Introduction: An ecological approach to growing fruit

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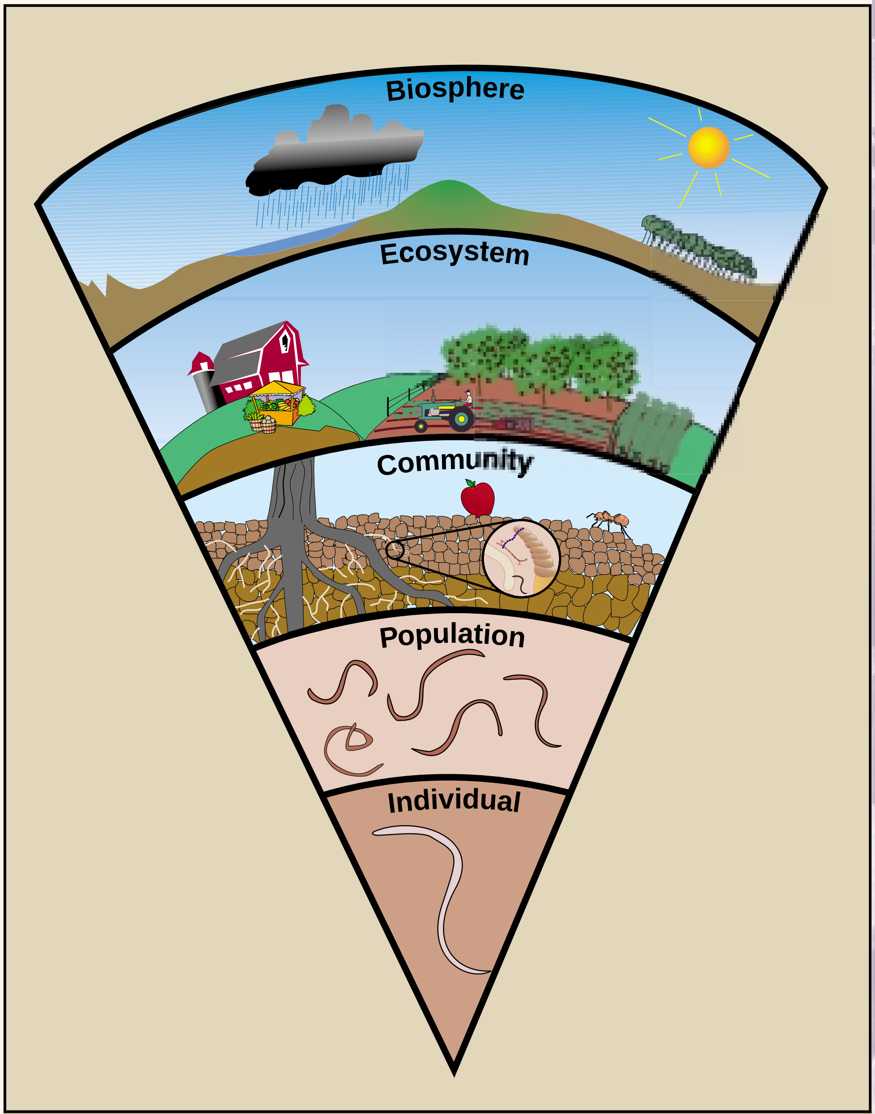
What is fruit crop ecology?

Biological and social factors are driving the need for new farming practices. Fruit crop ecology is the study of the interactions among the many biological, environmental and management factors that make up and influence fruit production. This book explores growing fruit within a complex web that connects soil, plants, animals, humans, landscapes and the atmosphere. An ecological approach to fruit production recognizes that these factors interact in a changing environment and that it is impossible to change one aspect of a farming system without affecting others.



Individuals of a species are connected to the rest of the ecosystem. The biosphere includes all the world's ecosystems.

Growers and consumers have benefited greatly from technological advances in fruit production that have increased yields and reduced labor costs. There have also been some unexpected environmental and social consequences, such as pesticide resistance, loss of biodiversity, potential water pollution, consumer concerns

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

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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.

