Brown Checking of Celery

variety and relative accumulation of potassium and boron found to be factors affecting incidence of disease

P. A. Minges, M. Yamaguchi, J. E. Knott, A. R. Spurr, and J. E. Welch

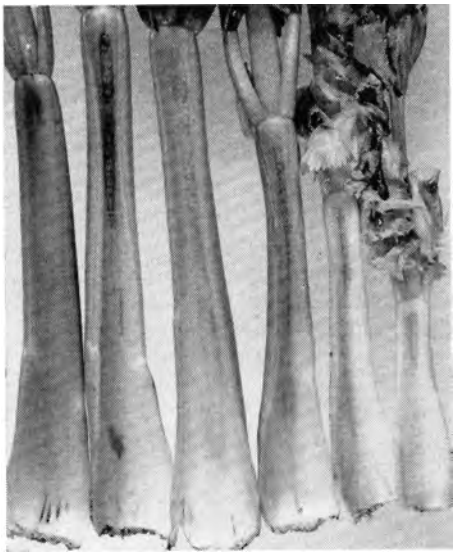
Use of less susceptible celery varieties—such as Summer Pascal or Utah 52–70—appears to be the best recommendation for control of brown checking.

This disease, also known as scratch, or adaxial—inside—cracked stem, occurs in all major celery producing areas of California, except the San Joaquin–Sacramento Delta region. Losses up to 100% are suffered in some celery fields.

A petiole—or shank—with advanced symptoms of brown checking is characterized by a brown lesion and conspicuous transverse cracks on the inner surface. The lesion usually is on the center portion of the shank, and extends from a point slightly below the first leaflets to about midpoint, or to two thirds or more down the petiole. The margins of an affected shank may grow inward and touch, giving the petiole a tubular or pinched appearance. Depending on duration and severity of the disorder, one or more petioles may show the symptoms.

Petioles showing brown checking also often develop transverse cracks in the ridges on the outside. The tissue, especially along the ridges, becomes brown, and sometimes the affected areas on the ridges near the cracks may pull away and curl outward. These symptoms are called cracked stem, a condition caused by insufficient boron.

The development of cracked stem and brown checking in field material and in nutrient-culture experiments in the greenhouse suggests that certain aspects of boron nutrition are a possible cause of brown checking.



Petioles from a single plant showing young as well as advanced stages of brown checking. This plant did not have any cracked stem.

This disorder was first reported about 1945. Some growers consistently have more trouble than others within the same district. It seems to occur more frequently in the crops harvested from August through January, but also occurs in some of the early spring crops. For the most part, summer celery is relatively free of brown checking. Usually the largest and most attractive plants within a field develop the condition first. The affected plants are often scattered at random; but sometimes the parts of fields away from the irrigation runs are more seriously affected than those nearer the head irrigation ditches. Fields that show brown checking one year may be free of the disorder when replanted to celery the following year.

A number of trials involving soil applications of boron were conducted, but brown checking occurred in only a few tests. Results of two field trials indicated that applications of boron to the soil were helpful in preventing or delaying the appearance of the disorder. However, some growers using soil applications of boron at the rate of 15 to 25 pounds of borax per acre still had brown checking develop. Since control areas were seldom left in the treated fields, it was impossible to ascertain whether the applications were beneficial or worthless. Spray applications gave control in several instances, but this method was not consistently effective.

Some growers who occasionally made late applications of nitrogen in strips through their fields reported that brown checking was more severe where these applications were used.

Irrigation waters used for practically all fields showed amounts of boron ranging from 0.07 ppm—parts per million—to 0.21 ppm. Boron extracted with water from soil samples ranged from 0.19 ppm to 0.80 ppm. These figures suggest that boron is present in adequate amounts in most soils, since solution-culture experiments showed that boron concentrations of 0.10 ppm were sufficient to prevent brown checking and cracked stem.

During the 1950 season some growers noted that certain strains of the Utah variety seemed less susceptible to brown checking. To study varietal susceptibility, 20 variety trials were conducted in 1951

Continued on next page

Left: **Celery showing advanced stage of brown checking on the inside of the petiole.** ***Right:*** **Same celery showing cracked stem on the outside.**

Continued from preceding page

in almost all the major celery-growing districts of the state. Included were Regular Utah, seven varieties or strains selected from Utah, Utah 52-70—a Crystal Jumbo type—and an eastern variety, Summer Pascal.

Utah 10-B Susceptible

Brown checking developed in four of the fields. The data from these four tests showed that Utah 10-B was most susceptible. Regular Utah was somewhat susceptible. A number of the tested strains appeared less affected while others were more susceptible. Summer Pascal showed no evidence of brown checking, and Utah 52-70 exhibited only a low percentage.

Utah 10-B, an excellent Utah type, came into general use about 1944, and since then is the principal variety grown in California except for the early spring crop. This date coincides with the occurrence of brown checking as a serious problem of celery in California.

