be more adequately supplied with boron than where they are from raw basaltic areas. Irrigation water from sedimentary areas seems to overcome boron deficiency symptoms, such as beet canker, celery stem crack and alfalfa yellow top.

Chemical determinations have been made in laboratories of samples of beet roots and beet tops from cankered and canker-free plants. Cankered beets tend to run lower in boron than normal plants. The boron content of normal beets appears to run 15 to 30 parts per million in the roots and 30 to 60 parts per million in the tops. Only slight increase in boron content was found either in leaves or roots from increasing rates of application of borax.

Different varieties and strains of beets seem to vary in susceptibility to canker. One strain of Detroit Dark Red in the field test of 1941 showed a high resistance to any severe degree of canker.

Methods of Application. Borax may be applied in several ways, such as (1) sown alone with a cyclone type grass seeder, (2) evenly mixed with a complete or incomplete fertilizer and broadcasted before seeding, (3) included in the fertilizer applied as a side dressing after the plants are seen in the row.

If the fertilizer in which boron is to be added is broadcasted over the beet area, it would be advisable usually to apply 500 pounds or so of the fertilizer per acre together with a suggested amount of borax, such as 60 to 80 pounds or so which is an economic rate for canker control and maintenance of a good yield. Broadcasting borax is satisfactory if done before seeding. Later applications are more promptly effective if side drilled.

If the fertilizer is side-dressed, the amount would ordinarily not exceed 200 to 300 pounds applied per acre, with 30 to 40 pounds of borax included in the fertilizer. Placement of such fertilizer should be about two inches from the row and slightly under the soil surface.

Borax for field application has a higher sowability where secured in the granular rather than powdered form. Borax carries about 11.5% of boron and is obtainable from wholesale chemists or wholesale druggists or certain fertilizer dealers in Portland. The current price is about \$3.25 per 100 pound bag or \$48.00 in ton lots. A 60 pound application would, therefore, cost about \$2.00 per acre and is known to last at least two years.

