Secondary pest problems are not always associated with the destruction of natural enemies. Control of codling moth by mating disruption entails releasing enough sex pheromone into orchards to interfere with mate location, reducing reproduction and subsequent larval infestations. However, using this highly specific tactic in place of broad-spectrum insecticides can also have a significant impact on other potential pests. In disrupted orchards, leafrollers that were kept at non-damaging levels by broad-spectrum insecticides are now suppressed only by natural enemies. Unless natural controls provide sufficient suppression, leafroller populations will increase, sometimes reaching damaging levels.

In similar fashion, minor diseases that are not normally a problem can become important when major diseases are controlled. Because pathogens often compete for space and nutrients, removing one pathogen with a fungicide may benefit other pathogens that are not affected by that particular fungicide. An example of this is the increase in *Alternaria* infections of blueberry fruit in fields that have been treated with a fungicide against anthracnose fruit rot.

Environmental effects on insects and diseases

Annemiek C. Schilder, Rufus Isaacs, Larry J. Gut, Jeff A. Andresen, Patricia S. McManus and Nikhil Mallampalli

R. Isaacs

A worker checks weather data and insect traps in a vineyard.

Weather and climate strongly affect how organisms function within an ecosystem. These effects include the rate at which organisms grow and develop and how some insects and pathogens are spread over time and space. Crop managers can use weather data to help predict when insect pests and pathogens will be present and most vulnerable to control measures.

Microclimate

“Microclimate” refers to weather conditions over a distance of less than half a mile. It includes climate effects from the orchard or vineyard down to the microscopic scale. The endless combinations of characteristics such as crop canopy structure, topography and soil type can create unique microclimates. Often microclimates are understood only after years of observation.

Air temperature within crop canopies is not usually uniform but varies with height, depending on the architecture of the crop, time of day and cloud cover. When the sun is shining, the highest temperature occurs in the top of the canopy. Under overcast skies, temperatures tend to be relatively uniform within crop canopies.

Different rates of heating from varying exposures to sunlight can greatly affect temperature in a small area. In a Michigan forest, researchers recorded temperatures inside gypsy moth egg masses placed 3 feet above the ground on four sides of an oak tree. Temperatures were recorded at various times on a clear fall day. Simultaneous temperatures on the same tree varied as much as 40˚F because of differences in the amount of sunlight shining on the egg masses.

Such differences lead to significant variations in the rate that organisms develop during the growing season. In this case, the date of egg hatch differed as much as three weeks the following spring.

Many pest-plant interactions take place on the plant surface, so it is important to consider that leaf temperature may vary from air temperature because of solar radiation or convective cooling. The surface of a sunlit leaf is commonly 8 to 15˚F warmer than the surrounding air. At night under clear skies, leaves can cool to 8 to 15˚F lower than the air temperature.

Snow cover can also significantly modify surface or soil temperatures by insulating the ground from extreme cold and fluctuating temperatures. Snow's capacity to insulate overwintering crops depends on its depth, age and density. In a study of vineyard micro-climates in Michigan, researchers observed daily maximum and minimum temperatures at various heights above and below the soil surface. The snow pack at the experimental site was approximately 16 inches deep. On a clear February day, the coldest minimum temperatures were observed at the top of the snow pack near the coldest, densest air. Temperatures at the snow surface were 11˚F colder than the air temperature at 5 feet above the ground and 43˚F colder than the soil surface temperature. This indicates the importance of snow cover for survival of vegetation and insects that overwinter in or on the soil.