DEHYDRATED GARLIC POWDER USED TO REDUCE *SCLEROTIUM CEPIVORUM* IN FIELD SOIL

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Abstract

For single applications in large field plots, 0, 18.5, 37, 74, 111, 148, and 185 g/m^3 of food-grade dehydrated garlic powder (DGP) lowered populations of *Sclerotium cepivorum* by 0, 20-23, 28-35, 92-95, 93-98, 94-98, and 100 percent, respectively, when applied within the optimal range of soil temperature and moisture for sclerotial germination. Data were composited from field trials near Walla Walla, Washington (1991-1992, fall applied), Bakersfield and Hollister, California (1998, spring applied), and Madras, Oregon (1999, spring applied). As per previous reports, > 0.5m1/m^2 diallyl disulfide (Madras and Bakersfield) or 22 ml/m^2 tarped methyl bromide (Bakersfield) reduced populations by about 98 percent. DGP was obtained from California processors and used within a few months of production, but amount and composition of germination stimulants was not assessed. For white rot control, all such treatments should be adjusted to the depth to which sclerotia have been tilled.

Introduction

Diallyl disulfide and related flavor and odor compounds from *Allium* species specifically induce high germination levels of sclerotia of *Sclerotiwn cepivorum,* the Allium white rot pathogen (Crowe et al. 1994). In 1996, the U.S. Environmental Protection Agency deregulated a number of minimum risk pesticides, including garlic products, from pesticide oversight (Appendix). Thus, dehydrated food-grade garlic may be used in the manner described in this report without U.S. Federal oversight. Reported here are efficacy trials using high-quality, food-grade dehydrated garlic powder to reduce soil populations of *S. cepivorum.* Product was "off-the-shelf' and unadjusted for any differences in germination stimulant content that may have existed.

Materials and Methods

Trials were located in naturally infested fields near Walla Walla, Washington, Bakersfield and Hollister, California, and Madras, Oregon. Each trial was a randomized-block experimental design. Trial-specific information is shown in Table 1. Dehydrated garlic powder was obtained from manufacturers within 1 month of processing. The powder was mixed with water and sprayed under agitation on the soil surface. Soil was then tilled immediately. Treatment dates were chosen such that soil temperatures would remain between 5-21°C, which is conducive to germination, for 2-3 months following application (Crowe and Hall 1980a), discounting temperatures below 5°C. Soil moisture was adequate prior to product application, plots were irrigated immediately to assist retention of germination stimulants, and plots were periodically irrigated to maintain optimuin moisture conditions for germination (Crowe and Hall, 1980a). At Bakersfield, methyl bromide (MeBr, Tri-Cal) was injected at a rate of 22 g/m^2 as a gas to 30 cm and tarped.

Table 1. Dehydrated garlic powder field trial descriptions.

	Walla Walla, WA	Bakersfield, CA	Hollister, CA	Madras, OR
Soil type	sandy loam	loam	sandy loam	loam
Plot dimensions (m)	1.8 x 5.2	6.1 x 6.1	6.1 x 6.1	1.8 x 18.2
Replications	3	4	4	4
Treatment date[a]	10/15/91	2/26/98	4/3/98	5/25/99
Post-trt sampling date	5/19/92	9/15/98	9/22/98	8/23/99
Incorporation depth (cm)	30	15	15	30
Incorporation tool	rotary tiller	rotary tiller	manual tillage	rotary tiller
Product source	De Francesco & Sons	Basic Vegetable Products	Basic Vegetable Products	Roger's Foods

aCorresponds with pretreatment soil sampling date.

At Bakersfield and Madras, diallyl disulfide (DADS, United Agri Products) was injected as a liquid to 30 cm, using 15-cm shank spacing, with injector point depths located at 10, 20, and 30 cm along the shanks. Rates of 5 ml/m^2 and 0.5 ml/m^2 were used in Bakersfield and Madras, respectively.

Pre- and post-treatment soil samples were composited from 20 subsamples per plot collected to the depth that garlic powder was tilled. Data not shown indicated that all germination activity had ceased by the date of post-treatment soil assay. Wet sieving soil assays and sclerotia viability tests, determined by growth on water agar, were performed (Crowe et al. 1980).

Results

Pre- and post-treatment *S. cepivorum* inoculum density means and statistical analyses are shown in Table 2. Percent reduction in sclerotia populations calculated from pre- and post application means is shown in Figure 1. For each trial, dehydrated garlic powder applications up to 74 g/m^3 provided less than 95 percent reduction in sclerotial populations. Applications of 110 g/m^3 or more reduced populations by more than 95 percent. For 74 g/m^3, the percent reduction ranged from 92-95 percent. As expected, percent reduction in sclerotial population was greater than 95 percent following both MeBr and DADS applications.

