EFFICACY OF ORGANIC BIOPESTICIDES FOR THE MANAGEMENT OF WHITE MOLD IN PROCESSING SNAP BEAN IN PENNSYLVANIA

FINAL REPORT FOR THE PENNSYLVANIA VEGETABLE MARKETING & RESEARCH PROGRAM (NOVEMBER 13, 2017)

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Summary. A replicated small plot trial was conducted to quantify the efficacy of biofungicides and OMRI-listed products for the control of white mold in snap bean in Pennsylvania. Application of all products led to significant reductions in white mold incidence on plants and pods following inoculation with *Sclerotinia sclerotiorum* ascospores. All products significantly reduced white mold incidence compared to nontreated control plots. The conventional fungicideS (Cercobin and Rovral) included in the trial for comparative purposes, were highly efficacious and resulted in disease control not significantly different between each other. Products that resulted in excellent white mold control with potential for use in organic snap bean production were Double Nickel, MBI-110 (undergoing EPA review), Nutrimag, F9110-9, and Naturall. The control of white mold resulting from these products was not sensitive to rates within the ranges tested. These products may provide additional options for the control of white mold within organic snap bean production.

Introduction

White mold, caused by the fungus *Sclerotinia sclerotiorum*, is one of the most devastating and problematic diseases of snap bean. The disease is difficult to control due to the: 1) long-lived sclerotia (resting structure of the fungus) produced on diseased plants; 2) wide host range of the pathogen which includes many of the cash crops, cover crops and weeds in typical vegetable rotations; and 3) absence of commercial bean varieties with resistance to *S. sclerotiorum.* In general, agronomic factors associated with high yields also exacerbate white mold by promoting canopy development and an ideal environment for disease development. Direct losses from white mold occur from reductions in the number of marketable pods. Indirect losses result when the disease causes lodging. Diseased pods also contribute to the perpetuation and increase of *S. sclerotiorum* inoculum for future susceptible crops.

Fungicides are one of the most critical control measures for white mold in snap bean and management is strongly reliant upon their well-timed use according to flower phenological development. Historically, major changes in the most commonly used fungicides have occurred due to the withdrawal of some products from the market (e.g. Ronilan®) due to health and environmental concerns. Diversity in efficacious products for use in conventional and organic production is therefore important for rotational purposes to adhere to best management guidelines.

More than 200 biopesticide active ingredients have been registered in the United States and some are certified by the Organic Materials Review Institute (OMRI). These biorational products are valuable tools because they generally have shorter restricted-entry and preharvest intervals. Earlier sponsored by PVMRP identified one biopesticide (Double Nickel) that provided similar control of white mold to conventional fungicides. The objective of this study was to support and facilitate organic production of snap beans by quantifying the efficacy of OMRI-listed products available to growers for white mold control in Pennsylvania.

Materials and Methods

The trial was planted at The New York State Agricultural Experiment Station in Geneva, New York, in a Honeoye silt loam soil (Research North field 25) on 14 June 2017. Seed (var. 'Huntington') was planted with a Monosem planter at a rate of 9 seeds/ft. Fertilizer (300 lb/A 15 N: 5 P: 10 K) was banded at planting and the pre-emergent herbicide, Dual Magnum® (1.8 pt/A) was applied on the same day. On 18 July, at 34 days after planting (DAP) and growth stage (GS) V3, additional nitrogen (50 lb/A) was applied by hand within the rows. Plant density within each plot was assessed on 25 July by counting the number of plants in a 4 foot section in each of two rows. The trial received supplementary irrigation using overhead sprinklers for optimal plant growth and disease development. Growth stage of the snap beans at critical points was recorded.

The trial design was a completely randomized block with four replications of each of the 13 treatments and a nontreated control (Table 1). Each plot was 10 feet long × 2 rows wide. Two noninoculated and nontreated rows separated plots between blocks, and 4-feet sections separated plots within rows. Fungicides were applied with a carbon dioxide-pressurized backpack sprayer with a volume of 26 gallons/A using a 38 inch long boom using four flat fan TJ 8002VS nozzles spaced 19 inches apart. Products were applied with a hand-held pump sprayer with a single flat fan TJ 8002VS nozzle on 26 July (~ 10% of plants with at least one open flower [GS = R1]; 42 DAP) and 1 August (~ 100% of plants with at least one open flower [GS = R2]; 48 DAP).

