



Biological and Biorational Fungicides May Be Effective Against Common Hemp Leaf Spot Pathogens: A Bioassay Study

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The demand for natural, organic, or chemical pesticide-free hemp material has driven an interest in biological and biorational pesticides. Because hemp is a new (newly reintroduced) crop, there is limited data showing efficacy of these products, particularly fungicides. Further, the approach to efficacy screening of biological products is different from conventional fungicides. For example, some products consist of living organisms and require colonization of host plants in order to suppress disease development. Other products contain active ingredients that produce antagonistic metabolites such as biosurfactants and lytic enzymes or are botanical extracts or fermentation by-products that indirectly reduce or inhibit disease-causing agents and require extended contact time. Some products induce host resistance. In general, these products have different non-toxic modes of action, work more slowly, and often lack the immediacy of conventional or synthetic fungicides. Thus, efficacy testing is more complex and requires different approaches than with synthetic fungicides. This study aimed to prescreen biological and biorational fungicides against common leaf spot pathogens.

Several diseases have been identified as commonly occurring on most hemp cultivars and in most years. In Kentucky, the most common leaf and flower diseases are *Bipolaris* leaf spot, *Botrytis* gray mold and tip blight, *Cercospora* leaf spot, and *Septoria* leaf spot. Isolates of the fungal pathogens used in this study were selected from a collection from field hemp in Kentucky: *Bipolaris gigantea*, *Botrytis cinerea*, *Cercospora flagellaris*, and *Septoria cannabidis*.

Eight microbial fungicides and three other minimum-risk biorational products were selected to prescreen for potential efficacy against common hemp pathogens. Registered products containing specific strains of *Bacillus* spp., *Trichoderma* spp., and *Ulocladium* sp. as active ingredients represent products containing living biological active ingredients. Non-living products represent those containing botanical extracts, copper soap, citric acid, and potassium silicate as active ingredients. A conventional fungicide containing azoxystrobin and tebuconazole was used as a positive control.

TABLE 1. SUMMARY OF POTENTIAL EFFICACY OF BIOLOGICAL AND BIORATIONAL FUNGICIDES AGAINST MAJOR FOLIAR PATHOGENS OF HEMP USING VARIOUS PRESCREENING METHODS. AN "X" INDICATES EFFICACY.

Fungicide	Amended Media	Exposure Timing	Inhibition Zone	Amended Media	Inhibition Zone	Amended Media	Exposure Timing	Inhibition Zone	Amended Media	Exposure Timing	Inhibition Zone
	<i>Botrytis</i>	<i>Botrytis</i>	<i>Botrytis</i>	<i>Bipolaris</i>	<i>Bipolaris</i>	<i>Cercospora</i>	<i>Cercospora</i>	<i>Cercospora</i>	<i>Septoria</i>	<i>Septoria</i>	<i>Septoria</i>
Bio-Tam®		X									
Botrystop®					X			X			X
Cease®		X	X		X		X	X		X	X
Cueva®	X			X		X			X		
Double Nickel®		X	X		X			X			X
LifeGard® WG	X	X		X		X			X		
Procidic® 2	X			X		X			X	X	
Regalia®										X	
SilMatrix®	X			X		X			X		
Stargus®		X	X		X		X	X			X
Trilogy®	X					X			X		

Products were screened using three different *in vitro* methods. Protocols were dependent upon product formulation and mode of action; products with induced resistance mode of action were included in assays to assess potential for activity beyond label claims, but induced resistance was not tested in this study. Amended media plate assays were used for products with direct adverse effects on pathogens but were not used for living organisms that had the potential to colonize media plates during experiments. Exposure assays were conducted with products that potentially depended upon extended exposure times for activity, such as cell disruption, degradation, and desiccation. Inhibition experiments rated suppression of fungal growth by products that produced fungicidal or fungistatic metabolites in the growing medium.

Results for select assays are shown in TABLE 1.

In conclusion, this study of bioassays using biological and biorational fungicides reveals that some products exhibit activity against hemp pathogens and, presumably, against aerial hemp diseases. All 11 fungicide products demonstrated some activity against at least one pathogen in at least one type of assay (TABLE 1). The three bioassays proved beneficial in demonstrating potential efficacy via different major modes of action. Although results from the bioassays evaluated in this study do not translate to efficacy data in the field or validate disease management recommendations, it presents regulatory scientists, Extension specialists, crop advisors, and growers a model for pre-screening aerial disease-management products based on their labeled mode of action claims before testing *in planta*.

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Complete research study can be found at

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