Disease-causing Pathogens Key Players in NPARL Biocontrol Research

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Biological control has proven itself a successful method for reducing rangeland weed infestations in the vast expanses of the Northern plains, but if we hope to reliably duplicate those efforts against new invasive weeds, or even other existing infestations, we need to better understand the many factors contributing to that success. For every triumph, there have been many more disappointments, wherein the same or similar biocontrol agent, introduced under seemingly identical conditions, failed to prosper. For every *Aphthona* spp. flea beetle aggressively munching leafy spurge, there are dozens of examples of failed insect introductions or ineffectual establishments.

Pictured is a plant cancer in knapweed caused by a soilborne bacterial species called *Agrobacterium*. The bacteria kill knapweed by causing a tumor that not only damages the health of the plant, but also provides an avenue for other soilborne pathogens to invade and kill the weed more quickly.

Researchers at the USDA-ARS Northern Plains Agricultural Research Lab are seeking to improve upon those limited success rates by introducing new approaches to the process of selecting biocontrol agents. Using findings and data derived from earlier experiments, ARS plant pathologists studying successful biocontrol efforts against leafy spurge have discovered the presence of specific plant pathogens (disease-causing agents, such as fungi or bacteria) alongside the insect agents in the most successful releases. In those studies, plant pathogens, acting in combination with the biocontrol agent, were determined to be a critical factor in not only the killing of leafy spurge, but also the speed with which it occurred.

Introducing a new field of study

The powerful effects arising from insects and plant pathogens acting in tandem, have been shown in other ways as well, and not always with beneficial results. In the case of Dutch Elm and several other tree diseases, the synergistic combination of insect and plant pathogen multiplies the damage done by either alone. On a more positive note, another insect/pathogen combination proved highly successful in controlling the spread

of prickly pear cactus in Australia; so successful, in fact, that it is credited with bringing this new field of research into being.

The prickly pear cactus, a native of the Americas, was an aggressive, highly invasive, and eventually dominant weed in Australia. When an insect was finally found that reduced the dense infestations of the cactus, its success was discovered to be due to the combined effects of insect feeding damage *and* fungi and bacteria that entered the damaged "pads" of the prickly pear. Once inside, the disease-causing pathogens eventually killed the plants in large numbers.

Purging spurge with pathogens

It was against this background, that ARS researchers in the early 1990s noticed that some of the first successful effects of the leafy spurge flea beetle were attributable to root diseases that followed from feeding damage by the insect in the soil. Later research showed that there were several species of highly aggressive fungi associated with the insects, fungi that proved even more potent against the weed when they could take advantage of "entry" wounds caused by insect larvae chewing on the underground roots of leafy spurge. Field findings were then duplicated in greenhouse studies with similar results.

New applications

Today, NPARL plant pathologists are applying these research findings to help develop improved procedures for selecting biocontrol insect species based on their demonstrated ability to produce synergistic interactions with plant pathogens. In the past, without clear data on the mechanisms leading to successful biocontrol of an invasive weed by a given insect, many insect species would be imported for release before one capable of surviving and eventually controlling the weed was found. In the case of prickly pear, 55 species were brought into Australia, but only one or two proved major players in ridding the landscape of the invasive plant.

The costs entailed in getting a new insect researched and released for control total can run to hundreds of thousands of dollars, with typically more than a decade of research done to ensure that the potential biocontrol agents brought over from Europe and Asia to battle weeds in North America will not harm plants native to their new home.

In new weed control efforts, such as one underway against whitetop (a perennial weed distantly related to cabbage and broccoli), a wide variety of insects feeding on the plant overseas are potentially available for use as biocontrol agents. Scores of those could potentially pass all other tests leading to their eventual release in the Western United States. And yet, as has often been seen in the past, a majority of those released may lack a major contributor to rapid and effective control – the ability to interact with, or favor, plant pathogen invasion that can rapidly lead to the reduction of a target weed from a major pest presence to a relatively minor member of the plant community.

Currently plant pathologists at NPARL, together with entomologists and other biocontrol researchers around the country and overseas, are studying ways to incorporate these beneficial insect/pathogen interactions into future weed control efforts through a variety of mechanisms, including, but not limited to:

- Supplementing insect releases for biocontrol with plant pathogens identified as having a beneficial synergistic relationship with the insect.
- Rearing insects on artificial food sources containing beneficial plant pathogens that can be ingested and delivered to the target weed inside the insect, or conversely
- Rearing insects to be free of certain classes of pathogens that have a negative impact on biocontrol efforts.

This article is the fourth in a series on research conducted at the USDA-ARS Northern Plains Agricultural Research Laboratory in Sidney, MT.