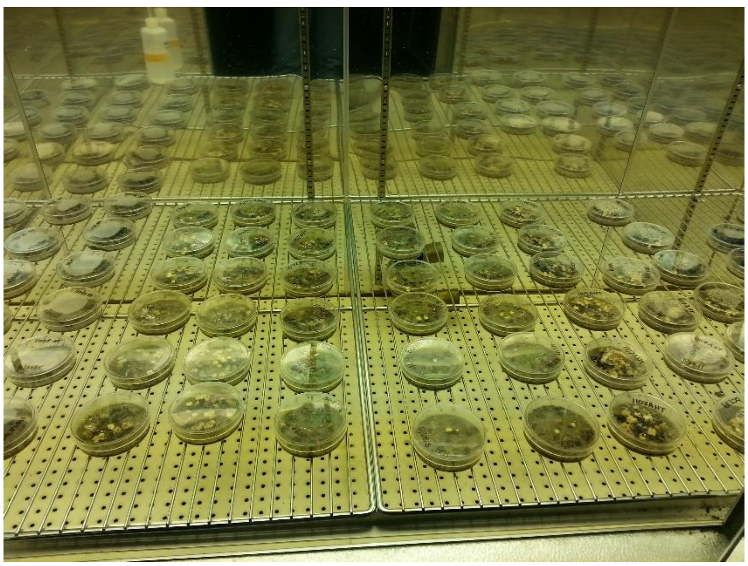
Plots were inoculated with *S. sclerotiorum* ascospores at 26 (43 DAP [GS = R1]), and 28 (44 DAP [GS = R1]) at concentrations of 5.6×10^3, and 3.2×10^3/ml using a backpack sprayer. The germination efficiency of ascospores was at least 99%. Carpogenic germination was induced and ascospores were collected (Fig. 1).

The efficacy of products was assessed on plants from two 3.2-feet sections within each plot on 16 August (63 DAP [GS = RH]) and removing marketable pods by hand. Pods and plants were separated into diseased (white mold symptoms) or healthy, and the number in each category counted to calculate the incidence of white mold on pods and plants (%). Plants with white mold had necrotic lesions on stems and often had signs of *S. sclerotiorum* (mycelia and sclerotia on diseased plant parts). The weight of the healthy pods was recorded to calculate the average weight of individual healthy pods. The efficacy of fungicides on white mold incidence (%) on pod and plants and yield (weight of healthy pods, and average individual weight of healthy pods) was quantified using generalized linear modelling (Genstat Version 17.1).

Table 1. Products and rates tested for white mold control in snap bean in 2017 at Geneva, New York.

Fungicide (Company)	Active ingredient	FRAC group	Product rate (/A)
OMRI-listed			
DoubleNickel LC (Certis USA)	*Bacillus amyloliquefaciens* D747 strain	44	1 & 2 quarts
Nutrimag (Innovative Surface Solutions)	Magnesium chloride	-	2 gall
MBI-110 (Marrone Bio Innovations)	*Bacillus amyloliquefaciens*	44	2, 3 & 4 quarts
F9110-9 (FMC Agricultural Solutions)	*Banda de Lupinus albus doce* (BLAD)	BM 01	32 oz
Naturall for Vegetables (ABM)	*Trichoderma harzianum, T. virens,* and *T. atroviride*	BM 02	0.5 fl oz (soil) @ 18 days after planting 3 ml/L (foliar)
Conventional (for comparison)			
Rovral (FMC Agricultural Solutions)	Iprodione	2	24 oz
Cercobin (FMC Agricultural Solutions)	Thiophanate-methyl	1	22 oz

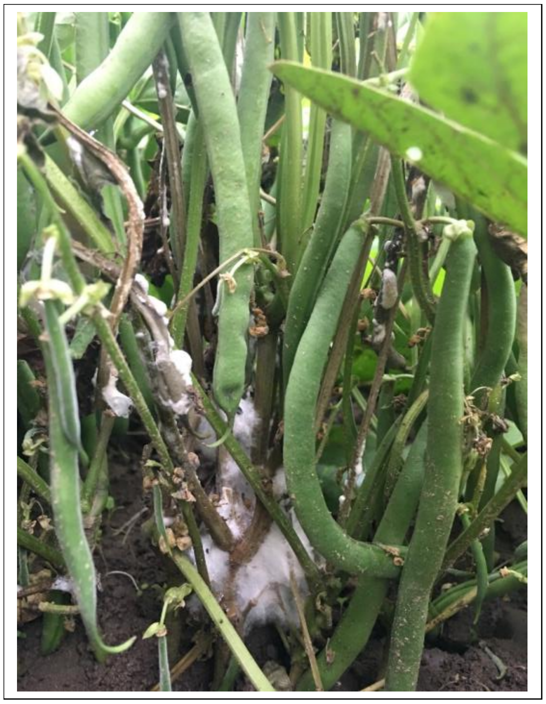
Fig 1. *Sclerotinia sclerotiorum* apothecia and sclerotia in the growth chamber. Ascospores are collected throughout the year and stored at -20°C until rehydrated for field inoculations.