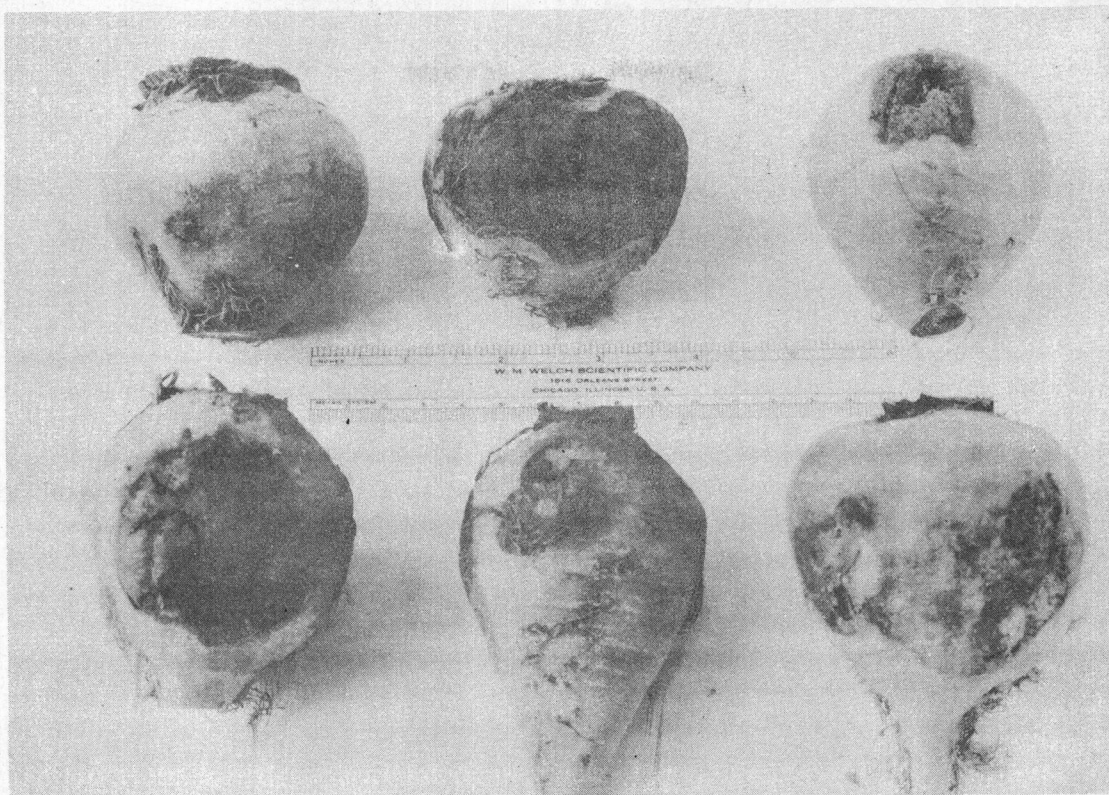


Fig. III External appearance of roots varying in degree of canker.

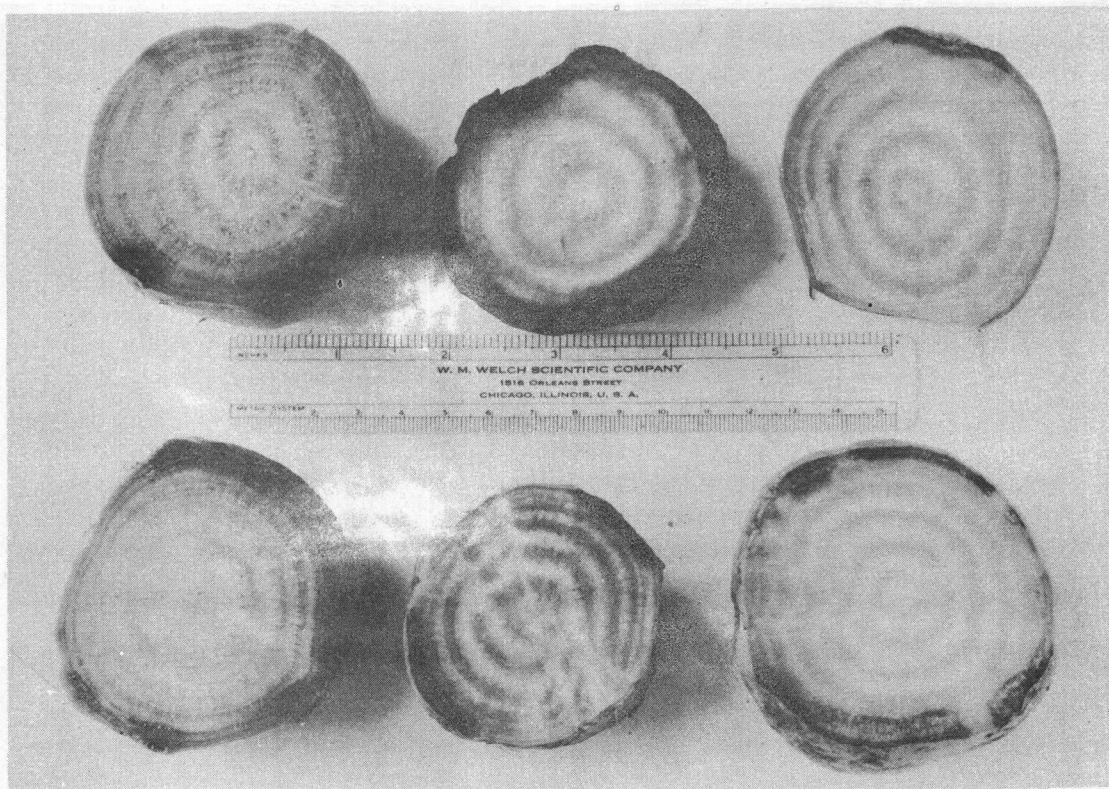


Fig. IV Internal appearance of same roots showing varying degree and depth of canker.