DOWNY MILDEW OF LETTUCE *(Bremia lactucae)*: Biology, Disease Symptoms and Damage. Using the Downy Mildew Index Model for Disease Management

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Introduction

Downy mildew *(Bremia lactucae)* is a common fungal disease of lettuce in cooler growing regions, especially the Central Coast of California. Growers report that 60% (or more) of the total fungicide spray applications on a lettuce crop specifically target this disease. A program that provides good disease control, yet decreases use of downy mildew fungicides, would significantly reduce the total use of pesticides on lettuce.

Life Cycle and Requirements of the Organism

Infection occurs when a downy mildew spore (conidium) germinates and enters the lettuce leaf via direct penetration of epidermal cells. Entry through leaf stomata also occurs. Colonization occurs when intercellular hyphae of the fungus grow and penetrate new lettuce leaf cells, utilizing the nutrients found in these plant cells. This systemic infection can proceed rapidly. When weather conditions are right, sporulation occurs when hyphae accumulate under leaf stomata. Conidiophores bearing conidia emerge from the stomata. Wind disseminates the conidia to repeat the infection process. Conidia may also form into zoospores that either directly infect leaf tissue or become encysted for later infection. Figure 1 depicts the different stages of the organism.

Figure 1 Disease cycle of lettuce downy mildew caused by *Bremia lactucae*. Modified from Agrios 1988

Downy mildew conidia require free water on the leaf surface for germination and infection. The heavy fogs and dews that occur on the Central Coast provide optimal conditions. Colonization proceeds when temperatures are around 21°C (70°F). Sporulation requires high relative humidity.

Symptoms and Damage

Leaf symptoms of downy mildew first show as angular, pale yellow patches which are delineated by leaf veins. The first leaves of the lettuce plant or older leaves close to ground usually are the first to show symptoms. The underside of the leaf opposite the yellow patch will show white masses of spores from 7 to 14 days after infection. As the spore mass grows larger, it takes on a white, downy appearance; hence the name downy mildew. As the disease spreads, the upper side of the leaves may also show the downy white fungus growth. Downy mildew can reduce yields and quality of the crop. Infected wrapper leaves must be removed at harvest. Infections on the cap leaves may result in leaving heads behind in the field. Downy mildew damaged leaf tissue can be an entry site for secondary rot producing organisms. These rot organisms may compound crop losses in the field, and can also cause losses later when the lettuce is in transit.

Disease Management and the Downy Mildew Index

There are downy mildew resistant varieties of iceberg lettuce, but no cultivar is sufficiently resistant to all the races of downy mildew to allow culture without fungicides. Both systemic and contact fungicides are necessary in a spray program to combat downy mildew. Control of the disease depends upon good coverage with the fungicide material, timely first applications, and repeated applications as weather and disease development dictate. Currently maneb, fosetyl-A1, and at times, copper compounds are the primary fungicides used for disease suppression. Because weather conditions on the Central Coast are mostly conducive to downy mildew infections and spread, calendar spray applications are the norm. However, there are times when weather conditions are not conducive to downy mildew infection and sporulation. Closely monitoring weather conditions to determine precisely the risk potential for downy mildew infections is the purpose of the Downy Mildew Index.

In-field weather stations collect pertinent weather data; these being temperature, relative humidity, wind speed and direction, leaf wetness, solar radiation intensity, and soil moisture content. The Downy Mildew Index compiles and analyzes these data. Conditions conducive to *Bremia lactucae* infection and spread accumulate "points," and conditions that deter downy mildew subtract "points." The Downy Mildew Index is expressed as a number; the greater the number, the higher the risk of infection and disease development, and the lesser the number, the lower the infection risk.

The Downy Mildew Index is being tested and validated in Lompoc and Santa Maria Valley commercial lettuce fields. Eliminating fungicide spray applications when they are not necessary, yet insuring good disease control, is the goal.

Resources for Further Information

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