Table 2. Effect of food-grade dehydrated garlic powder on inoculum density of *Sclerotium cepivorum* in field trials near Walla Walla, WA (1991- 1992), Bakersfield and Hollister, CA (1998), and Madras, OR (1999).

Walla Walla	viable sclerotia/L soil	
Product	Pre treatment	Post treatment
Untreated	9.7	8.0 A'
DGP[b] 18.5 g/m[3]	5.7	1.3 B
DGP 184 g/m[3]	6.0	0 B
P-value	0.1926	0.0207
Treatment	0.3180	0.0091
Block	0.1169	0.4219

Bakersfield	Pre treatment	Post treatment
Untreated	76.0	80.2 A
DGP 37 g/m[3]	79.3	23.0 C
DGP 74 g/m'	94.0	5.6 CD
DGP 148 g/m[3]	69.7	2.7 CD
DADS[d] (5 ml/m[2])	70.9	1.3 D
Methyl bromide (22 g/m[2])	71.7	1.9 D
P-value	0.6744	0.0001
Treatment	0.7422	0.0001
Block	0.3979	0.6517

Hollister	Pre treatment	Post treatment
Untreated	55.4	40.7 A
DGP 37 g/m[3]	59.3	21.2 AB
DGP 74 g/m[3]	60.3	2.8 B
DGP 148 g/m'	47.8	1.7 B
P-value	0.9651	0.0286
Treatment	0.8363	0.0092
Block	0.9377	0.4159

Madras	Pre treatment	Post treatment
Untreated	186	178 A
DGP 18.5 g/m[3]	176	118 AB
DGP 37 g/m[3]	149	50.6 BC
DGP 74 g/m[3]	179	15.6 C
DGP 111 g/m[3]	200	6.7 C
DADS (5 ml/m[2])	131	3.1 C
P-value	0.0001	0.0006
Treatment	0.6584	0.0006
Block	0.0001	0.0333

'Means followed by the same letter are not significantly different at P < 0.05 according to Fisher's protected least significant difference (LSD) test.

[b]Dehydrated food-grade garlic powder.

'Probability of obtaining F<005

[d]Diallyl disulfide.

