Cereal leaf beetle under projected Pacific Northwest climates

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Climate change can influence the range and severity of pests, both directly as these insects respond to climatic factors, and indirectly through effects on competitors and natural enemies. This is a global issue, but one that needs to be considered as part of any climate and agricultural research for our region. A recent U.S. Department of Agriculture (USDA) report lists 20 pests affecting U.S. crops that have the potential for increased pressure with climate change. One of these is the cereal leaf beetle (CLB), *Oulema melanopus* (Figure 1a, b), a pest of cereal grains, grass forage/seed crops, and other grass-host species in the Pacific Northwest. This REACCH study is using down-scaled climate models to examine the historical and projected suitability of future climates for CLB as a pest of wheat in the Pacific Northwest.

IMPACT

The cereal leaf beetle is a relatively new pest in our region and is being held in check by classical biological control. Projections indicate that although climatic conditions favorable to the cereal leaf beetle, and its potential impact as a pest, should increase, biological control will continue to be effective.

CLB is an invader from Europe that spread westward after first detection in Michigan in 1962. It appeared in the REACCH region in the late 1990s and is now well established, based on sampling carried out by REACCH entomologists (Figure 2). It has caused yield losses in spring wheat of 25% in Washington and 20% in Oregon, but seems to be held in check by the successful introduction of a parasitic wasp, *Tetrastichus julis* (Figure 1c) by Washington State University and USDA Animal and Plant Health Inspection Service (APHIS) scientists. However, the severity of this pest and the effectiveness of biological control could be altered under future climates. For example, climate models conducted by Canadian scientists indicate that CLB will affect more acreage and have higher populations in western provinces by the mid-21st century.

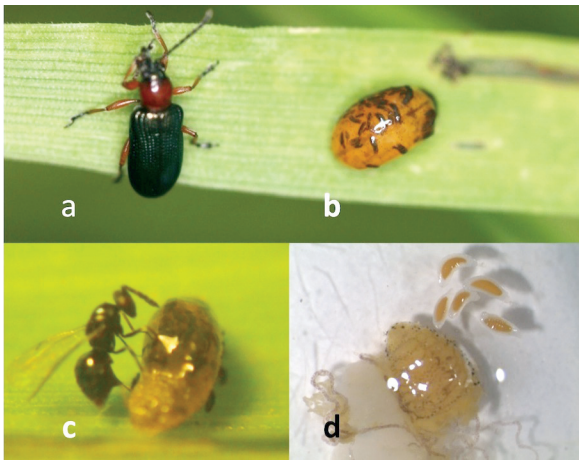

Figure 1. *The cereal leaf beetle and its parasitoid: (a) adult, (b) larva, (c) parasitoid (*T. julis*), (d) parasitoid larvae dissected from an affected cereal leaf beetle. Photos a-c by Nate Foote, d by Ying Wu.*

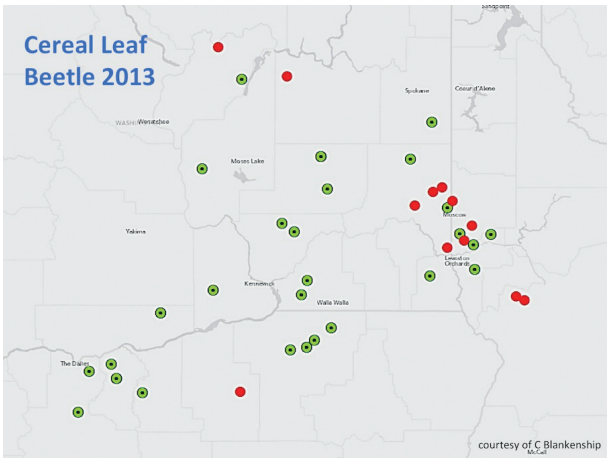

Figure 2. *Cereal leaf beetle distribution in the REACCH region, 2013. Green marker = injury; adult beetles or larvae were detected at this sample location. Red = no evidence of the presence of cereal leaf beetle. Abundance of the beetle was low at all locations where it was detected.*

