Biocontrol activity by *Myrothecium verrucaria* improved by surfactant activity

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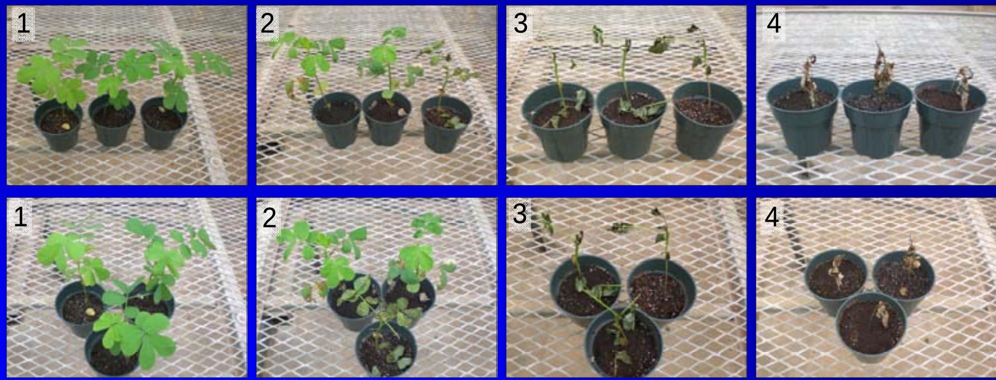
Abstract

Myrothecium verrucaria is a plant pathogen of many important weed species, including kudzu. For the fungus to infect weeds and provide bioherbicidal activity, it must be co-applied with a surfactant. We evaluated several commercially available spray adjuvants and polyoxyethylene tridecyl ether (TDA) in a plant bioassay for bioherbicidal activity. In the bioassay on the weed Senna obtusifolia, all of the surfactants improved the activity of *M. verrucaria* over the water-only treatments and TDA formulations with a hydrophilic – lipophilic balance (HLB) number of 8 or 10 had the highest activity. The mechanism for improved bioherbicidal activity with these adjuvants was investigated in vitro, and TDA HLB 8 and 10 did not significantly improve conidia dispersal or accelerate spore germination relative to other surfactants. It is possible that the role of the surfactant is in the alteration of the plant cuticle or otherwise preparing the infection court. Better adjuvant selection and integration with affordable synthetic herbicides should aid in the development of more cost-effective biological control of weeds.

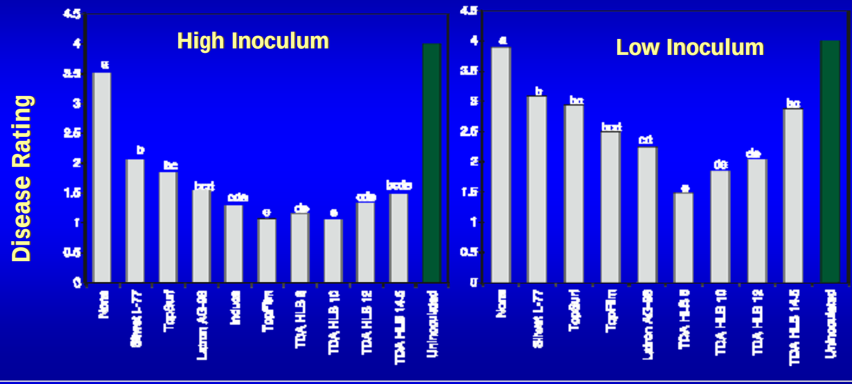


Representative Symptoms from Bioassay

Introduction

M. verrucaria is a highly effective pathogen of several important annual and perennial weed species, such as kudsu, hemp sesbania and sicklepod (Hoagland et al., 2007) but does not spread well in field conditions. One means of improving pathogen efficacy is through selection and addition of optimized spray surfactants. Studies on surfactants have mainly focused on their role in spore germination, mycelial growth, and formation of appressoria (Prasad, 1994, Zhang et. al., 2003, Bailey et. al., 2004). There are no general guidelines to assist in the optimization of compatible surfactants for mycoherbicide formulations (Zhang et. al., 2003). Further optimization studies are needed in relation to formulation processes. Non-ionic surfactants consist of a molecule that possesses both hydrophilic and lipophilic groups (or polar and non-polar groups), and it is the size and strength of these two groups that is called the hydrophilic-lipophilic balance number (HLB) (Griffin, 1949; 1954). A surfactant that is lipophilic in character is assigned a low HLB number and a surfactant that is hydrophilic in character is assigned a high HLB number. Jin et al. (2008) applied HLB number as a guideline in optimizing a compatible non-ionic surfactant in formulation development of an hydrophobic conidia-based mycoinsecticide. However, no studies have established guidelines for surfactant selection in the development of mycoherbicides. In this study, several commercially available spray surfactants and polyoxyethylene tridecyl ether (TDA) with a series hydrophilic-lipophilic balance (HLB) numbers were tested in vitro for their efficiency in improving biocontrol activity of *M. verrucaria* against sicklepod.