K-B Ratio Investigated

Plant samples for tissue analyses were obtained from clean and affected plants during 1951. Samples from clean fields were taken from districts affected with brown checking and also from the symptom-free Delta region. These samples were analyzed for boron and potassium. Some of the samples were analyzed for sodium, calcium, and nitrogen, but there seemed to be no relationship between the levels of these substances and the occurrence of brown checking. Clean plants in affected fields had an average boron content similar to plants in unaffected fields. On the average, the brown-checked plants showed a lower boron level than clean plants, although in several comparisons the brown-checked and clean plants were practically identical.

The main differences indicated by these analyses were in the potassium contents and in the ratios of potassium to boron. In general, affected fields showed a much higher potassium content than clean fields. Practically all brown-checked plants showed K-B—potassium-boron—ratios of 3,000:1 or higher. The average of clean plants from affected fields also showed a fairly high K-B ratio as compared with plants from clean fields. These data indicate that brown checking may be due to an unbalance between potassium and boron in the celery plant, and that high potassium may be a causative factor.

This hypothesis fits into the situations in the field. Celery growers in general are heavy users of potassium fertilizers. Yet, celery showed no response to potassium in tests conducted on mineral soils, and in a few such trials yields were reduced. On the other hand, potassium fertilizers are beneficial on the peat soils of the Delta region, which indicates a low native potassium level in the soil. This may account for the failure of brown checking to become a problem in this district. Some growers on mineral soils who reduced their potassium applications, reported less trouble with brown checking than others.

This hypothesis may explain why boron applications might prove beneficial by raising the boron content of the plant and thereby reducing the K-B ratio. Analyses of plants sprayed with boron solutions showed that considerable quantities of boron can be absorbed by the plant. Proper timing in the application of boron may be an important factor in the prevention of the disorder.

Plant samples of certain varieties were taken from several of the variety trials. Analyses of clean plants of three varieties showed that Utah 10-B averaged considerably lower in boron content than Utah 52-70 or Summer Pascal. Analysis of Utah 16 from three of the trials showed an average of 27 ppm boron and 4.6% potassium to give a K-B ratio of 1,700:1. This higher boron content which reduced the K-B ratio may explain why Summer Pascal is less susceptible. On the other hand, it also tends to question the idea of a boron deficiency in the soil, since Summer Pascal absorbed more boron than Utah 10-B and did not show any brown checking.

Recommendations

On the basis of investigations made so far, the selection of a variety less susceptible to brown checking seems to be the best recommendation for its control. In most areas, reduction in potassium applications might also prove helpful. A third solution might be found in the application of boron spray at appropriate intervals.

P. A. Minges is Extension Vegetable Crops Specialist, University of California College of Agriculture, Davis.

M. Yamaguchi is Assistant Olericulturist, University of California College of Agriculture, Davis.

J. E. Knott is Professor of Vegetable Crops, University of California College of Agriculture, Davis.

A. R. Spurr is Assistant Olericulturist, University of California College of Agriculture, Davis.

J. E. Welch is Associate Olericulturist, University of California College of Agriculture, Davis.

Farm advisors, B. J. Hall, San Diego County; A. S. Greathead, Monterey County; A. H. Holland, Orange County; D. E. Creighton, Ventura County; H. L. Hall, Santa Barbara County; J. P. Underhill, San Joaquin County; T. M. Aldrich, San Luis Obispo County; and W. A. Seyman, Santa Clara County, University of California College of Agriculture, conducted the variety trials in their respective counties and assisted in the collection of data and samples.

The above progress report is based on Research Project No. 1175.

Extent of Brown Checking in 10 Celery Varieties in Four Tests.

Variety	No. plants	No. affected	Per cent affected	Per cent mod.–sev.	Number of tests brown checking in the variety
Top Ten	195	45	23.1	9.7	2
Utah Special	189	55	29.1	20.6	3
Utah 10-B	260	148	56.9	28.8	4
Utah	206	30	14.6	4.8	3
Utah 16 (Com. strain)	253	11	4.3	1.2	3
Utah 16 PC	208	9	4.3	0.0	2
Utah 16-5	149	32	21.5	7.4	3
Utah 16-8	207	9	4.3	0.0	2
Utah 52-70	252	3*	1.2	0.4	2*
Summer Pascal	209	0	0.0	0.0	0

* One plant of this variety showing severe brown checking was distinctly off type and was probably a segregate or another variety due to a mixture. Two other plants showed questionable brown-checking symptoms.

Potasssium, Boron, and K-B Ratios of Clean and Brown-Checked Celery Plants.

Description	No. of fields	K per cent	ppm Boron Average	ppm Boron Range	K-B ratio
Affected fields					
Clean plants	19	5.9	21	14–26	2,800:1
Brown-checked plants	19	6.3	17	11–25	3,700:1
Clean fields					
All districts	10	4.3	22	17–27	2,000:1
San Joaquin Delta	2	3.0	24	23–25	1,200:1

Potassium and Boron Content of Celery Varieties (Healthy Plants) Averages of Samples from Six Tests.

Variety	K Per cent	ppm Boron Average	ppm Boron Range	K-B ratio
Utah 10-B	4.2	22	16–26	1,910:1
Utah 52-70	3.7	28	19–41	1,320:1
Summer Pascal	4.3	39	23–52	1,100:1