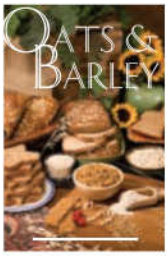
Finding Crown Rust Resistance That Can Go the Distance, in Oats



Crown rust is the most damaging fungal disease of oats in the world, wiping out entire fields and causing epidemics that can reduce yields up to 40 percent. But the disease may have met its match in a slender oat sometimes listed as a noxious weed.

Geneticists have been trying to combat crown rust for years by taking resistance genes from wild oats and inserting them into domestic varieties, where they produce proteins believed to recognize specific strains of crown rust and attack them. They have also developed multiline cultivars with several resistance genes.

Crown rust is caused by *Puccinia coronata,* a fungal pathogen that reproduces both sexually and asexually, giving it a genetic flexibility capable of countering such plant defenses. Research at the ARS Cereal Disease Laboratory in St. Paul, Minnesota, shows that crown rust will usually overcome resistance genes in about 5 years, making both the single gene and the multiline approaches unsustainable. A study by Martin L. Carson, the laboratory research leader, also shows that crown rust is increasing in virulence throughout North America and is able to overcome more and more of the 90 known resistance genes available to breeders. Carson also found that in an oat multiline cultivar with 10 resistance genes, crown rust is now able to overcome all 10 of them. "We've exhausted all the known single genes available for resistance in domestic oats," he says.

To find new genes for resistance, Carson is looking to a wild variety, *Avena barbata,* listed as a noxious weed in Missouri and classified as moderately invasive in California. The slender oat grows wild in South Asia, much of Europe, and around the Mediterranean region, and genes from it have been transferred into cultivated oats to build resistance to powdery mildew and stem rust. But its genes for resisting crown rust are largely untapped.

Carson inoculated 359 *A. barbata* accessions, grown from seed maintained at the ARS National Small Grains Collection in Aberdeen, Idaho, with a very diverse mix of crown rust strains from the University of Minnesota buckthorn nursery. Buckthorn is the alternate host of crown rust and is where the fungus sexually recombines. He evaluated the plants in greenhouses, and after several crosses, he found seedlings highly resistant to a wide variety of crown rust strains. In ongoing studies, he is crossing them with the domestic oat, *A. sativa,* to try to develop the right blend of resistance and desirable traits, such as high yield, drought resistance, durability, and taste.

Such crossbreeding efforts pose a major challenge. The domestic oat has 42 chromosomes, but *A. barbata* has 28 chromosomes, and that makes it more difficult to cross the two oats and ensure reliable transfers of specific genes. Carson and his colleagues are addressing that obstacle by crossing *A. barbata* with another wild species, taking the hybrid from that pairing, and crossing it with the progeny of other wild and cultivated crosses.

Carson is also taking a new approach: developing an oat variety with a more durable form of resistance called "partial," "slow-rusting," or "adult plant" resistance. With this type of resistance, the oat plant allows crown rust to survive on it, but the disease develops slowly, making it less damaging. The goal is a new oat line for breeders to use in developing varieties that can fight off crown rust for a long time.—By **Dennis O'Brien,** ARS.

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Martin L. Carson is with the USDA-ARS Cereal Disease Laboratory, 1551 Lindig St., St. Paul, MN 55108; (612) 624-4155, marty.carson@ars.usda.gov. ✸

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Plant pathologist Martin Carson (left) and technician Jerry Ochocki inspect crown rust infections on common buckthorn, an alternate host. Multiple varieties of oats are planted between rows of infected buckthorn to determine which varieties can resist crown rust.