Cereal aphids, climate variability, and change in the Pacific Northwest

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Like many insects, aphids respond to weather patterns and longer-term trends in winter and summer temperatures, precipitation, and wind patterns. The ongoing warming in the Pacific Northwest (PNW), coupled with reduced precipitation in summer, potentially could change the aphid abundance and movement patterns in the region, influencing their potential as pests. Since aphids are one of the principal pest groups affecting wheat, we are taking several approaches to delineating how they have responded to the climates of our region and how they might do so in the future.

IMPACT

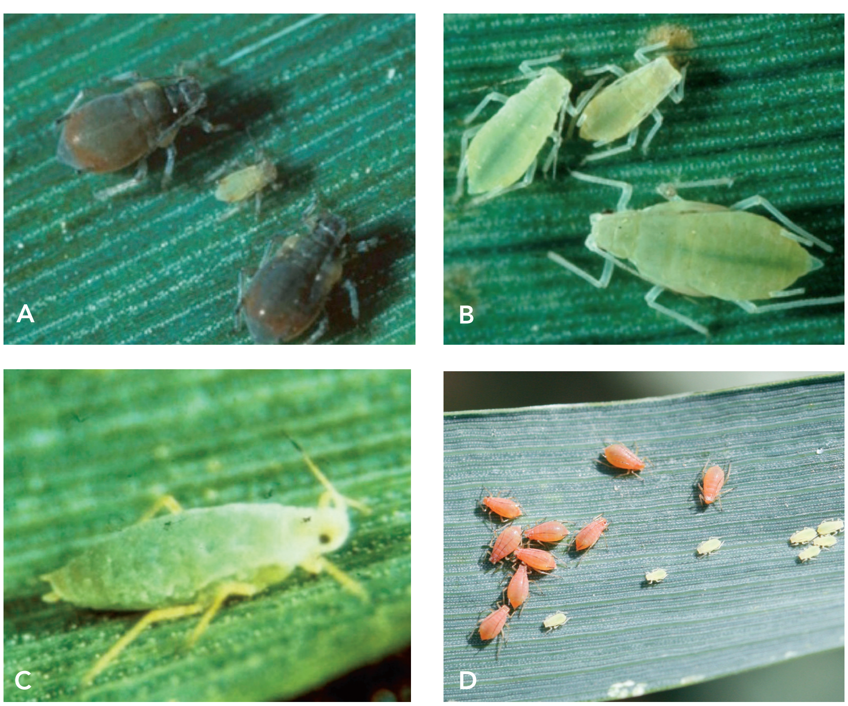
Aphids are consistent pests across the REACCH region, and many producers report observing and treating for them. Climate variability and change affect the flight patterns and abundance of aphids. Baselines and trends in aphid densities can help growers anticipate continued risks associated with these insects as climates change.

First, we have employed an extensive record of aphids captured in suction traps in our region to examine annual fluctuations in the key aphid species over a 20-year period, during which the region's climate has also warmed slightly. We focused for this work on bird cherry-oat aphid, rose grass aphid, and Russian wheat aphid (Figures 1a through 1c). Second, we are continuing to monitor aphid flights using pan traps at several sites. Third, we have been monitoring aphids by sampling with sweep nets each summer at field sites across our region that differ markedly in climate (annual accumulations of heat units and precipitation) to determine if there are trends related to these climatic factors and land use. These efforts give us a better understanding of the current biology and ecology of these pests as a basis for making projections and improving their management.

Historical patterns from suction traps

In the early 1980s, a network of 28 trapping locations was established in cereal grain production regions throughout the PNW and inland PNW. At each location, a suction trap was installed to sample populations of migrating aerial insects. These were operated for over 20 years, and the aphids captured each week were identified. With historic downscaled climate data, we have been able to relate capture records to weather patterns and trends. This information has allowed us to investigate how intrinsic and extrinsic climatic factors influence year-to-year variation in aerial densities of these aphid species.

In summary, we found that the population dynamics of all three aphid species showed evidence of feedbacks. That is, years with high numbers of trapped aphids were regularly followed by years with low aphid numbers. This indicates density-dependent mortality to aphids, whether from natural enemies, competition for winter hosts, or both. In addition, we detected changes in each of the species associated with climate trends (Figure 2). Interestingly, each species responded differently to climate. This illustrates the important point that different insect species, even very similar ones, respond differently to climate.



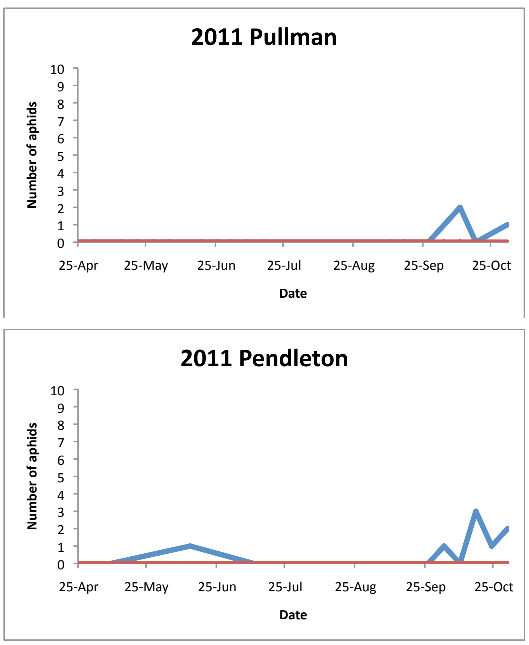
Pan trap sampling

Aphids collected in pan traps across the region can reveal arrival patterns that can help assess risks from these aphids during crop development, with the potential to discern patterns related to weather and trends. Figure 3 provides data for three years for two of the seven sites, Pendleton, OR, and Pullman, WA, and two aphid species, bird cherry-oat aphid (Figure 1a) and English grain aphid (Figure 1d). This example illustrates the continuing regionwide alternation between years in which aphids are abundant (2012) and years in which they are less abundant (2011 and 2013). It also illustrates differences in flight phenology between Pendleton (in Douglas

