Fungus Unleashed To Combat Yellow Starthistle

In a remote spot at Mead Ranch, in northern California's Napa Valley, scientists are monitoring the health of yellow starthistle (YST)—a seemingly odd thing to do considering this spike-crowned weed is an invasive species.

But the scientists—Bill Bruckart, Dale Woods, and Mike Pitcairn—don't want the thistle, *Centaurea solstitialis,* to flourish. Rather, they're checking the effects of a rust fungus whose spores they sprayed on the weed last summer as a natural, environmentally safe means of controlling it.

Bruckart is a plant pathologist with USDA's Agricultural Research Service. Woods, a plant pathologist, and Pitcairn, an entomologist, are with the Biological Control Program of the California Department of Food and Agriculture in Sacramento.

Herbicide spraying, mowing, and prescribed burning are some of the methods landowners have used to fight YST, which arrived in the United States in the mid-1800s, probably from southern Europe or the Caucasus Region. Today, the invasive weed can be found in many of the 48 contiguous states, with California being the most infested (more than 14 million acres). Worse, YST continues to spread.

Like many other exotic plants now calling the United States home, the weed thrives without the natural enemies it left behind. At Mead Ranch, however, scientists arranged for a deadly reunion.

With approval from USDA's Animal and Plant Health Inspection Service (APHIS), the State of California, and the Napa County Agricultural Commissioner, the team chose the YST-infested ranch as the first release site for *Puccinia jaceae* var. *solstitialis,* a rust species known to attack the thistle in its native range—Mediterranean countries.

APHIS's approval of the rust caps 25 years of laboratory and field research by Bruckart, his predecessor Robert Emge, and others to ascertain the fungus's safety and potential as a biological control agent. Because of the rust's exotic origins, the scientists conducted their work inside a containment facility at ARS's Foreign Disease-Weed Science Research Unit at Fort Detrick, Maryland.

STEPHEN AUSMUS (K11322-3)

Yellow starthistle.

July 2003 marked the first outdoor release of the rust fungus.

The scientists see the rust as a self-spreading addition to augment current weed-control options. Once the rust takes hold, it should weaken YST's ecological grip on the land and flora. Low-traffic areas such as pasture or rangeland—rather than cultivated fields, orchards, or vineyards—may benefit most from the fungus's presence, says Woods. Plus, treating such large land areas with herbicide can be costly and potentially harmful to the environment.

Every few weeks, the research team visits the site to monitor for fungal infection of the thistles, damage to the plants after attack, and the rust's spread to new areas.

"We didn't anticipate that it would spread the first year, and it hasn't," says Woods. "Right now, it's in its overwintering stage. By March, we'll start to see it spread—just a few meters or so, then hopefully miles by the end of summer."

They're also closely monitoring other plants, including a native thistle species, near the test plot. But where YST grows, little else can compete. Woods estimates that 40 percent of the valley floor at Mead Ranch is YST-infested, with some grass species still holding out against the weed.

One characteristic in the weed's favor is a root system able to tap water sources at soil depths beyond the reach of other plants. Seed production is another. Large plants can produce as many as 100,000 seeds, each sporting barblike hairs that cling to a passing animal's fur or person's clothing. Spines radiating out from beneath the plant's flower head discourage grazing.

But such defenses fail against YST rust fungus.

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STEPHEN AUSMUS (K11316-15)

STEPHEN AUSMUS (K11321-14)

ARS plant pathologist Bill Bruckart (left) and California Department of Food and Agriculture plant pathologist Dale Woods inspect one of 20 test sites 3 weeks after inoculation with rust spores to learn about the pathogen's performance.

Morning dew on a yellow starthistle leaf. Evening inoculations are made to catch the overnight dew needed for spore germination and infection.

It attacks the thistle's leaves and stem, forming orange-brown lumps called pustules. "These pustules rob YST of nutrients," Bruckart says. "If the pustule number is great enough, root growth and seed production will decrease."

If such attacks stunt the thistle's growth, other plants will be more likely to outcompete the weed for sunlight, nutrients, and water. "That, in and of itself, is a successful control," Woods adds.

To make sure other plants don't suffer the same fungal fate as YST, Bruckart conducted host-specificity studies inside a climate-controlled greenhouse containment facility at ARS's Fort Detrick lab. There, he inoculated 65 plant species, representing 10 families, so he could monitor their responses to the fungus. Thirty-nine of those, including commercially grown safflower, were chosen for their close relationship to the thistle. Though some infection did occur on safflower, the plant suffered little harm, reports Bruckart, who compared YST rust with *P. carthami,* a naturalized rust that attacks U.S. safflower crops. His studies also identified the combination of temperature and humidity at which the YST rust grows best.

The researchers used this information to make an inoculum, or spore preparation, of the fungus using YST plants grown in their greenhouse. Woods harvests the spores three times a week with a vacuum harvester and freezes them for later use.

Before releasing the fungus, the scientists had to furnish APHIS with an environmental assessment. In deciding whether to grant a 1-year permit, the regulatory agency also considered recommendations of the Technical Advisory Group for Biological Control of Weeds, which represents federal, state, and university interests. APHIS made the final decision on the release and signed the necessary documentation. The scientists are now awaiting approval extending the current permit for additional releases of rust in California.

STEPHEN AUSMUS (K11314-12)

STEPHEN AUSMUS (K11320-3)

Dale Woods (left) and Bill Bruckart find small, rust-colored spots *(above)* on starthistle leaves, indicating that the first field releases are a success.

STEPHEN AUSMUS (K11319-5)

California Department of Food and Agriculture lab assistant Viola Popescu uses a cyclone spore collector developed at the Fort Detrick lab to harvest inoculum from plants at the CDFA greenhouse in Sacramento.

The fungus joins five other APHIS-approved biological control organisms now established on YST. These include two exotic fly species and three weevil species that diminish the weed's seed production.

At least three of these insects are known to occur at the Mead Ranch site. Though their success against the weed has been mixed, "We're hoping the rust will tip the balance," Bruckart says.

Biological control is a gradual process, so a decline in YST populations may take several years. But once the rust secures a good choke hold, it isn't likely to ease up.—By **Jan Suszkiw,** ARS.

This research is part of Plant Diseases, an ARS National Program (#304) described on the World Wide Web at www.nps.ars.usda.gov.

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