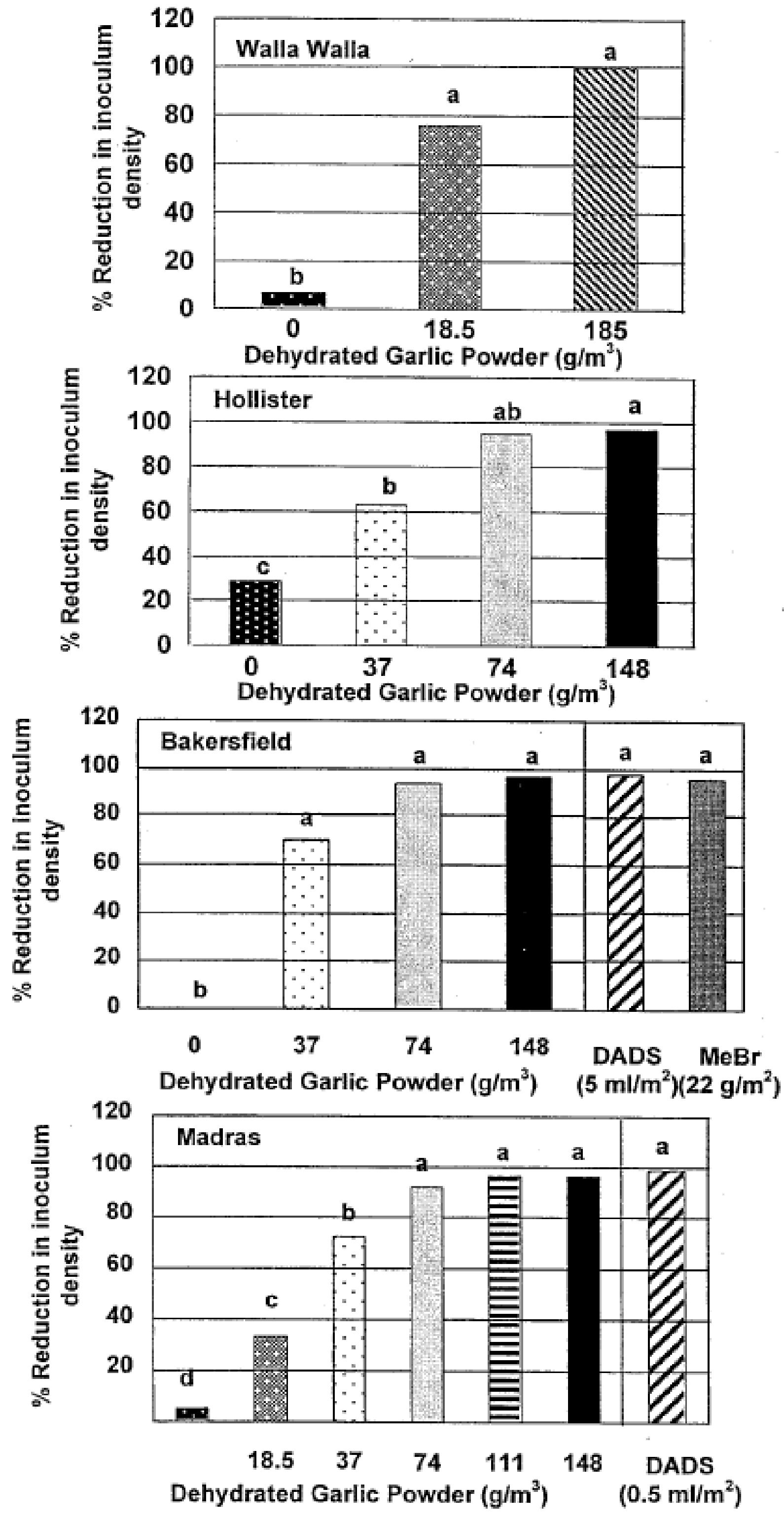

Figure 1. Percent reduction in *Sclerotium cepivorum* soil inoculum density after treatment with dehydrated garlic powder, diallyl disulfide (DADS), or methyl bromide (MeBr) in field trials near Walla Walla, WA (1991- 1992), Bakersfield, CA (1998), Hollister, CA (1998), and Madras, Oregon (1999). Means labeled with the same letter are not significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference (LSD) test.

Discussion

Diallyl disulfide obtained from petroleum sources previously has been shown to induce high levels of germination in *S. cepivorum* (Crowe et al. 1994). Population reductions as high as 97-99 percent can be obtained from rates as low as 0.5 ml/m^2 when soil temperatures and moistures remain within the range conducive to optimal germination for at least 2 months. Similarly high germination levels and population reductions were achieved in field trials reported here by soil application of food-grade commercially dehydrated garlic powder. Our data suggest that rates of 90-100 g/m^3 (equivalent to 250-270 lb/acre applied 12 inches deep, or 125-135 lb/acre applied 6 inches deep) may be the minimum sufficient amount to reliably achieve >95 percent population reduction. Although substantially higher application rates may be more effective in reducing populations, they may not be cost effective. The depth of application of a germination stimulant only needs to be as deep as sclerotia have been tilled. However, because root infections below 30 cm may fail to reach bulbs by season's end (Crowe and Hall 1980b), this may be an effective limit to the required depth of application.

Supplies of garlic powder for these field trials were obtained within 1 month of processing from several commercial companies in California that grow clones of the closely related but poorly described varieties 'California Early' and 'California Late.' While our data suggest little variation in products used, the actual content of germination stimulants was unclear. Garlic variety, product grades, storage and shipping periods and conditions, and manufacturing variables may influence the stimulant content of garlic powder. In a separate project not reported here, a simple quantification test for diallyl disulfide is being developed to provide an assurance level for product lots used for germination stimulation.

Literature Cited

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Appendix A

Environmental Protection Agency:

Exemption of Certain Pesticide Substances From Federal Insecticide, Fungicide, and Rodenticide Act Requirements

Summary:

This rule establishes an exemption from regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for certain pesticides. EPA has determined that these pesticides, under certain conditions, are of a character not necessary to be regulated under FIFRA in order to carry out the purposes of the Act. EPA has concluded that exemption of products covered by this final rule will not pose unreasonable risks to public health or the environment and will, at the same time, relieve producers of the burden associated with regulation. Pesticidal products that do not meet the conditions of this final rule will continue to be regulated under FIFRA.
Effective: May 6, 1996

Table A. Abbreviated list of minimum risk pesticides exempted from FIFRA, 1996.

Castor Oil	Garlic and Garlic Oil	Cedar Oil
Geranium Oil	Cinnamon	Lemongrass Oil
Citric Acid	Linseed Oil	Citronella
Mint and Mint Oil	Cloves	Rotten Egg Solids
Corn Oil	Rosemary	Dried Blood
Sesame		