Results

Plant density was not significantly different according across the trial (*P* = 0.057). Disease incidence in the nontreated plots was high with 44.7% and 18% of plants and pods, respectively (Table 2; Fig. 2). The incidence of plants with white mold was significantly reduced by all treatments, but was significantly reduced in plots receiving Rovral and Naturall (foliar drench) compared to those receiving F9110-9. All products also significantly reduced the incidence of white mold in pods but MBI-110, Rovral, Naturall (soil drench), and Naturall (foliar drench) were more efficacious than F9110-9. No significant differences in white mold control was observed between the rates tested of Double Nickel, and MBI-110 (Table 2). Treatments had no significant effect on marketable pod yield. However, the average weight of a healthy pod was significantly increased in plots treated with Cercobin, MBI-110 (2 and 4 quarts/A), and Nutrimag compared to nontreated plots (Table 2).

Fig. 2. White mold in snap bean caused by *Sclerotinia sclerotiorum* within the nontreated plots in the small plot replicated trial conducted at Geneva in 2017.



Discussion

Inoculation with *S. sclerotiorum* ascospores led to a high incidence of white mold in nontreated plots providing optimal conditions to quantify product efficacy. The 'standard' program for pod disease control in conventional snap bean production is one application of thiophanate methyl (aka. Cercobin in this trial) or Endura at early bloom (10% flowering) followed by an additional application at 100% flowering approximately 7 to 10 days thereafter if conditions are conducive to disease development. In this study, Rovral also provided excellent control of white mold and was not significantly different from Cercobin. Applications of Double Nickel at either rate tested (1 and 2 quarts/A) again resulted in significant control of white mold on plants and pods compared to nontreated plots. Analogous disease control was also obtained from all rates tested of MBI-110. This product is also a microbial biopesticide containing the bacterium, *Bacillus amyloliquefaciens* but a different strain to that within Double Nickel. MBI-110 is expected to soon be approved by the EPA and registered for white mold control in a broad range of field and specialty crops with OMRI certification. Nutrimag produced some transient bronzing phytotoxicity to the upper leaves but provided white mold control and significant increases in the average weight of a healthy pod. Similar benefits have also been reported for white mold control in dry beans in New York in 2016 (Pethybridge, *unpublished data*). F9110-9 is the formulation of BLAD that will soon be OMRI-listed by FMC Agricultural Solutions. When applied alone, F9110-9 provided moderate white mold control and no benefits were observed when tank-mixed with the conventional fungicide, Rovral. Naturall is microbial biopesticide containing a mixture of *Trichoderma* species approved for organic production by the National Organic Program and for use in certified organic vegetable production by the Organic Materials Review Institute. Naturall provided excellent white mold control when applied as either a soil drench soon after establishment or as a foliar drench applied at the same phenological developmental stages as the other products tested. Naturall is currently registered only for application as a soil drench but registration for use as a foliar application is expected.

Table 2. Effect of conventional and OMRI-listed products on white mold, marketable yield, and the average weight of a healthy pod in a small plot replicated trial at Geneva in 2017.

Fungicide (/A)	Incidence of plants with white mold (%)	Incidence of pods with white mold (%)	Marketable pod yield (g/m)	Average weight of a healthy pod (g)
Double Nickel (1 q)	7.5 bc	4.8 bc	0.90	8.59 ab
Double Nickel (2 q)	16.7 bc	4.9 bc	1.04	8.14 abc
Nutrimag (2 gall)	7.2 bc	3.7 bc	0.99	8.79 a
MBI-110 (2 q)	7.6 bc	5.2 bc	1.04	8.71 a
MBI-110 (3 q)	6.4 bc	3.2 bc	1.09	8.43 ab
MBI-110 (4 q)	5.7 bc	0.6 c	1.29	8.82 a
F9110-9 (32 oz)	21.5 b	6.3 b	1.08	7.94 abc
Rovral (24 oz)	0 c	0.7 c	1.05	8.13 abc
Rovral (24 oz) + Cercobin (22 oz)	3.2 bc	3.9 bc	0.97	8.14 abc
Rovral (24 oz) + F9110-9 (32 oz)	8.0 bc	2.5 bc	0.82	7.80 abc
Cercobin (22 oz)	5.4 bc	3.3 bc	0.92	8.79 a
Naturall (soil)	3.6 bc	0.6 c	0.97	7.28 c
Naturall (foliar)	2.6 c	1.1 c	1.05	7.14 c
Nontreated	44.7 a	18 a	0.79	7.57 bc
Df	55			
LSD	18.3	4.9	-	1.11
P =	0.002	<0.001	0.479 (ns)	0.034
CV (%)	27.8	23.2	20.6	4.6

Extension of findings. A fact sheet is available for distribution at local meetings. Presentations will be conducted as requested.

A final expenditure report, courtesy of Ms. Janice Valerio, Finance Manager, is provided below:

Field Research Unit Charges	$ 550
Materials & Supplies	$ 950
Salaries	$ 5,300
Total funding spent	**$ 6,800**