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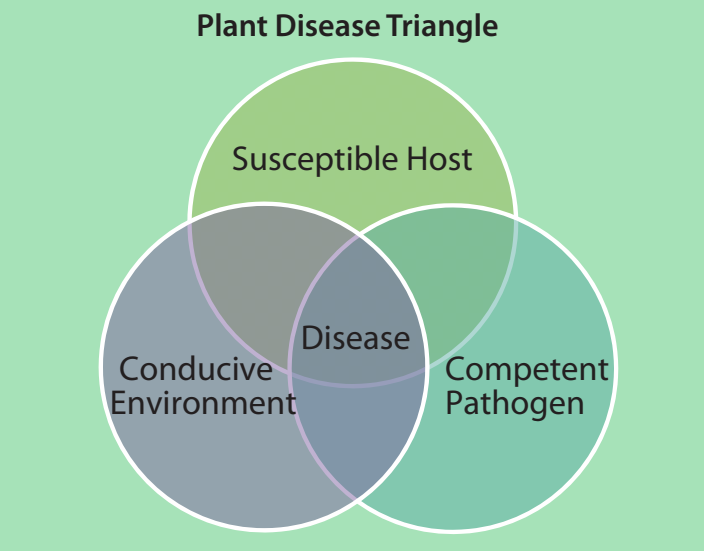
Disease Risk Management with Crop Biodiversity

As biodiversity diminishes in both wild and agricultural systems, the risk level for plant disease increases. Some diseases, such as potato late blight, can have devastating effects on crop yields. Those effects may be lessened if more than one variety of potato is planted. Risk of plant disease depends on three components of the plant disease triangle (below): a susceptible host plant, an effective (competent) pathogen, and an environment that is conducive to disease. The greater the density and frequency of the susceptible host, the greater the risk and severity of disease.



Potato crops are often planted in monocultures, which contain just a single crop planted over a wide area. This creates a situation where disease can spread more easily. Increasing the biodiversity in an agricultural field – whether by mixing different plant species or different genetic varieties of the same species – has the potential to decrease disease risk for the host plant. However, research on the effects of host biodiversity has shown a spectrum of results, from minimal to significant impacts. Garrett et al (2009) developed a simple model and a series of field trials to identify the factors that determine when crop mixing is likely to be a beneficial disease management strategy.

Potato plant tubers and leaf infected by potato late blight, caused by the pathogen *Phytophthora infestans*

Factors affecting potato late blight

Garrett and the research team studied how different resistance levels within a species affect the potato plants' likelihood of getting late blight. They paired resistant and susceptible host varieties in the field trials. Each of the varieties was also grown as a monoculture to compare with the effects of crop mixing on disease risk. To evaluate how season length influences the effects of diversity within a species on disease risk, field studies were conducted in Ecuador (long seasons), two locations in Peru (intermediate seasons), and the United States (short seasons).

Red LaSoda potatoes (pictured left) are a variety grown in the United States susceptible to late blight

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Effects of season length and diversity within a species on disease risk:

- Host diversity (crop mixtures) generally decreases the likelihood of disease.

- The greater the variation of disease resistance of the types of plants in the mixture, the greater the effect on disease risk. Combining a highly resistant variety or immune variety with a susceptible variety will often be more effective than a partially resistant and susceptible pair.

- Resistant types tend to have a higher disease incidence when mixed with a susceptible type than when grown as a solo crop because there is greater exposure to the disease amidst susceptible hosts.

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- Locations with shorter seasons often have lower disease severity. With shorter seasons, there will be fewer generations of the pathogen, and therefore less disease spread. Also, the pathogen population size tends to be lower at the start of the season.

- Locations with longer seasons may benefit less from crop mixes. Because of the greater pathogen population size and higher number of pathogen generations that long seasons permit, the disease resistance benefits of a crop mixture may decline by the end of the season.

Crop mixtures will often provide the greatest disease management benefits when:

- the higher value variety is disease susceptible
- there is a large difference between the susceptibility of the crops in the mix (high functional divergence), or the types of resistance genes are different
- the environment has a moderate disease severity and moderate season length

Crop mixtures are less likely to provide significant disease management benefits when:

- the seasons are long and there are a lot of pathogens present at the beginning of the season (situations with high disease risk)
- there is a small difference between the susceptibility of crops in the mix
- the environment already has a low disease risk

Peruvian farmers sort potatoes. Potatoes are a major crop for farmers in the Andes.

More information: Garrett, K.A., L.N. Zuñiga, E. Roncal, G.A.Forbes, C.C. Mundt, Z. Su, and R.J. Nelson. 2009. Intraspecific functional diversity in hosts and its effect on disease risk across a climatic gradient. Ecological Applications 19(7): 1868-1883. http://dx.doi.org/10.1890/08-0942.1

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