Evaluation of fumigant ratios and biological products to manage Charcoal Rot caused by *Macrophomina phaseolina*

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Summary

Management of charcoal rot, caused by *Macrophomina phaseolina*, relies on reduction of pathogen inoculum in the field. Previous research has demonstrated that crop residue, in particular strawberry crowns, is the main source of *M. phaseolina* inoculum. In this study, a *Trichoderma*-based biological product reduced crown weight by 22.7% compared to the non-treated control and could accelerate crop residue decomposition. Accelerated decomposition could potentially promote the release of *M. phaseolina* microsclerotia into the soil and allow for more effective fumigation. Moreover, we determined that 1,3-dichloropropene (Telone) alone reduced populations of *M. phaseolina*, which is contrary to the literature that says that Telone has no fungicidal activity. However, the combination of 1,3-dichloropropene and chloropicrin (Pic) at different ratios worked best in reducing pathogen populations, confirming the synergistic effect between these products.

Methods

Performance of a biological product on the degradation of strawberry residue to reduce inoculum of *M. phaseolina*

Strawberry crowns infected with *M. phaseolina* were weighed and placed inside disposable cups containing pasteurized field soil (Fig. 1). Entire crowns were placed on the surface or buried at 1- or 2-in depths in the soil. *Trichoderma koningiopsis*, the main component of a biological product, was sprayed over the crowns at 0.3, 0.4, 0.5, and 0.6 lbs/acre. Non-treated control was not sprayed with the product. Containers were incubated in growth chambers at 82°F (28°C) and, after 30 days, crowns were recovered, air-dried at room temperature and weighed to verify a possible reduction in mass that would indicate degradation. Afterwards, each crown was processed, plated on semi-selective media and incubated at 86°F (30°C) for 7 days in the dark. The survival of *M. phaseolina* inoculum was evaluated by counting the number of colonies.

Figure 1. Strawberry crowns infected with *M. phaseolina* placed inside disposable cups containing pasteurized field soil and incubated in growth chambers at 82°F (28°C) after product application (Credits: T. Tomasini).

Effect of 1,3-dichloropropene (Telone) and chloropicrin (Pic) rates and different ratios of both products for the reduction of *M. phaseolina* populations

Rates of 1,3-dichloropropene (Telone) and chloropicrin (Pic) alone and different ratios of both

products (1,3-D:Pic) were evaluated for the reduction of *M. phaseolina* inoculum. *M. phaseolina* inoculum was prepared in the laboratory, bagged in double layers of nylon, placed on pasteurized field soil inside mason jars, and treated with different doses of the fumigants alone or in combination (Fig. 2). Strawberry crowns infected with the pathogen were also used. Non-treated control did not receive any of the fumigants. Inoculum was retrieved 4 days after fumigant applications, processed and analyzed as described above.

Figure 2. *M. phaseolina* inoculum placed on field soil inside mason jars and treated with different rates of 1,3-dichloropropene (Telone), chloropicrin (Pic) and their combination to simulate field applications.

Results

Performance of a biological product on the degradation of strawberry residue to reduce inoculum of *M. phaseolina*

The lower dose of the biological product (*Trichoderma koningiopsis*) (0.3 lbs/acre) was the best in reducing crown weight (22.7%), compared to 10% in the non-treated control, regardless of the depth of crown burial (Fig. 3). The only other dose that differed from the non-treated control was 0.5 lbs/acre, which reduced crown weight by 16%. Doses 0.4 and 0.6 lbs/acre reduced weight by 15 and 14.5%, respectively, but did not differ from the non-treated control (Figure 3). The product was shown to be effective in degrading strawberry residue, which could promote the release of *M. phaseolina* microsclerotia in the soil, facilitating later fumigant action. However, none of the doses tested was able to reduce *M. phaseolina* populations in infected strawberry crowns for any of the burial depths.

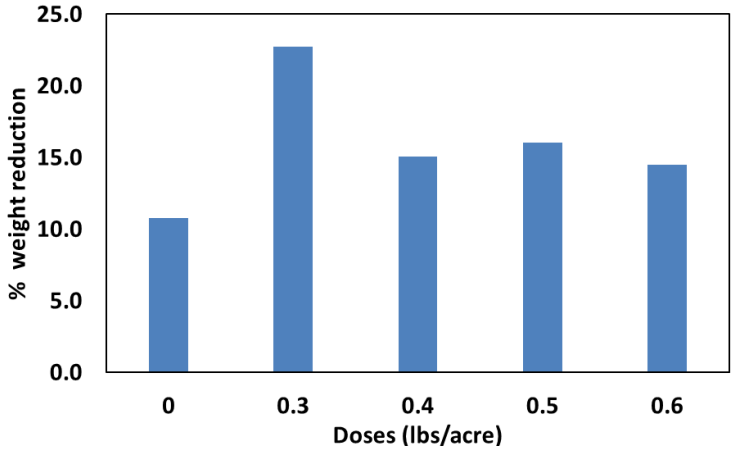

Figure 3. Reduction of weight (%) of strawberry crowns infected with *M. phaseolina* 30 days after application of a biological product (*Trichoderma koningiopsis*) at different doses.

Effect of 1,3-dichloropropene (Telone) and chloropicrin (Pic) rates and different ratios of both products for the reduction of *M. phaseolina* populations

In this laboratory test, we confirmed that 1,3-dichloropropene (1,3-D) alone reduced populations of *M. phaseolina* (Table 1 and Figure 4). As the rate of 1,3-dichloropropene (Telone) increased, the recovery of *M. phaseolina* populations declined, showing that this product also plays a role as a fungicide, which is contrary to the literature that states that Telone has no fungicidal effect. Different rates of chloropicrin were also effective, but 1,3-dichloropropene and chloropicrin combined at different ratios worked best in reducing the pathogen populations, confirming the synergestic effect between these products.