To assess future risks from CLB, we are conducting a two-stage modeling project. In the first stage, we use projected climate data and published data about the environmental conditions suitable for CLB to map projected changes in potential severity of this pest by the mid-21st century. To do this, fine-scaled climate projections are estimated daily and are used to create a "suitability index" (SI) based on historical climate data and projected climates. The index ranges from zero to 30. We then subtract historical indices from future ones to generate a projected change in this index. In general, this index is projected to stay the same or increase (Figure 3). Indeed, in some areas (the Willamette Valley and near Walla Walla), this index increases considerably more than in others. Based on these projections, CLB could become more difficult to manage under future climates in the Pacific Northwest.

On the other hand, our projections also need to consider biological control by the parasitic wasp. The second stage of our project is based on published data on the life cycles of the wasp and the beetle and how these respond to climate. Our models so far indicate that the overlap between wasp attack and vulnerable larval stages of the beetle will stay the same or increase by the mid-21st century across most of the REACCH region (Figure

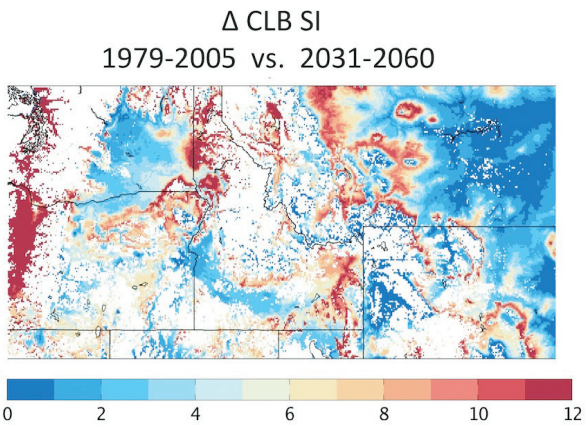

Figure 3. *Map of the change in the Suitability Index (SI) for cereal leaf beetle under projected climates by the mid-21st century in the Northwest. Warmer colors indicate an increase in suitability.*

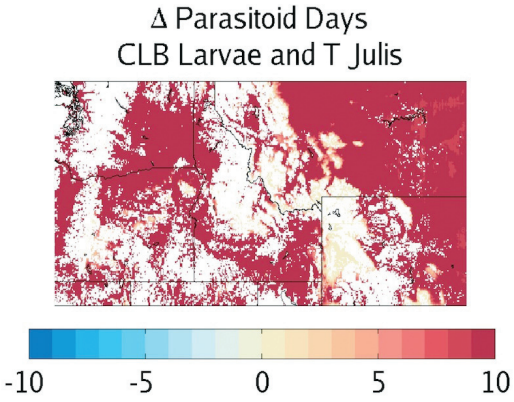

Figure 4. *Map of the change in overlap (number of days) between cereal leaf beetle larval stages and activity of both generations of the parasitic wasp,* T. julis, *in the mid-21st century. Throughout most of the region, overlap is projected to increase, suggesting that biological control by this wasp should be at least as effective as it is today.*

4). This result indicates that the successful biological control program for CLB should continue to be effective across most of our region. Nonetheless, in some restricted areas, increases in CLB SI, coupled with no increase in the potential for biological control, could lead to hot spots where CLB will be more difficult to manage.

These models can be refined or augmented by information acquired through experiments. Greenhouse experiments underway within REACCH are determining whether injury caused by CLB is more severe on drought-stressed wheat, and whether drought conditions alter the growth and development of the beetle or the capacity of the parasitic wasp to attack. These complex interactions involving all three components of the system (crop, pest, and biological control agent) can work together to determine the net effects of climate change on pest management. As results are acquired, they will be incorporated into more comprehensive projections for CLB as a pest of wheat into the 21st century.

Cereal in early summer on the Palouse. Photo by Brad Stokes.