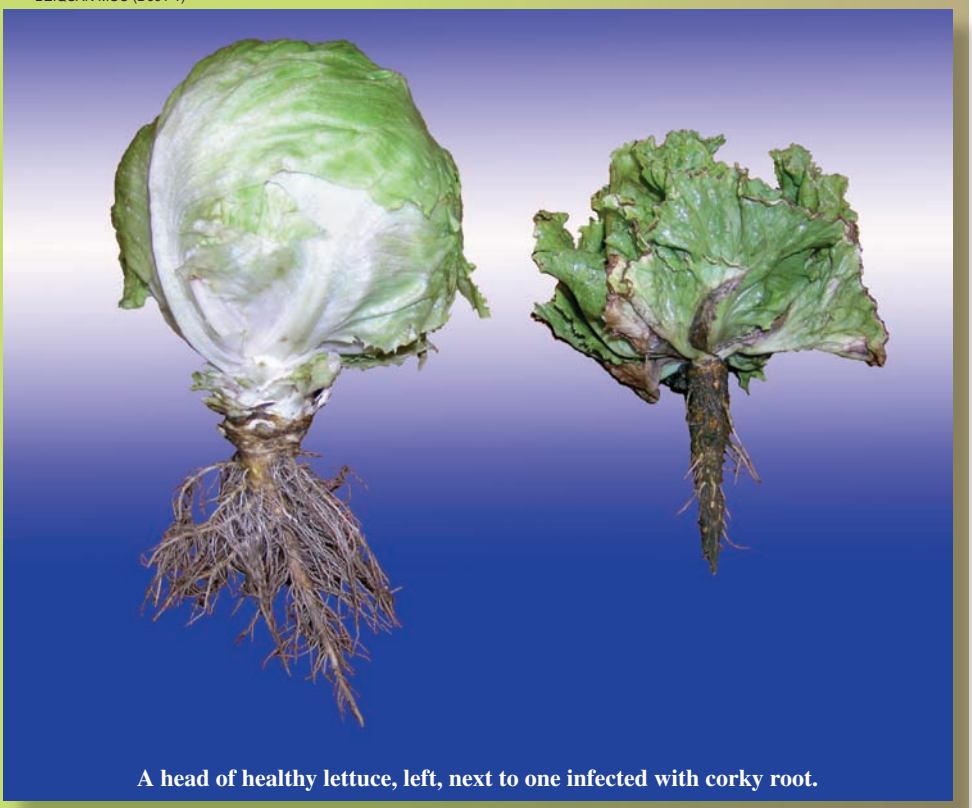
Putting the Crunch on Lettuce's Worst Enemies

BEIQUAN MOU (D691-1)



A head of healthy lettuce, left, next to one infected with corky root.

Cool, crisp, iceberg lettuce rates as one of the country's top five favorite veggies. With its delicate, slightly sweet taste and pleasingly crunchy texture, the humble crisphead—as it is also known—is perfect to toss with other leafy greens for a refreshing salad. And, increasingly, folks from coast to coast roll up their favorite sandwich fillings—whether beef, chicken, fish, or veggies—in an iceberg lettuce leaf as a convenient way to dodge the carbs of other wraps, like a tortilla, for instance.

Iceberg lettuce and its relatives—the elegant romaine of Caesar salads; the softer textured, crimson-tipped or rich-green leaf lettuces; or the creamy butterheads like Boston and bibb—are vulnerable to attack by an impressive array of stealthy microbes. Some of these microbes are ferried to lettuce fields in the saliva of piercing and sucking insects such as aphids and whiteflies. Still others team up with fellow microbes, using them as a means of invading susceptible lettuces.

All this moving about means the threats to a newly planted field of your favorite lettuce can change from year to year, emerging, destroying, and then—sometimes—mysteriously vanishing. And a field can, of course, be besieged by more than one enemy at the same time.

Today, breeding strong, natural resistance into lettuces is still the most economical and eco-friendly way to defend vulnerable leafy greens from attack by microbial menaces. That's according to horticulturist James D. McCreight, who directs a team of ARS specialists investigating diseases of lettuce—among other veggies—and fruits. These scientists are intent on discovering—in the world's wild and domesticated lettuces—new and prized genes that can be moved into cultivated lettuces to boost their resistance.

The team is headquartered in the Crop Improvement and Protection Research Unit, at Salinas, California.

Parent Lettuces Head Off Big Vein, Lettuce Mosaic

In recent years, the scientists have developed parent lettuces that have dual resistance; that is, they contain genes that fend off two major diseases.

For example, now-retired ARS geneticist Edward J. Ryder developed five new kinds of iceberg lettuce breeding lines that offer resistance to both big vein virus and lettuce mosaic virus.

Lettuce big vein gets its name from the unhealthy, enlarged appearance of veins in infected lettuce leaves. These lettuces may be bushy looking or undersized. The likely culprit? Mirafiori lettuce big vein virus, which makes its way to lettuce roots via a soil-dwelling, funguslike microbe.