Figure 1. *The four predominant aphids in historic suction trap records. (a) bird cherry-oat aphid, (b) rose grass aphid, (c) Russian wheat aphid, (d) English grain aphid . Photos by (a) D. Schotzko, (b) Lancaster Univ. (c) D. Schotzko, and (d) Brad Stokes.*

	Bird cherry-oat aphid		Rose grass aphid		Russian wheat aphid	
Annual Abundance	With feedback	Without feedback	With feedback	Without feedback	With feedback	Without feedback
Mean temperature						-
Thermal sum (degree days)			-		+	+
Cumulative precipitation			+			
Peak Flight						
Mean temperature	Earlier				Earlier	

Figure 2. *Summary of responses of bird cherry-oat aphid, rose grass aphid, and Russian wheat aphid to temperature and precipitation over a 20-year period in the PNW. "With feedback" means that the data analysis included the interannual feedbacks from the effects of natural enemies or competition. "Without feedback" means that the feedback was excluded. In either case, the effects of climatic variables are shown if detected. The upper section refers to annual abundance—total aphids captured. The lower section refers to the estimated peak flight observed during each year.*



Zone 4), where bird cherry-oat aphid flights peak late in the season, and Pullman (in Douglas Zone 2), where midseason flights are more evident. The late-season flights of bird cherry-oat aphid are important, since these aphids are the primary vectors of *Barley yellow dwarf virus–padi-avenae* virus, the principal viral pathogen of wheat. Their late-fall flights can bring the virus into emerging fall-planted wheat.

Aphid communities

More than 10 species of aphids, including one species new to our region (see "Update on Metopolophium festucae cerealium, a new aphid in the PNW" pages 48-49), were encountered in sweep net samples taken near booting stage at 40 farms and several other research plot sites throughout the region each year for four years. Total aphid populations throughout the region have varied among sites; total aphids sampled were 4,213, 4,343, 3,584, and 7,043 in years 2011 to 2014, respectively. Since the sites we have sampled differ considerably in terms of climate (accumulating 400 growing degree days as early as mid-May or as late as early July), we compared these sites as po ssible surrogates for differing climates. Some of the patterns evident in these data include (1) a prevalence of Russian wheat aphid only in the warmer regions of northern OR and southern WA, (2) differences in the responses of each aphid species to climatic factors such as temperature, (3) fluctuating abundance between years, consistent with the feedbacks that are evident in suction and pan traps data. Ongoing analyses are relating the four years of aphid data with cropping systems and other land uses on the landscapes.

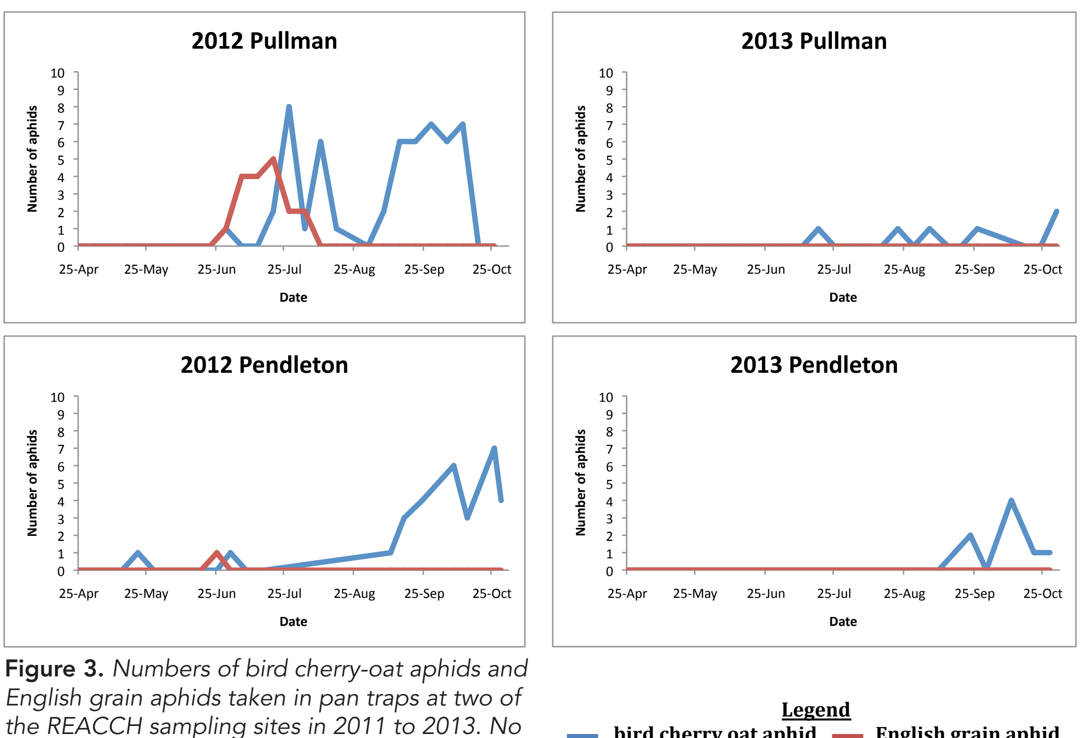


Figure 3. *Numbers of bird cherry-oat aphids and English grain aphids taken in pan traps at two of the REACCH sampling sites in 2011 to 2013. No English grain aphids were found at either site in 2011.*