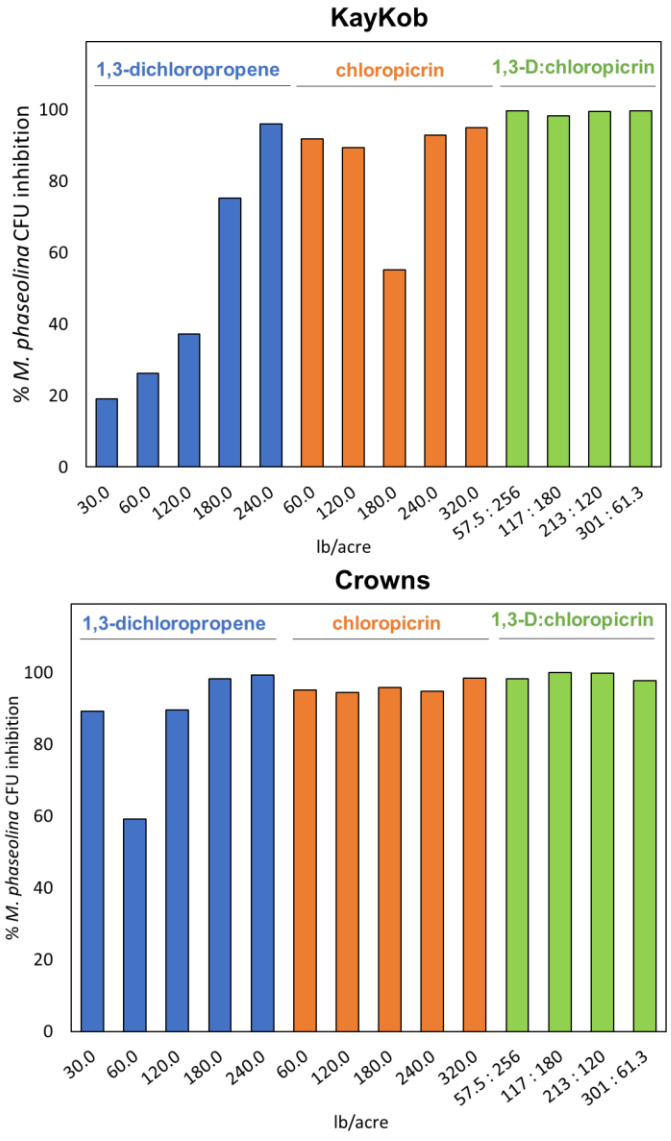

Figure 4. Reduction of *M. phaseolina* population (%) in **KayKob** inoculum and infected strawberry **crowns** treated with different doses (lbs/acre) of 1,3-dichloropropene (Telone) and chloropicrin (Pic) alone and different ratios of both products (1,3-D:chloropicrin) in relation to the non-treated control.

Summary and Recommendations

Strawberry fields with a history of charcoal rot should be destroyed as soon as possible after the end of the season. The Macrophomina inoculum will remain viable and build up during the summer, thus crop removal or any practice that accelerates crop decomposition is recommended. Pre-plant fumigation with combinations of 1,3-dichloropropene and chloropicrin (Pic) such as Telone C35 and PicClor 80 as well as metam products applied at recommended rates and field conditions have shown to be effective in reducing inoculum and disease. Re-using plastic for a second year is not recommended in fields with a history of charcoal rot.

Disclaimer

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Table 1. Efficacy of 1,3-dichloropropene (Telone) and chloropicrin (Pic) alone and different ratios of both products (1,3-D:Pic) applied in jars containing field soil on artificial (KayKob) and natural (crowns) inoculum of *M. phaseolina*

Treatments	Rate (lbs/acre)		*M. phaseolina*			
	1,3-D	chloropicrin	KayKob (CFU/bag)		Crowns (CFU/g)	
1,3-dichloropropene (Telone)	30.0	-	803.0	a	331.9	bc
1,3-dichloropropene (Telone)	60.0	-	731.0	ab	1261.2	ab
1,3-dichloropropene (Telone)	120.0	-	621.5	ab	323.7	bcd
1,3-dichloropropene (Telone)	180.0	-	245.5	cd	56.5	defg
1,3-dichloropropene (Telone)	240.0	-	39.3	fg	22.5	fgh
chloropicrin (Pic)	-	60.0	81.3	ef	149.2	bcde
chloropicrin (Pic)	-	120.0	105.5	de	170.5	bcde
chloropicrin (Pic)	-	180.0	445.0	bc	130.4	cde
chloropicrin (Pic)	-	240.0	71.3	ef	164.2	cde
chloropicrin (Pic)	-	320.0	50.5	ef	47.5	efg
1,3-D 20% - Pic 80%	**57.5**	**256.0**	**3.3**	**h**	**54.2**	**cdef**
1,3-D 40% - Pic 60%	**117**	**180.0**	**16.5**	**gh**	**0.0**	**h**
1,3-D 60% - Pic 40%	**213**	**120.0**	**5.8**	**h**	**8.8**	**gh**
1,3-D 80% - Pic 20%	**301**	**61.3**	**2.8**	**h**	**68.8**	**defg**
Non-treated control	-	-	991.5	a	3091.5	a
Probability of a greater F value			<0.0001		<0.0001	

*Treatments followed by the same letter within a column are not significantly different according to the Fisher's Protected LSD test ($p \leq 0.05$) on squareroot-transformed data. Non-transformed means are presented.