Lettuce mosaic, caused by a virus of the same name, results in stunting and unattractive mottling. Green peach aphids, about one-eighth-inch long, can spread the virus from an infected plant to an uninfected one as they move about a lettuce field, sipping plant juices.

These diseases can easily leave many lettuces in an infected field unmarketable. That's why lettuce breeders and lettuce-seed companies were eager to get samples of the new, disease-fighting parent lettuces when the seed first became available in 2004.

The new lettuces were the first publicly available crispheads—developed especially for California climates and soils—that

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Lettuce aphid, *Nasonovia ribisnigri.* This pest (about 1-3 millimeters long) of lettuce appeared in California's Salinas Valley in 1998 and is now found in all lettuce-production areas of that state and Arizona.

were equipped with resistance to both big vein and lettuce mosaic.

In fact, the slender black seeds were requested by major lettuce seed companies in California and Europe. That was also the case in 2006 when the team of geneticists Beiquan Mou, Ryan J. Hayes, and Ryder offered seven iceberg breeding lines that boast resistance not only to lettuce mosaic virus, but also to another headache—corky root.

The bacterial cause, *Sphingomonas suberifaciens,* creates—on roots—ugly, yellow to brown lesions that later harden to a corklike texture. Infected plants produce stunted heads 30 to 70 percent smaller than normal.

What's A-head?

All the new parent lettuces owe at least some of their lineage to predecessors like Salinas 88, Misty Day, Glacier, and Pacific, each the work of decades of plant breeding and testing by Ryder—acknowledged as one of the world's foremost lettuce breeders. In keeping with the lab's tradition of excellence, the scientists are expanding on this work by pursuing other genes. The new genes would provide superior resistance to these diseases or to any of about a half-dozen other bad-guy microbes that the researchers are scrutinizing. Other sought-after genes would defend lettuces against attack by lettuce aphids and leafminers.

To speed screening of lettuces for big-vein-resistance genes, plant pathologist William M. Wintermantel is creating a new test, based on technology known as "quantitative RT-PCR," to measure the amount of Mirafiori big vein virus in a lettuce sample. The test will enable the scientists to determine more rapidly—and with better precision—whether a lettuce is resistant and, if so, to what extent.

There's more ahead in the battle against corky root, too. Today's corky-root-resistant lettuces are armed with just one gene—known as *cor*—for thwarting this foe. Mou and co-investigator Carolee T. Bull, a plant pathologist, have screened more than 1,000 cultivated and wild lettuces from America's official lettuce collection—an ARS-managed genebank in Pullman, Washington—in the search for new and different genes that conquer corky root.

Four wild lettuces may hold that genetic treasure, they note. Tests by the two investigators indicate that these candidate lettuces don't have the genetic markers that are telltale indicators of the *cor* gene's presence. So, the resistance could stem from another, as-yet-untapped gene or genes.

What's the need for another resistance gene?

Equipping a lettuce with more than just a single gene for resistance to a specific disease "gives you a stronger base of defense," says Mou.

Chances are good that any iceberg lettuce you've enjoyed in this country owes at least some of its heritage to lettuces bred at the Salinas research center. Tomorrow's best lettuces—not only icebergs but romaines, leaf lettuces, and butterheads, too—will likely have roots in the lettuce labs of Salinas, as well.—By **Marcia Wood,** ARS.

This research is part of Plant Genetic Resources, Genomics, and Genetic Improvement (#301) and Plant Diseases (#303), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

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Geneticist Beiquan Mou (right) and plant pathologist Carolee Bull (center) observe specificity of molecular detection methods that are used in breeding lettuces for resistance to corky root. In the background, technician Polly Goldman prepares samples.

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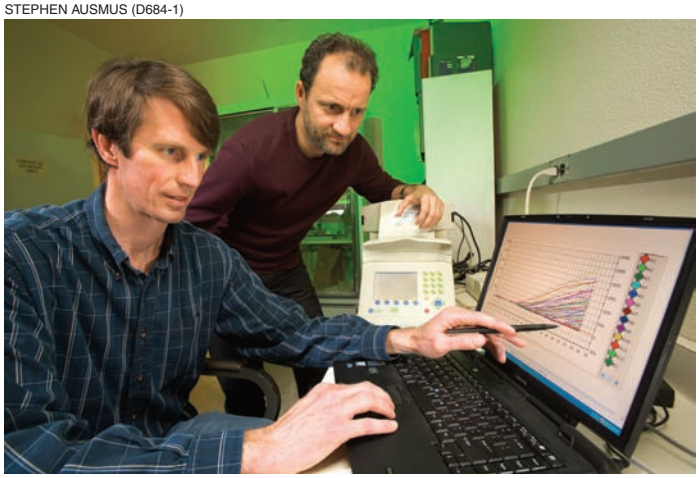

Plant pathologists Bill Wintermantel (left) and Ivan Simko view results of quantitative RT-PCR testing for Mirafiori lettuce big vein virus in lettuce breeding lines.