Sicklepod Control in Greenhouse Trials



Materials and Methods

Cultures of *M. verrucaria* (IMI 361390) were grown on PDA plates under a 12 hour light-dark cycle. Cultures were scraped with a transfer pipette under deionized water to collect conidia. Surfactants used in this study were SilwetL-77, Topsurf, Latron AG-98, Induce, TopFilm, TDA HLB 8, TDA HLB 9, TDA HLB 10, TDA HLB 12, and TDA HLB 14.5. Maximum use rates were determined by the manufacturer's label guidance, and based upon a 374 L/ha application volume. Sicklepod seedlings were grown to the two true leaf stage. Surfactants were added to suspension of *M. verrucaria* conidia to yield 0.25% surfactant concentration and 1 X 10^9 (high inoculum) and 2 X 10^7 (low inoculum) conidia/ml, respectively. Plants were sprayed to run-off (ca. 400l/ha) and rated after 5 days with a disease severity scale (1=dead plants; 2=no living leaves, some green stems; 3=lesion or limited necrosis; 4=healthy plants).

Results and Discussion

Selection of surfactant had a significant effect on the plant disease ratings and on the plant dry weights (Figure and Photo). While Silwet L-77 has been used with *M. verrucaria*, it was the least effective surfactant at the tested concentrations in the bioassay against sicklepod. Of the commercially available products tested, Induce, Latron AG-98 and TopFilm provided the highest level of bioherbicidal activity, depending on the concentration. The activity of TopFilm was especially noteworthy as this is a grain-derived product. Use of this, or a similar product might facilitate the use of M. verrucaria in organic crop production. In addition to tests with the commercial surfactants, which include proprietary components, we also tested TDA with a series of HLB numbers. In general, TDA formulations with lower HLB numbers resulted in better bioherbicide efficacy, especially at low inoculum concentration. The best bioherbicidal activity was associated with TDA formulations with an HLB of 8 to 10, although statistically similar results at high inoculum concentrations were found with HLB 12.

Results presented here demonstrate the possibility of greatly improved weed control by *M. verrucaria* though improved selection of spray surfactants. Our results indicate the potential of HLB numbers as a guideline in selection of a compatible non-ionic surfactant. In the selection of a surfactant for any application, we must have the correct chemical group, which means compatibility in most cases, and the optimized HLB number (Griffin, 1949). Optimized HLB number of a compatible surfactant may not only enhance bioactivity of a bioherbicide, but also improve the chemical properties of a formulation.

Literature

Bailey, B.A., O'Neill, N.R., Anderson, J.D., 2004. Influence of adjuvants on disease development by Pleospora papaveracea on opium poppy (Papaver somniferum). Weed Science 52: 424-432.

Griffin, W.C., 1949. Classification of surface-active agents by HLB. Journal of the Society of Cosmetic Chemists 1: 311-326.

Griffin, W.C., 1954. Calculation of HLB values of non-ionic surfactants. Journal of the Society of Cosmetic Chemists 5: 249-256.

Hoagland, R.E., Weaver, M.A., Boyette, C.D., 2007. Myrothecium verrucaria fungus: A bioherbicide and strategies to reduce its non-target risks. Allelopathy Journal 19: 179-192.

Jin, X., Streett, D.A., Dunlap, C.A., Lyn, M.E., 2008. Application of hydrophilic-lipophilic balance (HLB) number to optimize a compatible non-ionic surfactant for dried aerial conidia of Beauveria bassiana. Biological Control: 46, 226-233.

Prasad, R., 1994. Influence of several pesticides and adjuvants on Chondrostereum purpureum- a bioherbicide agent for control of forest weeds. Weed Technology 8: 445-449.

Zhang, W., Wolf, T.M., Bailey, K.L., Mortensen, K., Boyetchko, S.M., 2003. Screening of adjuvants for bioherbicide formulations with Colletotrichum spp. and Phoma spp. Biological Control 26: 95-108.

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