

WHITE MOLD

CAN CALCIUM HELP DEFEND CROPS?



Reduction of white mold may be due to calcium's role in strengthening plant tissue. Calcium forms strengthening bridges especially in the pectate materials that form the middle cell membrane of plant cells. Calcium is also important in maintaining selectivity of cell walls and in binding the cell wall. Calcium also binds strongly to oxalic acid, an important toxin produced by *Sclerotinia sclerotiorum*. Calcium may be a nutritional supplement that increases plant resistance to white mold. (1)

White mold is caused by the fungus *Sclerotinia sclerotiorum*. White mold is heavily influenced by weather and microclimatic conditions. Progress of the disease is favored by below-average air temperatures, high relative humidity, and soil moisture. When these conditions occur during the two weeks prior to peak flower on the lower stems, the disease incidence can be especially severe. (2)

The trend to plant soybeans more frequently in specific fields is another factor contributing to the white mold problem. *Sclerotinia sclerotiorum* is a necrotrophic spore forming fungus with a broad host range (>400 species) (3). The more frequently a host crop is present, the more opportunity the white mold pathogen has to reproduce and reach population densities in soil that can result in outbreaks of white mold. The risk of white mold is even greater if other host crops are grown in rotation with soybean.

Highly susceptible crops are soybean, sunflowers, canola, potato, alfalfa, and red clover. Examples of crops that are much less susceptible to the white mold pathogen are corn, small grains, and all forages and grasses. Currently all forms of the pathogen are believed to be equally pathogenic to all hosts and varieties of soybean.

Approximately 90% of the life cycle of *Sclerotinia* species is spent in soil as sclerotia. At certain times of the year, depending on the inherent nature of the fungus and various environmental factors, the sclerotia germinate and form mycelium which can infect a host. Many microorganisms in the soil have a detrimental effect on sclerotia.

White mold fungus attacks soybean plants during flowering stage and treatments to protect soybean have to be made before or during the flowering period. Mycelium from white mold produce oxalic acid. Oxylate pulls calcium out of the plant wall, weakening it and allowing an infection site. The fungus then grows on crystals of calcium-oxylate which form at the infection site. (4)

Oxalate may be directly toxic to host plants, presumably because of its acidity. The secretion of oxalate has been suggested to weaken the plant, thereby facilitating invasion (Noyes and Hancock, 1981). White mold ties up calcium in the pectates of the cell wall, allowing for the rapid destruction of the plant (5). The chelation of cell wall calcium by the

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oxalate anion has been proposed compromise Calcium dependent defense responses and to weaken the plant cell wall.

Oxalate is believed to aid fungal invasion by direct cellular toxicity or by development of a more suitable plant sap pH for cell wall degrading enzymes. Oxalates affinity for calcium which may weaken plant barriers by leaching the stabilizing calcium from the host plant cell wall. As internal Calcium stores become depleted, plant tissues are invaded by an oxalate-secreting fungus. (6)

In studies done on pumpkin and sunflower, the effect of calcium deficiency greatly amplified the infection by *S. sclerotiorum*. (7) Infection by many fungi activates a variety of calcium dependent defenses in the hosts, slowing or suppressing the attacker and limiting the efficacy of their toxins.

Since the 19th century, it has been appreciated that Calcium plays a crucial role in determining the structural rigidity of the cell wall It follows that low calcium should make the cell wall more pliable and easily ruptured. High concentrations should rigidify the wall and make it less plastic.

Calcium is a phloem-immobile mineral nutrient, meaning once absorbed by the plant and transported in xylem, it is not redistributed to other parts of the plant via the phloem. Mobile mineral nutrients, such as nitrogen and phosphorus, can be redistributed in plants via the phloem when there is a deficiency. Continuous uptake of calcium by the roots is required to avoid calcium deficiency.

Calcium is required in the extracellular solution and is the reason that it must constantly absorb calcium to keep growing. It cannot redistribute calcium already deposited in the plant to the growing points. (8)

Reference:

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- 2 Venette, James R (1998) Calcium micronutrient may reduce white mold of dry beans. Department of Plant Pathology, North Dakota State University
- 3 Oxalic Acid Is an Elicitor of Plant Programmed Cell Death during *Sclerotinia sclerotiorum* Disease Development Kyoung Su Kim, Ji-Young Min, Martin B. Dickman *Molecular Plant-Microbe Interactions* 2008 21:5, 605-612
- 4 Peter K. Hepler Calcium: A Central Regulator of Plant Growth and Development *Plant Cell* 17: 2142-2155
- 5 <http://hdl.handle.net/1811/32174>
- 6 Chrominski, A., Abia, J. A. & Smith, B. N. (1987). Calcium deficiency and gibberellic acid enhance susceptibility of pumpkin and sunflower seedlings to *Sclerotinia sclerotiorum* infection. *Journal of Plant Nutrition*, 10(17), 2181-2193. doi:10.1080/01904168709363771
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- 8 <http://www.madsci.org/posts/archives/2003-02/1044583064.Bt.r.html>

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<http://www.ent.iastate.edu/images/plantpath/soybean/whitemold/3185.4whitemoldkill.jpg>