

Integrating Biocontrol Agents With Chemical Seed Treatments for Resistance Management

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Metalaxyl (Apron® FL) and mefenoxam (Apron® XL) are both currently registered with the United States Environmental Protection Agency for use as seed treatments to control sunflower downy mildew caused by *Plasmopora halstedii*. Both of these fungicides are legal for domestic and export use as seed treatments. Kodiak® (*Bacillus subtilis*, Gustafson, Inc., Plano, TX, USA) a biological seed treatment is also registered, and can be safely used with either of the other products. Kodiak® has limited activity against Oomycetes, but other biological agents currently being screened do have specific activity against this class of fungi (Brannen, P. Personal Communications, Gustafson, Inc., Plano, TX).

The biological agents need to meet several criteria besides efficacy against the pathogen. Fungicide compatibility, ease of production, and shelf life should also be considered. Antibiotic production (1), or induction of resistance (2) in the host are two of the many potential modes of action that are useful. Spore forming bacteria have in the past held the most promise, but other organisms are also being investigated (3). The spore forming bacteria have a good shelf life as a formulated product because of the ability of the spore to survive a wide range of environmental conditions over extended periods of time. The spores also remain viable during the seed treating processes where they are routinely mixed with liquid fungicides in a slurry for as long as 48 hours before being applied to the seed. This practice occurs regularly without significant reductions in colony forming units. Past experience with Kodiak® has shown it to be most effective when combined with a fungicide. The fungicide inhibits pathogenic and competitive organisms around the germinating seed while the bio-control agent is establishing itself on the new root system (1). Because the fungicide and the bio-control agent would probably have different modes of action they would be ideal in a resistance management strategy. It would be improbable that the fungus could survive as a viable pathogen against two or more different modes of fungicidal action.

Fungicides are also being screened for Oomycetes activity, and could have potential as co-fungicides with metalaxyl or mefenoxam. Approaching the problem with two or more fungicides with different modes of action would also seem to offer a longer term solution to fungal resistance. Newer chemistry such as azoxystrobin (Quadris?), hymexazol (Tachigaren®), and cymoxanil (Curzate®) are potential candidates. Other older chemicals like captan, mancozeb (Dithane®), and TCMTB (Busan®) are also being researched.

A project to screen combinations of biological and chemical seed treatments requires an inoculation technique that closely mimics what occurs under field conditions. Inoculation techniques that are commonly used to screen breeding lines, may not always be best for screening chemical and bio-control agents, as they can sometimes be too severe. Also some fungicides work well on zoospores for instance, and do not inhibit mycelial growth (Matheron, M. Unpublished. Univ. of A Ag. Center, Yuma, AZ). In some instances a false reading could occur if more than one fungal structure caused infection, and only one spore type was used for inoculation. Trials are being planned at this time that to screen various combinations of products, and see if resistant strains of sunflower downy mildew can be controlled.

References

1. Kodiak® a successful biological-control product for suppression of soil-borne plant pathogens of cotton. Brannen, P. and D. Kenney. 1997. in : Journal of Industrial Microbiology & Biotechnology 19:169-171.
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3. Suppression of *Fusarium* colonization of cotton roots and *Fusarium* wilt by seed treatments with *Gliocladium virens* and *Bacillus subtilis*. Zhang, J., Howell, C., and Starr, J. 1996. in : Biocontrol Science and Technology 6:175-187.