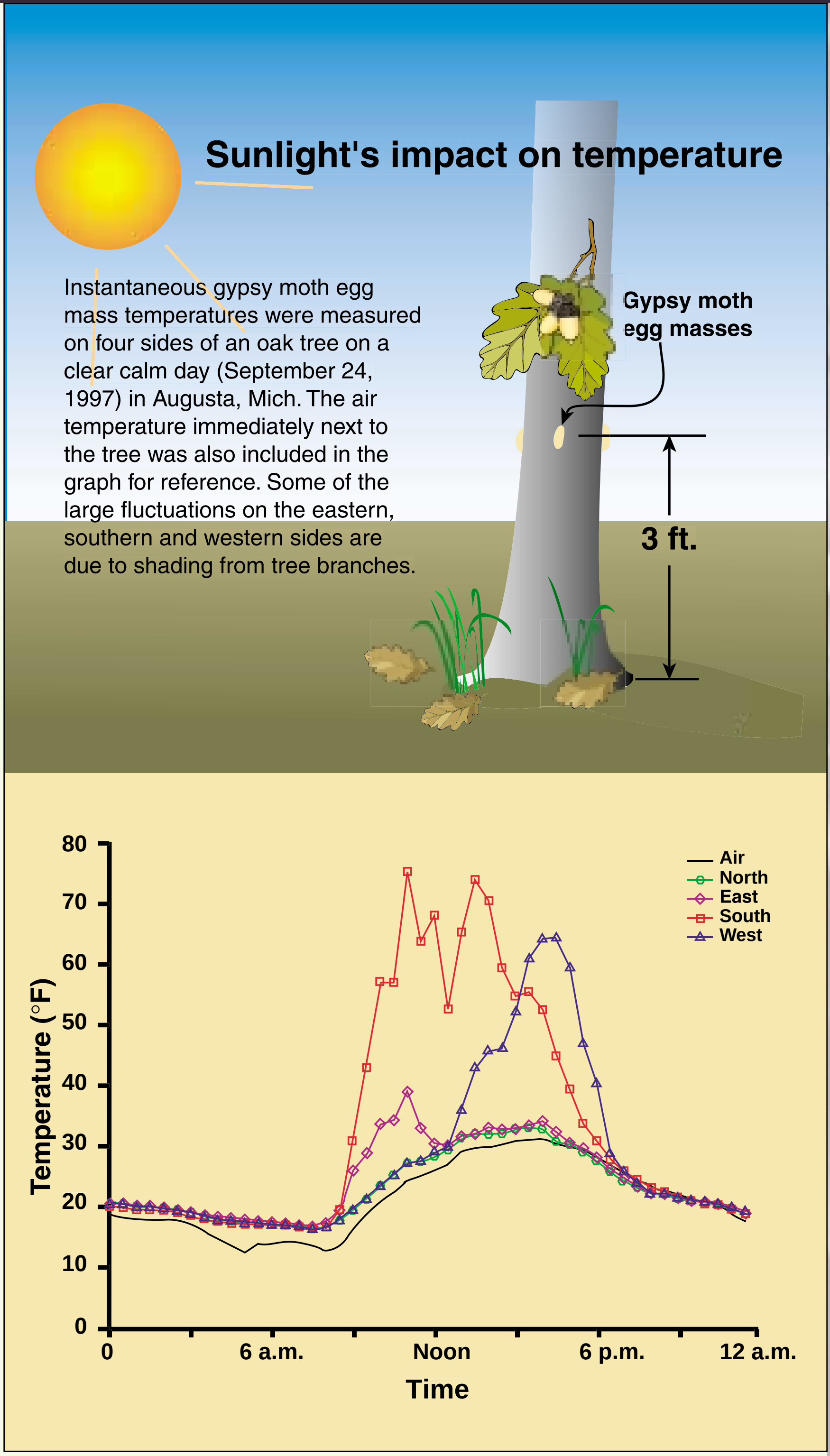
Air temperature within crop canopies is not usually uniform but varies with height, depending on the architecture of the crop, time of day and cloud cover. When the sun is shining, the highest temperature occurs in the top of the canopy. Under overcast skies, temperatures tend to be relatively uniform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

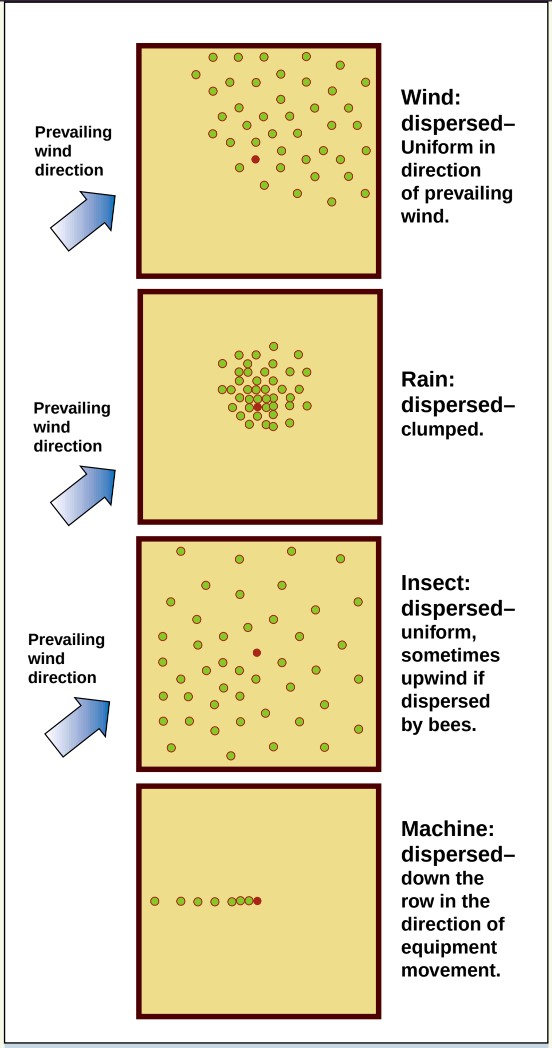


by ascospores are typically more numerous downwind from a source. Fruit infection caused by bee-dispersed conidia tends to be more severe upwind, because bees tend to fly upwind while foraging. In some cases, soilborne pathogens can be dispersed by wind-blown soil.

Rain or overhead irrigation can splash fungal spores and bacteria from plant surfaces or wash them off in runoff water. Splash droplets can be thrown more than a meter from the point of splash, but most travel only a few centimeters. Soilborne pathogens are often dispersed by water flowing through soil.

Dispersal distances are usually smaller for rain splash-dispersed pathogens than for windborne pathogens, except in the case of wind-driven rain or splash droplets that form aerosols in the wind. Rain-dispersed pathogens also tend to spread more readily along the rows than across rows because the distances between plants are smaller. Some pathogens use both tactics. The grape black rot fungus uses windborne ascospores produced on fruit mummies to get from the ground into the canopy. Then conidia produced on leaf lesions are splashed by rain to the developing fruit. The dispersal mechanisms of insects are similar to those of pathogens, but wind has greater impact and rain has less.

Pathogens can also be dispersed by farm equipment. For example, blueberry mechanical harvesting machines have been shown to move the blueberry aphid and the shoestring virus it transmits from infected to uninfected plants down the row. Washing the harvester between fields is a simple way to reduce transfer of this virus from field to field.



How pathogens are dispersed. Disease distribution in a field varies with method of pathogen dispersal from a diseased source plant. Above, red dots indicate location of source plant; green dots indicate locations of infected plants.

This aerial view of a blueberry field indicates that machinery spread blueberry shoestring virus down the rows.

Amer. Phytopath. Soc.

Chapter 3. The human setting

Chapter questions

- How can ecological management offer fruit growers special marketing opportunities?
- How can non-farm neighbors become valued customers and allies of farming?
- How can a grower attract and retain the skilled workers needed for ecological fruit management?

Fruit growers operate within a human setting that affects their production choices as much as the natural setting. The human setting begins with the grower and extends to the families and employees on whom growers rely, the communities where fruit is grown, distributors and processors who establish intermediate markets, the consumers who buy the fruit and the diners who eat it. The human setting also includes the organizations that research and advise on all these stages from farm to table, as well as the government agencies that regulate various aspects of growing and processing fruit. To fruit growers interested in ecological management, this setting offers special challenges as well as special opportunities.

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Production and marketing strategy: How best to grow fruit depends upon who will buy it

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In the supermarket produce department, large, perfect, individual apples sell for double the price of the medium-sized bagged apples across the aisle. Organic apples sell for even more. The first price difference arises because most consumers prefer large, good-looking fruit to smaller, less striking fruit. The organic apples attract a still higher premium from consumers who perceive them as a healthier choice.

The growers who produce the three classes of apples follow different marketing strategies. The bagged apples are a **commodity** and cost the least to produce. To make a profit, How will fruit producers who adopt ecologically based management principles be better equipped to survive and prosper in the fruit business? Many issues challenge fruit production today. Using ecologically based management is not a silver bullet, but it does offer sustainable options.

Apple producers, for example, currently face poor prospects because of worldwide overproduction and low prices. In addition to weak markets, they have suffered weather-related disasters such as windstorms, drought and fire blight epidemics. They need lower costs if they are to continue as commercial commodity producers. Management strategies that control insects or diseases with fewer pesticide applications can lower costs.

Some growers believe that adopting ecologically based fruit management can pay off by directing their fruit toward more profitable markets. The optimistic producers talk about marketing strategies as well as production techniques.

Apple grower Kevin Winkel saved his orchard during the Michigan fire blight outbreak of 2000. He used information from his own weather station plus disease development information from a computer model. Winkel's orchards were sprayed when a critical combination of open blossoms, warm temperatures, free water and threshold levels of bacteria coincided. "We saved the orchards, but it took time, effort and money," he said.

Winkel had limited plantings of the newest varieties, such as Gala, Fuji and Jonagold, which are most susceptible to fire blight. He grows mostly Red and Golden Delicious, which are less susceptible. He maintains a 1.5-acre test orchard on his farm and is evaluating 150 new varieties that are more resistant to fire blight and apple scab. While some evidence suggests that consumers are looking for novel tastes in apples, history says it takes years to establish a market for a new apple.

Winkel continues to use ecologically based principles. He spent years establishing a good environment for predatory mites—seeking them out and transporting them from abandoned orchards to his own. Since 1999, he has used no miticides, not even dormant oil. He uses his weather station and information on growing degree day accumulations, his own scouting and reports on regional trap catches to time sprays accurately.

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